1997 DISK/TREND® REPORT

REMOVABLE DATA STORAGE

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FOREWORD

The removable data storage products included in this report are covered in six individual product groups. Despite the fact the products are derived from a diverse mixture of rigid disk drive, flexible disk drive, optical disk drive and semiconductor technologies, there are numerous examples of overlapping market coverage, accompanied by intense competition for newer applications which require removable data storage.

This report includes both material being published for the first time and material which appeared earlier in the 1997 DISK/TREND Reports on rigid disk drives and optical disk drives, such as the product groups on PC Card rigid disk drives, rigid disk cartridge drives and small optical disk drives. The reason for combining such a product mixture into a single market study is the active competition between product groups for individual markets, despite the usage in many cases of completely disparate product technologies.

Because DISK/TREND has been active in the data storage industry for more than two decades, it has established extensive files on the industry and a data base management system which was essential in organizing and presenting the data for this report on removable data storage. Annual reports on rigid disk drives have been published since 1977, with reports on optical disk drives added in 1986 and on disk drive arrays in 1993.

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

James N. Porter

Robert H. Katzive

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INTRODUCTION

Removability is the common denominator. Each of the product groups included in this report is distinctly different from the others, varying in technology, form factor, performance, price or storage capacity -- but all share the common trait of removability. Because all of the products are removable, several areas of intense competition have emerged, as manufacturers of various types of removable data storage products identify the same target markets.

You will find differences in the way data is organized in each product group, due to the need to address the individual product technologies, markets and applications of each of the six product groups in this report. There are 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 flash cards and floppy drives.

All DISK/TREND data on removable data storage combined. This report includes data published for the first time, plus some information included in other DISK/TREND Reports released earlier this year. The only place in which DISK/TREND data on low capacity flexible disk drives, high capacity flexible disk drives and flash cards is published is in this report on removable data storage. The product section on rigid disk cartridge drives is the same as the equivalent section from the DISK/TREND Report on rigid disk drives. The section on PC Card rigid disk drives has been extracted from the broader data base used in the report on rigid disk drives. In a similar way, the product section on small optical disk drives has been extracted from the DISK/TREND Report on optical disk drives, with the same data, but organized into tables unique to this report.

Please note how sales prices are reported. If the DISK/TREND Report is new to you, please note the definitions used for the relative price differences in each market channel. 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/Distributor 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 generated total sales revenues of $3 billion in 1996. With one exception, each of the six product groups is expected to maintain growth in unit shipments through 2000, but relentless downward pressure on average unit prices will produce a forecasted decline in sales revenues for three product groups. The overall sales revenue total for all six product groups in 2000 is projected at $4.4 billion, representing an average annual increase of 10.2% for the 1997-2000 period.

Some of the product groups covered by the report are competing in the same market segments, despite utilization of different technologies or recording materials. The most competitive contests have developed between the manufacturers of rigid disk cartridge drives, high capacity flexible disk drives and small optical disk drives, as they individually develop the growing markets for graphics and printing production, multimedia content preparation, backup of personal computer hard disks, downloading of Internet files, and a variety of other applications. The combined unit shipments for these three product groups grew to 6.2 million drives in 1996, and 33.9 million drives are forecasted for 2000.

For the most part, the other three product groups compete against other alternatives, with different application patterns dictated by distinctive combinations of product features and price levels. Low capacity flexible disk drives typically offer only 1.44 megabytes per drive, but today's extremely low OEM prices keep the 3.5" floppy drive a continuing part of the personal computer. PC Card rigid disk drives provide a unique combination of data storage capacity and performance in a standardized small package, but prices which are relatively high compared to small fixed disk drives have restricted usage to specialized applications. Shipments of flash cards are growing in numerous specialized and mobile applications, notably in the rapidly growing digital camera market. Flash cards offer capacities generally below those offered by most disk drives except low capacity floppies, but flash price per megabyte levels are significantly higher than those of most disk drives, preventing major penetration of markets requiring higher capacities.

TABLE 1

CONSOLIDATED WORLDWIDE REVENUES

REMOVABLE DATA STORAGE

REVENUE SUMMARY

	REMOVABLE DATA STORAGE REVENUES, BY SHIPMENT DESTINATION ($M)									
	1996 Revenues		Forecast 1997		1998		1999		2000	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
PCM/Distributor	378.1	539.8	418.0	637.1	544.8	818.4	646.2	959.4	682.9	1,009.1
OEM/Integrator	77.2	142.3	217.9	339.1	309.9	491.3	387.2	600.4	431.2	657.7
TOTAL U.S. NONCAPTIVE	455.3	682.1	635.9	976.2	854.7	1,309.7	1,033.4	1,559.8	1,114.1	1,666.8
TOTAL U.S. REVENUES	455.3	682.1	635.9	976.2	854.7	1,309.7	1,033.4	1,559.8	1,114.1	1,666.8
Non-U.S. Manufacturers										
Captive	--	157.6	22.5	176.4	25.2	177.9	26.8	173.4	27.6	168.6
PCM/Distributor	280.7	901.1	317.5	1,032.9	336.6	1,121.3	364.4	1,160.0	365.6	1,124.5
OEM/Integrator	417.0	1,275.9	563.7	1,369.7	606.2	1,434.6	649.4	1,474.7	650.0	1,426.1
TOTAL NON-U.S. REVENUES	697.7	2,334.6	903.7	2,579.0	968.0	2,733.8	1,040.6	2,808.1	1,043.2	2,719.2
Worldwide Recap										
TOTAL WORLDWIDE REVENUES	1,153.0	3,016.7	1,539.6	3,555.2	1,822.7	4,043.5	2,074.0	4,367.9	2,157.3	4,386.0

Marketing channels

The DISK/TREND Report uses product prices which represent the estimated selling price when each product is sold for the first time to a nonaffiliated buyer, at captive end user, PCM/Distributor or OEM/Integrator levels. 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.

Despite the fact that significant changes are occurring in the sales patterns for individual product groups, the shares for each marketing channel employed by removable data storage products during the five year span covered by this report are expected to be relatively stable, with noncaptive channels remaining dominant. The PCM/Distributor channel held 47.8% of 1996's total sales revenues, and is expected to retain 48.6% of the 2000 total. OEM/Integrator sales revenues were 47.0% of the overall total for 1996, with 2000 projected at 47.6%. Captive revenues are expected to be only 3.8% of the 2000 total for all revenues. It should be noted, however, that some of the individual product groups have marketing channel patterns which differ significantly from the overall averages.

The high capacity floppy drive product group is undergoing a major shift in market channel dominance, as PCM/Distribution shipments to the personal computer aftermarket lose leadership to the growing OEM market with personal computer manufacturers. In 1996, 12.3% of high capacity floppy drive shipments were sold through the OEM/Integrator sales channel, but in 1997 that channel will account for 48.1% of unit shipments, growing to a projected 59.9% in 2000. OEM/Integrator shipments have historically provided leadership in the low capacity flexible disk drive product group, and are expected to retain 62.4% of the 2000 total. The OEM market also leads in shipments of PC Card rigid disk drives, with 61.4% of 1996 unit shipments, with modest growth to 70.6% in 2000, buoyed by producers of systems for specialized applications. OEM shipments increased to 72.4% of the flash card total in 1996, and are expected to remain at about the same level in 2000.

PCM/Distributor shipments of rigid disk cartridge drives were 94.4% of the group's 1996 total and are expected to hold 82% of the 2000 total, down modestly in share due to sales growth with specialized OEMs. Small optical disk drives are currently sold predominantly through PCM/Distributor channels, and the 2000 total for that channel is forecasted to increase slightly, to 78.2%.

TABLE 2

CONSOLIDATED WORLDWIDE REVENUES
REMOVABLE DATA STORAGE
MARKET CLASS REVIEW

REVENUE SUMMARY

WORLDWIDE REVENUES	1996		Forecast							
BY MANUFACTURER TYPE	Revenues		1997		1998		1999		2000	
	$M	%	$M	%	$M	%	$M	%	$M	%
U.S. Manufacturers										
PCM/Distributor	539.8	17.8%	637.1	17.9%	818.4	20.2%	959.4	21.9%	1,009.1	23.0%
	+70.7%		+18.0%		+28.5%		+17.2%		+5.2%	
OEM/Integrator	142.3	4.7%	339.1	9.5%	491.3	12.1%	600.4	13.7%	657.7	14.9%
	-7.7%		+138.3%		+44.9%		+22.2%		+9.5%	
Total U.S. Manufacturers	682.1	22.5%	976.2	27.4%	1,309.7	32.3%	1,559.8	35.6%	1,666.8	37.9%
	+31.6%		+43.1%		+34.2%		+19.1%		+6.9%	
Non-U.S. Manufacturers										
Captive	157.6	5.2%	176.4	4.9%	177.9	4.3%	173.4	3.9%	168.6	3.8%
	-3.7%		+11.9%		+.9%		-2.5%		-2.8%	
PCM/Distributor	901.1	29.8%	1,032.9	29.0%	1,121.3	27.7%	1,160.0	26.5%	1,124.5	25.6%
	+40.7%		+14.6%		+8.6%		+3.5%		-3.1%	
OEM/Integrator	1,275.9	42.5%	1,369.7	38.7%	1,434.6	35.7%	1,474.7	34.0%	1,426.1	32.7%
	-9.9%		+7.4%		+4.7%		+2.8%		-3.3%	
Total Non-U.S. Manufacturers	2,334.6	77.5%	2,579.0	72.6%	2,733.8	67.7%	2,808.1	64.4%	2,719.2	62.1%
	+5.1%		+10.5%		+6.0%		+2.7%		-3.2%	
Worldwide Recap										
Captive	157.6	5.2%	176.4	5.0%	177.9	4.4%	173.4	4.0%	168.6	3.8%
	-25.5%		+11.9%		+.9%		-2.5%		-2.8%	
PCM/Distributor	1,440.9	47.8%	1,670.0	47.0%	1,939.7	48.0%	2,119.4	48.5%	2,133.6	48.6%
	+50.6%		+15.9%		+16.1%		+9.3%		+.7%	
OEM/Integrator	1,418.2	47.0%	1,708.8	48.0%	1,925.9	47.6%	2,075.1	47.5%	2,083.8	47.6%
	-9.7%		+20.5%		+12.7%		+7.7%		+.4%	
Total All Manufacturers	3,016.7	100.0%	3,555.2	100.0%	4,043.5	100.0%	4,367.9	100.0%	4,386.0	100.0%
	+10.2%		+17.9%		+13.7%		+8.0%		+.4%	

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

Product groups

1996 was the first year of major growth for high capacity flexible disk drives, with strong continuing growth expected in future years. High capacity floppy drives are projected to provide most of the growth for floppy drives through 2000, despite some industry confusion over competition between noncompatible standards. The Iomega Zip drive initiated the current wave of activity in 1995, followed by the LS-120 in late 1996, with drives currently from Matsushita-Kotobuki Electronics, Mitsubishi Electric, Imation (with contract manufactured drives), and O.R. Technology (with drives produced under contract by Kaifa). An agreement between Swan Instruments and Mitsumi Electric is expected to result in a third type of high capacity floppy drive, the UHC, by the end of 1997. Shipments of 3.9 million drives in 1996 are expected to increase to 8.9 million in 1997, and reach 26.6 million in 2000. Sales revenues will also achieve high growth, but are expected to top out at $910.6 million in 1999, with a slight decline in 2000, as average unit prices continue to drop.

Low capacity flexible disk drives provide the highest shipments and the highest sales revenues among the six product groups included in this report, but the end is in sight for future growth in unit shipments. By 2000, annual shipment growth is projected to drop to only 0.3%, with 101,350 drives. It is expected that standard 1.44 megabyte 3.5" floppy drives will still be shipped with the majority of desktop personal computers, but there will be significant displacement by high capacity floppy drives in the desktop PC market, and the problem for low capacity drives will be intensified by the increasing tendency of notebook computer manufacturers to leave floppy drives out of some models.

The emergence of the digital camera market has provided a major surge in flash card shipments, especially for the cards smaller than the PC Card form factor. Prior to 1996, most of the flash cards shipped were in the PC Card format and used for a diverse set of applications, ranging from mobile computers to industrial equipment. With the advent of smaller card formats and the developing market opportunities provided by newly emerging applications, such as digital cameras and portable telecommunication equipment, shipments in 2000 are expected to exceed 15 million flash cards, an average annual increase during the 1997-2000 period of 88.3%. Although shipment increases are expected for higher capacity flash cards, cards with capacities less than 10 megabytes held

80% of 1996 shipments and are projected to grow to 86.5% of the 2000 total, due to the nature of the requirements of the booming digital camera market. In 2000, 63.5% of all flash cards shipped are expected to be in formats smaller than PC Cards.

The changing product mix in the rigid disk cartridge drive product group has also resulted in a pattern of strong growth, with 1996 shipments topping the million drive level for the first time. Pioneered by the Iomega Jaz 3.5" one gigabyte drive, the traditional "prepress" and graphics applications for rigid disk cartridge drives have been supplemented by multimedia and video applications, plus a diverse range of other emerging markets. SyQuest's 1.5 gigabyte drive has renewed a competitive contest for products of this type, and disk capacities are expected to follow the disk drive industry's upward trend. The product group's 2000 unit shipments are projected at 5.5 million drives, producing sales revenues of $879.2 million.

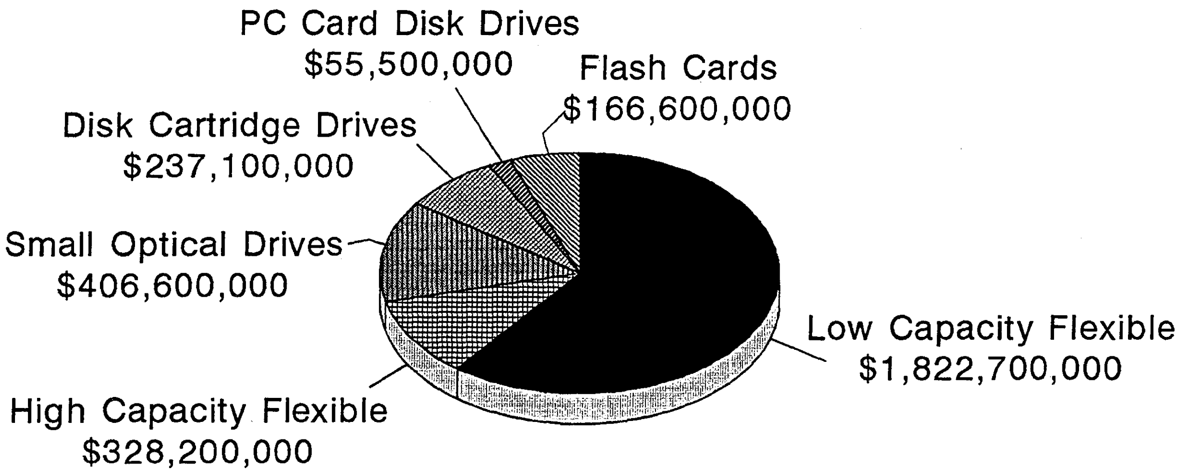
Forecasts for PC Card rigid disk drives have been lowered again, with current shipments still predominantly driven by relatively small specialized markets. The remaining manufacturers of PC Card drives continue to try to develop applications with broader markets, but the applications envisioned for PC Card rigid disk drives with lightweight subnotebook computers, handheld computers, personal communicators, automotive mapping systems and high-end digital cameras have been slow to develop. The existing applications and gradual development of new markets is expected to increase shipments from 1996's 232,300 drives to 765,000 in 2000, with sales revenues of $175.3 million.

Competition from several of the other removable storage products included in this report are expected to provide difficult competition for small optical disk drives, with the most severe impact from magnetic rigid disk cartridge drives and high capacity floppy drives. Small optical disk drives have enjoyed widest usage in Japan's domestic market, but the increasing use of networks will probably shrink the size of that market, as networks reduce the need for a cartridge interchange medium. The expected availability of higher capacity drives and continually falling unit prices will keep the market for small optical disk drives alive, but unit shipments are expected to peak in 1999 at 2 million drives, dropping to 1.8 million in 2000. Sales revenues are also forecasted to peak in 1999, at $554.1 million, with the total for 2000 down to $469.4 million.

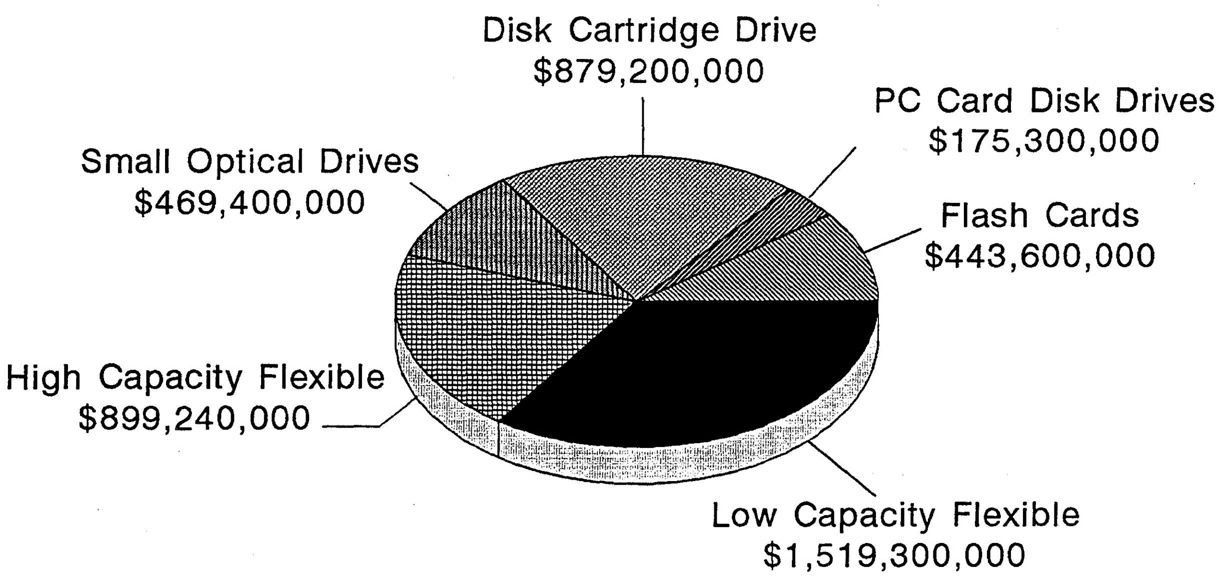
Figure 1

CHANGING PRODUCT MIX

Worldwide Removable Data Storage Revenue



1996



2000

TABLE 3

CONSOLIDATED WORLDWIDE REVENUES
REMOVABLE DATA STORAGE
PRODUCT GROUP REVIEW

REVENUE SUMMARY

WORLDWIDE REVENUES	1996		Forecast							
ALL MANUFACTURERS	Revenues		1997		1998		1999		2000	
	$M	%	$M	%	$M	%	$M	%	$M	%
FLASH CARDS	166.6	5.4%	244.5	6.9%	318.0	7.9%	385.7	8.8%	443.6	10.1%
	+15.4%		+49.4%		+30.1%		+21.3%		+15.0%	
PC CARD RIGID DISK DRIVES	55.5	1.8%	89.4	2.5%	121.4	3.0%	146.0	3.3%	175.3	4.0%
	-33.5%		+61.1%		+35.8%		+20.3%		+20.1%	
RIGID DISK CARTRIDGE DRIVES	237.1	7.9%	350.4	9.9%	533.6	13.2%	742.2	17.0%	879.2	20.0%
	+53.2%		+47.8%		+52.3%		+39.1%		+18.5%	
SMALL OPTICAL DISK DRIVES	406.6	13.5%	508.5	14.3%	545.0	13.5%	554.1	12.7%	469.4	10.7%
	+60.4%		+25.1%		+7.2%		+1.7%		-15.3%	
HIGH CAPACITY FLEXIBLE	328.2	10.9%	597.7	16.8%	794.9	19.7%	910.6	20.8%	899.2	20.5%
DISK DRIVES	+168.1%		+82.1%		+33.0%		+14.6%		-1.3%	
LOW CAPACITY FLEXIBLE	1,822.7	60.5%	1,764.7	49.6%	1,730.6	42.7%	1,629.3	37.4%	1,519.3	34.7%
DISK DRIVES	-8.1%		-3.2%		-1.9%		-5.9%		-6.8%	
Total Worldwide Revenue	3,016.7	100.0%	3,555.2	100.0%	4,043.5	100.0%	4,367.9	100.0%	4,386.0	100.0%
	+10.2%		+17.9%		+13.7%		+8.0%		+.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

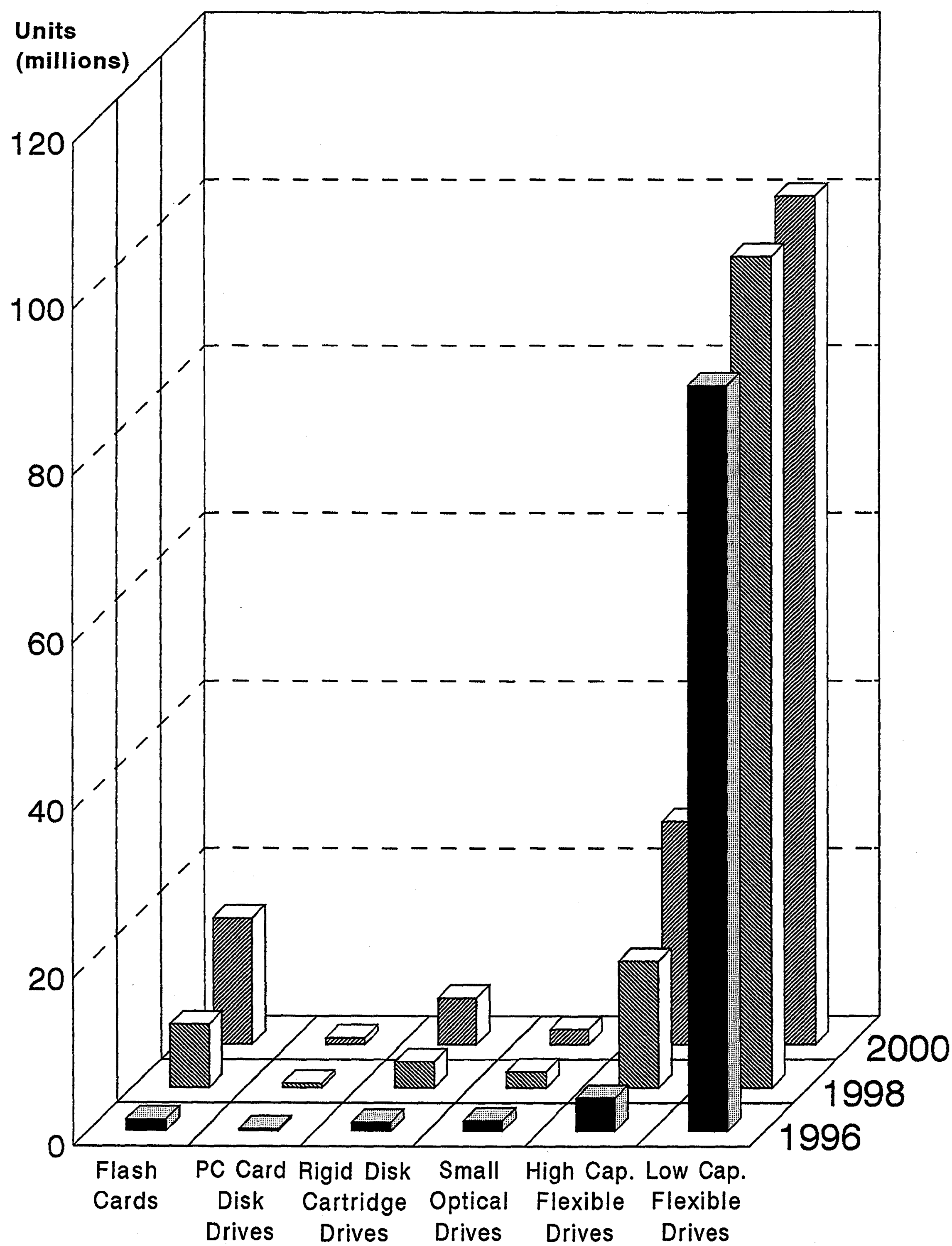


TABLE 4

CONSOLIDATED WORLDWIDE SHIPMENTS
REMOVABLE DATA STORAGE
PRODUCT GROUP REVIEW

UNIT SHIPMENT SUMMARY

UNIT SHIPMENTS IN THOUSANDS	1996 Shipments Units	1996 %	1997 Units (Forecast)	1997 %	1998 Units (Forecast)	1998 %	1999 Units (Forecast)	1999 %	2000 Units (Forecast)	2000 %
FLASH CARDS	1,377.5	1.4%	3,553.1	3.2%	7,551.2	5.9%	11,114.9	7.9%	15,046.4	10.0%
	+60.3%		+157.9%		+112.5%		+47.2%		+35.4%	
PC CARD RIGID DISK DRIVES	232.3	.2%	355.0	.3%	510.0	.4%	625.0	.4%	765.0	.5%
	-31.7%		+52.8%		+43.7%		+22.5%		+22.4%	
RIGID DISK CARTRIDGE DRIVES	1,044.0	1.1%	1,915.0	1.7%	3,125.0	2.5%	4,510.0	3.2%	5,540.0	3.7%
	+72.2%		+83.4%		+63.2%		+44.3%		+22.8%	
SMALL OPTICAL DISK DRIVES	1,215.3	1.3%	1,624.2	1.5%	1,929.0	1.5%	2,037.0	1.4%	1,804.0	1.2%
	+134.4%		+33.6%		+18.8%		+5.6%		-11.4%	
HIGH CAPACITY FLEXIBLE DISK DRIVES	3,938.5	4.1%	8,885.8	8.0%	15,110.0	11.8%	21,285.0	15.1%	26,610.0	17.6%
	+375.8%		+125.6%		+70.0%		+40.9%		+25.0%	
LOW CAPACITY FLEXIBLE DISK DRIVES	89,006.1	91.9%	95,333.0	85.3%	99,301.0	77.9%	101,050.0	72.0%	101,350.0	67.0%
	+8.2%		+7.1%		+4.2%		+1.8%		+.3%	
Total Worldwide Shipments	96,813.7	100.0%	111,666.1	100.0%	127,526.2	100.0%	140,621.9	100.0%	151,115.4	100.0%
	+13.4%		+15.3%		+14.2%		+10.3%		+7.5%	
% U.S. Manufacturers	5.7%		10.1%		14.1%		16.9%		18.7%	

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

Noncaptive market

Since computer system manufacturers are involved in manufacturing products in only a few of the product groups included in this report, captive sales, in which products are sold by the original manufacturers with their own systems, represent a very small portion of the sales revenues and unit shipment totals. Worldwide captive sales revenues for 1996 were $157.6 million, only 5.2% of the total, and captive sales revenue for all removable data storage products in 2000 is projected at only 3.8% of the overall total.

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

Noncaptive sales constitute all of the current flash card shipments, and the total is forecasted to remain noncaptive through 2000. OEM/Integrator shipments are clearly in the lead, with 72.4% of the 1996 worldwide total. OEM shipments are expected to maintain approximately the same share in 2000. PCM/Distributor channels for flash cards have moved the balance of the shipments, for the more widely used applications such as handheld computers, personal communicators, and the emerging digital camera market. The future noncaptive/captive channel split will be affected by the manner in which the digital camera market develops during the next few years. If any one of the new small card formats becomes predominant, it is likely that standardization of the market will encourage the more rapid development of flash card shipments through distribution and retail dealers to a wide end-user market.

The OEM/Integrator lead in PC Card rigid disk drive shipments has been driven by a reliance on manufacturers of specialized systems, who make the buying decisions for removable storage products. As a result, the OEM channel is expected to remain the major market for PC Card drives, with 70.6% of 2000 unit shipments, based on the assumption that the outlook for PDAs, subnotebook computers and personal communicators is not expected to be significantly greater during the rest of the decade.

SyQuest Technology was the unit shipment leader in rigid disk cartridge drives for a decade, selling its drives primarily in the PCM/Distributor channel, through a variety of storage subsystem vendors who combine drives with enclosures, cables and software appropriate for specific target system markets. SyQuest's shipment lead for the product group has been eclipsed by Iomega's Jaz 3.5" drive, but that product has also found most of its success with aftermarket add-on sales through distribution channels. With the substantial increase in shipments forecasted for this product group, it is expected that the market share for OEM shipments will grow, as a variety of specialized system manufacturers add rigid disk cartridge drives as standard system features. However, stronger aftermarket sales are expected to keep PCM/Distributor shipments in the lead, declining modestly from 1996's 94.4% of the worldwide total to 82% in 2000.

The aftermarket add-on market has provided the predominant market for small optical disk drives. These drives tend to follow a sales pattern similar to that of the rigid disk cartridge drives, in that system manufacturers frequently regard them as nonstandard products, priced at a level above the drives they consider to be industry standard. Sales resistance by system manufacturers confines most of the market opportunity to the aftermarket, predominantly in applications for which removable disks provide a functional advantage. 70.9% of the product group's 1996 shipments were through the PCM/Distributor channel, with the 2000 total projected to increase to 78.2% of the worldwide total.

The predominant marketing channel for low capacity floppy drives continues to be the OEM/Integrator channel, with sales by drive manufacturers directly to manufacturers of personal computers providing the largest market. It is projected that 62.4% of shipments for low capacity floppy drives will be OEM/Integrator in 2000. The marketing channel pattern for high capacity floppy drives will undergo a major change, as the success of new 3.5" high capacity floppy drives in the aftermarket is supplemented with growing OEM sales to personal computer manufacturers. PCM/Distributor shipments accounted for 87.7% of 1996 shipments, but by 2000 growing shipments to personal computer manufacturers will boost the OEM/Integrator share to 59.9%.

TABLE 5

NONCAPTIVE WORLDWIDE REVENUES
REMOVABLE DATA STORAGE
PRODUCT GROUP REVIEW

REVENUE SUMMARY

WORLDWIDE REVENUES ALL MANUFACTURERS	1996 Revenues $M	1996 %	Forecast 1997 $M	1997 %	1998 $M	1998 %	1999 $M	1999 %	2000 $M	2000 %
FLASH CARDS	166.6	5.7%	244.5	7.2%	318.0	8.2%	385.7	9.2%	443.6	10.5%
	+15.4%		+49.4%		+30.1%		+21.3%		+15.0%	
PC CARD RIGID DISK DRIVES	55.5	1.9%	89.4	2.6%	121.4	3.1%	146.0	3.5%	175.3	4.2%
	-33.5%		+61.1%		+35.8%		+20.3%		+20.1%	
RIGID DISK CARTRIDGE DRIVES	237.1	8.4%	350.4	10.5%	533.6	13.9%	742.2	17.8%	879.2	20.9%
	+53.2%		+47.8%		+52.3%		+39.1%		+18.5%	
SMALL OPTICAL DISK DRIVES	390.6	13.6%	486.0	14.3%	518.0	13.4%	524.7	12.5%	437.4	10.4%
	+99.8%		+24.4%		+6.6%		+1.3%		-16.6%	
HIGH CAPACITY FLEXIBLE DISK DRIVES	328.2	11.5%	597.7	17.7%	794.9	20.5%	910.6	21.7%	899.2	21.3%
	+168.1%		+82.1%		+33.0%		+14.6%		-1.3%	
LOW CAPACITY FLEXIBLE DISK DRIVES	1,681.1	58.9%	1,610.8	47.7%	1,579.7	40.9%	1,485.3	35.3%	1,382.7	32.7%
	-8.1%		-4.2%		-1.9%		-6.0%		-6.9%	
Total Worldwide Revenues	2,859.1	100.0%	3,378.8	100.0%	3,865.6	100.0%	4,194.5	100.0%	4,217.4	100.0%
	+13.1%		+18.2%		+14.4%		+8.5%		+.5%	

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

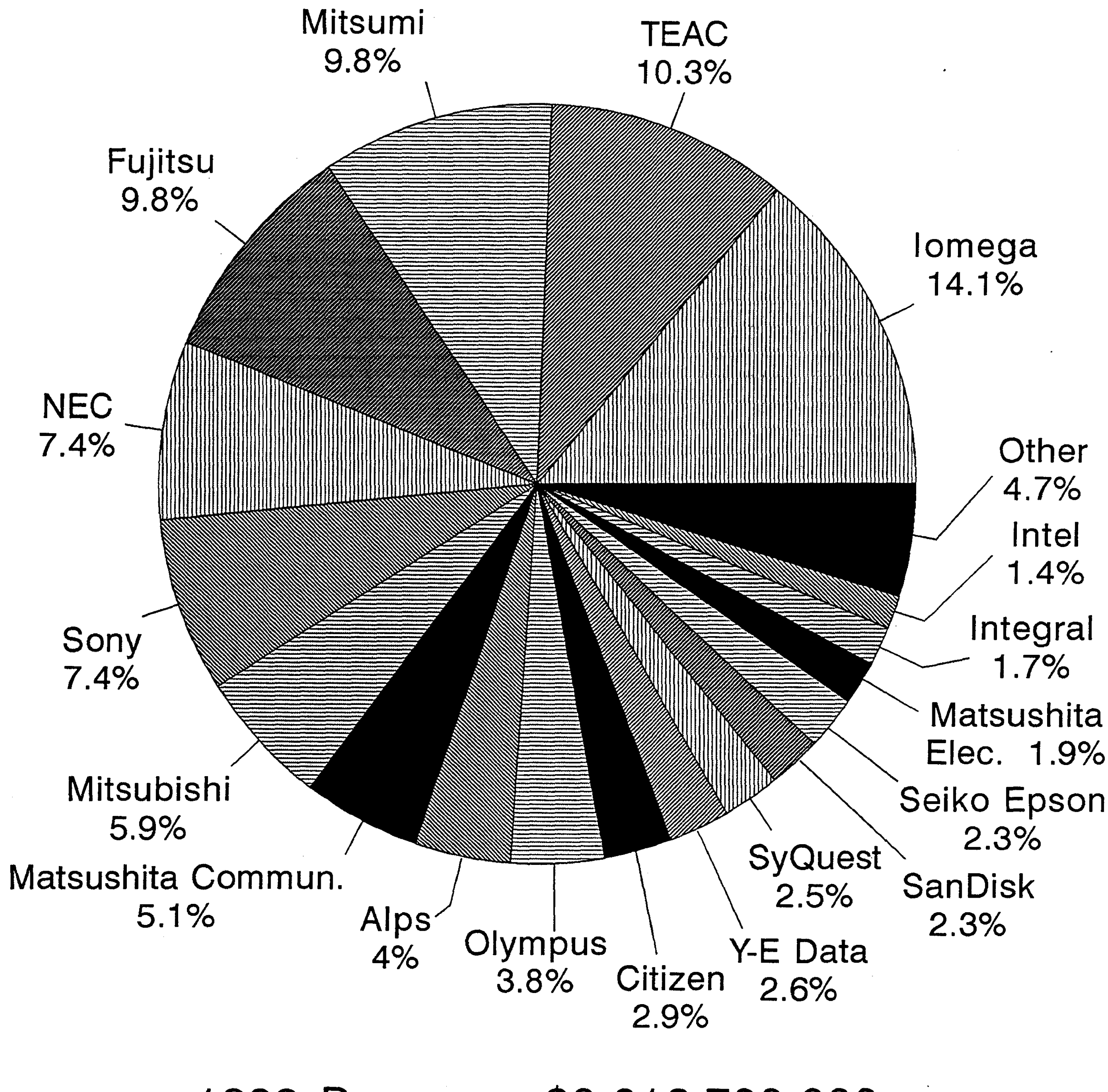
UNIT SHIPMENTS IN THOUSANDS	1996 Shipments		Forecast 1997		Forecast 1998		Forecast 1999		Forecast 2000	
	Units	%	Units	%	Units	%	Units	%	Units	%
FLASH CARDS	1,377.5	1.5%	3,553.1	3.3%	7,551.2	6.1%	11,114.9	8.0%	15,046.4	10.2%
	+60.3%		+157.9%		+112.5%		+47.2%		+35.4%	
PC CARD RIGID DISK DRIVES	232.3	.2%	355.0	.3%	510.0	.4%	625.0	.5%	765.0	.5%
	-31.7%		+52.8%		+43.7%		+22.5%		+22.4%	
RIGID DISK CARTRIDGE DRIVES	1,044.0	1.1%	1,915.0	1.8%	3,125.0	2.5%	4,510.0	3.3%	5,540.0	3.7%
	+72.2%		+83.4%		+63.2%		+44.3%		+22.8%	
SMALL OPTICAL DISK DRIVES	1,183.3	1.2%	1,579.2	1.4%	1,869.0	1.5%	1,967.0	1.5%	1,724.0	1.2%
	+153.7%		+33.5%		+18.4%		+5.2%		-12.4%	
HIGH CAPACITY FLEXIBLE DISK DRIVES	3,938.5	4.2%	8,885.8	8.3%	15,110.0	12.2%	21,285.0	15.6%	26,610.0	18.0%
	+375.8%		+125.6%		+70.0%		+40.9%		+25.0%	
LOW CAPACITY FLEXIBLE DISK DRIVES	87,008.1	91.8%	92,393.0	84.9%	96,191.0	77.3%	97,860.0	71.1%	98,110.0	66.4%
	+7.8%		+6.2%		+4.1%		+1.7%		+.3%	
Total Worldwide Shipments	94,783.7	100.0%	108,681.1	100.0%	124,356.2	100.0%	137,361.9	100.0%	147,795.4	100.0%
	+13.1%		+14.7%		+14.4%		+10.5%		+7.6%	
% U.S. Manufacturers	5.8%		10.4%		14.5%		17.3%		19.1%	

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

Figure 3

1996 ESTIMATED MARKET SHARE

Removable Data Storage Worldwide Revenue



1996 Revenue: $3,016,700,000

TABLE 7

1996 ESTIMATED MARKET SHARES

WORLDWIDE REVENUES OF ALL REMOVABLE DATA STORAGE
(Value of non-U.S. currencies estimated at average 1996 rates)

	CAPTIVE		PCM/DISTRIBUTOR		OEM/INTEGRATOR		TOTAL INDUSTRY	
	$M	%	$M	%	$M	%	$M	%
U.S. MANUFACTURERS								
Integral Peripherals	--	--	18.4	1.3	31.9	2.3	50.3	1.7
Intel	--	--	18.9	1.3	22.6	1.6	41.5	1.4
Iomega	--	--	410.3	28.5	14.6	1.0	424.9	14.1
SanDisk	--	--	15.4	1.1	55.1	3.9	70.5	2.3
SyQuest Technology	--	--	70.4	4.9	4.7	.3	75.1	2.5
Other U.S.	--	--	6.4	.4	13.4	.9	19.8	.7
U.S. Total	--	--	539.8	37.5	142.3	10.0	682.1	22.6
NON-U.S. MANUFACTURERS								
Alps Electric	--	--	42.1	2.9	79.7	5.7	121.8	4.0
Citizen	--	--	--	--	88.8	6.3	88.8	2.9
Fujitsu	16.0	10.2	266.4	18.5	13.8	1.0	296.2	9.8
Matsushita Communication Ind.	--	--	88.3	6.1	65.4	4.7	153.7	5.1
Matsushita Electric Industrial	--	--	--	--	56.2	4.0	56.2	1.9
Mitsubishi Electric	--	--	--	--	177.4	12.7	177.4	5.9
Mitsumi Electric	--	--	198.2	13.8	98.6	7.0	296.8	9.8
NEC	126.9	80.5	37.5	2.6	59.8	4.3	224.2	7.4
Olympus Optical	--	--	43.0	3.0	71.8	5.1	114.8	3.8
Seiko Epson	--	--	24.9	1.7	45.5	3.2	70.4	2.3
Sony	--	--	66.1	4.6	157.5	11.2	223.6	7.4
TEAC	--	--	37.9	2.6	271.6	19.4	309.5	10.3
Y-E Data	--	--	38.3	2.7	41.5	3.0	79.8	2.6
Other Non-U.S.	14.7	9.3	58.4	4.1	48.3	3.4	121.4	4.0
Non-U.S. Total	157.6	100.0	901.1	62.7	1,275.9	91.0	2,334.6	77.4
WORLDWIDE TOTAL	157.6	100.0	1,440.9	100.0	1,418.2	100.0	3,016.7	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:

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

TABLE 8

CURRENT PRODUCT LINES
MANUFACTURERS OF REMOVABLE DATA STORAGE

DISK/TREND PRODUCT GROUP		40/41/42/43	2/3/4	1	22	13	14
U.S. Manufacturers (19)	Type	Flash Cards	PC Card Disk Drives	Rigid Disk Cartridge Drives	Small Optical Disk Drives	High Capacity Flexible Disk Drives	Low Capacity Flexible Disk Drives
ActionTec	O,P	FD,FM					
Advanced Micro Devices	O	FM					
Avatar Peripherals	O,P			2			
Centennial Technologies	O,P	FD,FM					
IBM	C,O,P	FD					
Imation	O,P					3	
Integral Peripherals	O,P		PIII				
Intel	O,P	FM					
Iomega	O,P			3		3	
Kingston Technology	O,P	FD					
Lexar Microsystems	O,P	FD					
MagicRAM	P	FM					
Mountain Optech	O				3		
New Media	O,P	FM					
SanDisk	O,P	FD					
Simple Technology	P	FD,FM					
Smart Modular Technologies	O,P	FD,FM					
Swan Instruments	O,P					3	
SyQuest Technology	O,P			3,5			
Asian Manufacturers (26)							
Alps Electric	O,P						3
Carry Computer	O,P	FD,FM					
Citizen Watch	O,P						3
Fuji Photo Film	O,P	FD,FM					
Fujitsu	C,O,P	FM			3		
Hitachi	O,P	FD			3		
Hyundai Electronics	O,P	FM					
Kingmax Technology	O,P	FD,FM					
Matsushita Communication Ind.	C,O,P					3	3,5
Matsushita Electric Ind.	O,P	FD,FM					
Matsushita-Kotobuki Electron.	O,P					3	
Mitsubishi Electric	O,P	FD,FM				3	3,PII
Mitsumi Electric	O,P					3	3
NEC	C,O						3
Olympus Optical	O,P				3		
O.R. Technology	O,P					3	
Samsung Electro-Mechanics	C,O,P						3,5
Seiko Epson	O,P	FD,FM	PIII				
S.F.R.	O,P						3
Sharp	O,P	FM			2		
Sony	C,O,P				2,3		3
Tae Il Media	O						3,5
TEAC	O						3,5
Toshiba	O,P	FD,FM					
Transcend	O,P	FD,FM					
Y-E Data	O,P						3,5,8
European/Middle East Manufacturers (5)							
Calluna Technology	O,P		PIII				
M-Systems	O,P	FM					
Memory Card Technology	P	FM					
Nomai	O,P			3			
SCM Microsystems	P	FM					

TECHNICAL REVIEW

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

* Flash cards
* PC Card rigid disk drives
* Rigid disk cartridge drives
* Small optical disk drives
* High capacity flexible disk drives
* Low capacity flexible disk drives

Flash card technology

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

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

Notebook computers, subnotebook computers, pen-based computers, and PDAs (Personal Digital Assistants) have created demand for removable mass storage, much of which can be satisfied by flash cards. 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. Some noncomputer applications, such as storage for digital cameras, voice recorders and personal telecommunications devices, are fueling increased demand. While most flash memory cards have previously been used in industrial applications, consumer applications involving small form factor cards are becoming dominant.

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

Three small card form factors are receiving significant industry support: Compact Flash (ATA flash disk), Miniature Card (flash memory), and Solid State Floppy Disk Card (flash memory). A fourth form factor, the MemoryStick, was proposed by Sony in 1997. None of these are interchangeable with each other. Industry associations have been formed to support each proposed standard, and there is not yet a confirmed winner (Compact Flash has the strongest position at present), and it will take a year or two for the market to decide. It is quite possible that differing form factors will predominate in different consumer applications. The small size of these cards makes them ideal for use with digital cameras, phones, and other handheld equipment, but they can also be used with adapters that provide connections to standard PC Card interface connectors, permitting interchange of data between consumer products and computing equipment.

Because flash cards are easily removable, there are security issues attached to their use. A few firms offer encryption for flash memory cards, protecting data and software should a card be lost or stolen.

Some important aspects of flash cards are reviewed below.

* Chip density and card capacity: Because a flash card carries 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, 16 megabit chips and 64 megabit chips in PC Card flash cards, and the 64 megabit chips are becoming mainstream elements. SanDisk and NEC have a joint development program to create a 256 megabit chip, which is intended to achieve an advantageous cost per megabit position relative to other chip densities. In 1994, Intel announced it was developing multiple bit per cell chip designs intended to result in major improvements in chip density. The Intel chips are currently expected to be in production in 1999. SanDisk introduced its 2 bit/cell chip in 1997, doubling its highest chip density to 64 megabits/chip.

* 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. While flash disk cards include a controller chip not needed by linear flash cards (at additional cost), the standardized interface and compatibility between multiple types and generations of equipment and operational simplicity overcome the cost issue in the minds of many OEMs.

  Linear flash memory does not inherently 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 incorporating flash memory, 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. Host based software can provide disk-like functionality with minimum hardware cost, but at the expense of performance and universal interchange.

* 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 cards are also becoming available. Some cards manage power internally, reducing power when the memory is inactive, although this results in short delays upon reactivating the memory card as well as creating compatibility problems in some systems.

* Packaging: The PC Card standards define a set of standard packages of various thickness but with the same width and length. PC Card Type I cards are 3.3 millimeters thick, PC Card Type II cards are 5 millimeters thick, and PC Card Type III cards are 10.5 millimeters thick. All PC Cards are 54 millimeters wide and 85.6 millimeters long. An additional thicker "Type IV" package has been suggested by JEIDA (Japan Electronic Industries Development Association), but has not been approved by PCMCIA. As noted above, sub-PC Card form factors are becoming the preferred form for packaging flash memory on cards for nonindustrial applications.

* Interface: The electrical and mechanical interface for PC Card flash cards has evolved to accommodate a wider 32 bit PCI-like data bus, often called "CardBus". The software interface between the card and the host system has also been standardized, though sufficient ambiguities remain to prevent universal interchange between all cards and all systems. The actual physical interface between card and host is implemented in a socket contained in a "card drive", sometimes called a card reader/writer. Older card drives were configured to operate with PCMCIA Release 1 specifications, which are not compatible with PCMCIA Release 2 specifications. Consequently, the older card readers must be replaced or reconfigured (if possible) to use any PC Card cards other than memory cards.

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

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

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

  Newer computers usually have PC Card support software preinstalled as part of the BIOS or operating system, and any operating system drivers required will be capable of operating with most PC Card flash cards. The major computer and card suppliers have cooperated to eliminate potential incompatibility problems with PC Cards, but the small form factor cards are all mutually incompatible.

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

* Competing technologies: Other semiconductor technologies compete with flash memory. PC Card models using SRAM with a backup battery to provide nonvolatility are sold by many of the same firms that supply flash

cards, but are being displaced by flash technology in applications where fast writes are not required. ROM or EEPROM based cards compete if read-only or write-once characteristics are acceptable. And in the future, ferroelectric memory, which is also inherently nonvolatile and is less restrictive in the number of write/erase cycles allowed, may be a significant competitor, as ferroelectric chips reach 4 megabit densities and above.

PC Card magnetic rigid disk drive technology

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

Rigid disk drives packaged in PC Card format are well suited for providing primary or secondary storage for full function mobile computers, because of the higher capacities available. Computer users who wish to take their full suite of applications on the road with them will find the 85 megabyte to 520 megabyte capacities of drives now in production to be adequate, though not generous. More capacity is needed, especially for multimedia and graphics applications. Some improvement can be obtained indirectly by using data compression, which can expand drive capacity by a factor of two for an average application and user file mix.

* Areal Density: The most significant aspect of rigid disk drive technology is the trend line of areal density (TPI x BPI) increase. The rigid disk drive industry is currently increasing recording density at an average rate of 60% annually, and this rate is expected to be maintained through this decade. It is this inexorable improvement that will keep the cost per megabyte of rigid disk storage well below the cost of flash memory during the remainder of the decade. The highest areal density announced for a 1.8" drive as of mid-1997 was about 786 megabits per square inch (Integral's 510 megabyte drive), while the industry average remained in the 380 megabits per square inch range, a conservative level allowing for rapid improvements.

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

* Packaging: All current rigid disk PC Card drives employ standard Type III PC Card form factors today. A drive in the Type II form factor was announced by Maxtor, but was never shipped before Maxtor withdrew from the PC Card drive market. The major pacing element in establishment of volume production for new PC Card Type II disk drives will be availability of adequate quantities of critical new components, such as motors, disks, head assemblies and semiconductors. The small area available in the card for electronics also dictates increased use of higher density semiconductor elements and innovative packaging techniques. It may also be possible to produce magnetic rigid disk drives which conform to the form factors of the new smaller card standards currently being proposed for flash cards. However, attempts to start new companies to design and manufacture such drives have so far been frustrated by the lack of adequate venture capital investments.

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

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

* Shock resistance: Because they have moving parts, PC Card rigid disk drives are more vulnerable to mechanical disturbances than their all-electronic counterparts. However, considerable insensitivity to the effects of operating shock has been obtained by incorporating piezoelectric shock sensors into the drive and halting writing operations when an excessive shock is detected, eliminating the possibility of off track or adjacent track writing that can cause unrecoverable errors. Dynamic head loading, used by Integral Peripherals, helps reduce nonoperating shock damage because the heads are parked off the disk when the drive isn't operating. When removed from the host system, a card mounted drive is much more

susceptible to shock damage, so nonoperating shock damage elimination is critical for PC Card rigid disk drives.

* Performance: Today's 1.8" drives have average access times in the 18 to 22 millisecond range, substantially inferior to flash memory cards. Startup time is in the 1-2 second range, also slow compared to flash memory. Media data transfer rates are in the 3 to 6 megabytes per second range, with burst rates at 10 megabytes per second. Media data transfer rates will probably increase as linear densities increase.

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

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

Magnetic rigid disk cartridge drive technology

Disk cartridge drives are currently available in 5.25", 3.5", and 2.5" form factors. The SyQuest 1.8" drive actually fit into a PC Card compatible mounting, but cost, technical problems and the drive's 80 megabyte capacity limited industry acceptance, and the product was withdrawn in early 1996.

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

Driven by competition from optical disk drives and high capacity flexible disk drives, and able to draw upon basic improvements in magnetic drive technology, rigid disk cartridge drive technology has improved dramatically in the past few years. 5.25" disk cartridge drives currently are available from SyQuest with capacities up to 200 megabytes, but industry direction has shifted to smaller form factors, with a gigabyte now available on Iomega's 3.5" Jaz drive and 1.5 gigabytes available on SyQuest's SyJet, with capacity upgrades imminent. Avatar is now producing 2.5" drives with 250 megabytes capacity. Higher capacities for the smaller form factors are expected to quickly become available as areal densities increase. 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, video, and desktop publishing, plus secure system data storage, where they compete with PC Card rigid drives, small optical drives, high capacity flexible drives, and, in nongraphics applications, with flash memory as flash capacity increases. Compared to the competition, rigid disk cartridge drives can offer cost advantages, and frequently provide more capacity and convenience of use. The major technology challenge for disk cartridge drives, as always, is to improve reliability, a difficult assignment due to the lack of a completely closed head/disk assembly. Disk cartridge drive reliability is currently regarded as adequate by most users, but it will be necessary to continue to improve, as competition increases from other data storage products.

Small optical disk drive technology

Small form factor optical disk drives offer cartridge removability in the same way as magnetic cartridge disk drives, and compete against both rigid and flexible magnetic cartridge disk drives, largely in the same desktop application niches. However, their larger size and power needs have kept them from playing a significant role in portable system applications. 3.5" optical disk drives in 128, 230 and 640 megabyte capacities are currently on the market, manufactured by a few Japanese companies. Sony introduced a 650 megabyte version in late 1995, but has also announced 640 megabyte media compatible with the industry standard 640 megabyte models. 2.5" drives originally introduced by Sony have been de-emphasized pending redesign to provide higher capacity. 1.8" optical drives have not yet appeared. Although Fujitsu has discussed the possibility of such a future drive, their appearance is unlikely until capacity can be improved.

Optical disk drives and media can demonstrate high areal density exceeding 1 gigabit per square inch for the 640/650 megabyte 3.5" 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 are expected to encourage library use. At present, only two libraries containing 3.5" drives are available, holding up to 35 disks.

The 640/650 megabyte generation of 3.5" optical disk drives improves capacity through the use of improved recording techniques and shorter wavelength lasers. Magnetic rigid cartridge disk drives offer serious competition to optical drives in many situations. SyQuest's 3.5" 230 megabyte removable drives compete with 3.5" 230 and 128 megabyte optical drives in capacity, price and performance, while Iomega's 1 gigabyte Jaz and SyQuest 1.5 gigabyte SyJet drives outdistance 3.5" optical drives in capacity and performance. Even high capacity floppy drives, such as the 100 megabyte Zip drive and the 120 megabyte LS-120 compete where price is of primary importance.

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

2.5" optical disk 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 most recent form, the 2.5" drive offered 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 technological competition and upon improvements in CD-ROM technology and the success of the audio format drive, which may reduce the costs of the computer version and induce manufacturers to invest in improvements.

All 3.5" optical disk drives currently being manufactured use magneto-optic (MO) media, and although 3.5" drives employing phase change media, which uses a different recording technology and is incompatible with MO media, have been considered by some producers, their appearance is considered unlikely given the already large number of available choices for small removable disk storage. Recently introduced drives using MO media can directly overwrite previously recorded data. On older drives, 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 older MO drives had read performance approaching that of a magnetic drive, but inferior write performance. Optical disk 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.

The fundamental technology driving improvements in all optical disk 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 capacity increase, with proportionate increases at lesser wavelength improvements. The prospects for blue light (400 nanometer) semiconductor lasers are improving as the result of improvements made by Nichiya Chemical and other firms, but usable products are not expected until the next decade.

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. 3.5" MO drives with capacities over 1 gigabyte are expected in the 1998/1999 period.

High capacity flexible disk drive technology

Flexible disk drives in this group use a variety of technologies to provide capacities above those offered by standard floppy drives, including the 100 megabyte Iomega 3.5" "Zip" drive, the 3.5" 120 megabyte "floptical drives" initially introduced by Insite Peripherals and now manufactured by Matsushita-Kotobuki Electronics and others, and the Swan/Mitsumi UHC 130 megabyte floppy drive. Because of the relatively high prices of these drives, compared to standard floppy drives, they compete with rigid magnetic disk drives, optical disk drives and tape drives, for specialized markets which need recording devices with removable media. It is a difficult competitive environment, however, with rapidly dropping prices for the alternative products.

Originally introduced in an 8" diameter format, the Iomega Bernoulli Box (now phased out) transitioned to a 5.25" format and was available in capacities up to 230 megabytes. Performance was competitive, with average seek times in the 20-25 millisecond range. The performance of high capacity 3.5" drives in this group can approach that of the Bernoulli drives, and is better than that of standard 1.44 or 2.88 megabyte floppy drives. Typical high capacity 3.5" floppy drives are 1 inch high, but thinner drives are entering the market in the second half of 1997. Individual design approaches have been used to create high capacity 3.5" flexible drives, generally not compatible with each other. They are reviewed briefly below:

Thin motors suitable for inclusion in high capacity floppy drives intended for notebook computers are still a problem for the industry, but it appears that supplies of motors permitting the manufacture of 12.7 millimeter and 15 millimeter high drives will become available during the second half of 1997.

* Rigid drive technology: The Iomega "Zip" drive borrows head and semiconductor technology from the rigid drive industry, obtaining design simplicity, low parts count and reduced costs as a result of being able to use components similar to those already being produced in volume for the rigid drive industry. Iomega's success is judged likely to tempt other

competitors to adopt a similar philosophy in future high capacity drive design efforts.

* Optical tracking: Developed by Insite Peripherals, the original 20 megabyte 'Floptical' drives used optical tracking to provide 1,245 TPI and 1,7 RLL coding to reach almost 24,000 BPI. The barium ferrite media was packaged in a standard 3.5" floppy disk shell. To provide a tracking servo signal, the media was laser branded with a pattern of concentric rings. A multisensor pickup device received reflected light and generated appropriate tracking data. As manufactured in recent years, track density of the floptical drives was 1,245 TPI, but improved optics, the use of metal powder media and tighter track spacing have increased the available capacity several times. The second generation floptical technology drive with 120 megabyte capacity has 2,490 TPI and 44,880 BPI, also using 1,7 RLL coding. Because it has two heads, the new drive is backward compatible with standard 3.5" floppy drives, but its initial high production cost (resulting from the need to support dual read/write channels and the optical tracking system) has made cost reduction imperative for the companies supporting the format.

* Metal powder media: Using metal powder media and conventional recording techniques, several Japanese firms, including NEC, Matsushita Communication Industrial and Y-E Data introduced 3.5" floppy drives from time to time with capacities up to 20 megabytes (NEC introduced a 10 megabyte version in 1990), but all were withdrawn from the market due to limited acceptance of their limited capacity. Proponents of the metal powder approach have long claimed that it can support floppy drive capacities of 100 megabytes or more using standard form factor flexible disks, and recent history supports this claim. The Iomega "Zip" drive achieves its 100 megabyte capacity with metal powder media, as does the 120 megabyte LS-120 drive and drives from others still in development. Metal powder media is expected to be able to support significant increases in disk capacities.

* 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 questionable if the limited increase in capacity warrants the industry-wide standardization effort required to gain acceptance for any given method or combination of methods.

Low capacity flexible disk drive technology

There has been little recent, significant change in low capacity floppy drive technology. Notebook computers use large numbers of half inch high 3.5" drives, but one inch high 3.5" drives are still the standard for desktop computers. 2.88 megabyte 3.5" drives, once standard on many IBM PS/2 personal computers, are now being phased out, having generated limited market response among IBM's customers. The most significant technical development efforts are now aimed at high capacity drives.

Low capacity floppy drive development has slowed, but other technologies competing with floppy drives as a universal distribution medium remain too costly, too slow, or are not standardized for universal data interchange. Standard 3.5" flexible disk drives have succeeded because they offer low cost, recordability, random access, interchange standards and media removability. CD-ROM drives, now growing in usage for software distribution, are limited to the distribution role, due to the lack of recording capability. A critical problem for competitors is that any alternate technology must offer significant improvements at a competitive price, and the 1997 OEM price for 3.5" floppy drives is below $18 for large quantities.

Ever-smaller form factors, higher capacities, more effective designs, the need to read existing libraries of disks, and lower cost manufacturing methods have sustained floppy drive cost-effectiveness against competitive data storage technologies. Consequently, alternate technologies find only limited success in breaking into floppies' established markets, although some displacement of floppy drives is occurring in notebook and handheld computers where there is insufficient space or power for floppy drives. The most likely successor to the low capacity floppy disk drive is a high capacity floppy disk drive, although prices will have to decline greatly to produce a large-scale displacement.

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

* Form factor: Half inch high 3.5" floppy drives now in production permit designers of notebook computers to reduce weight and system size, and to match the heights of new 2.5" rigid disk drives. The nominal half inch high floppy drives now offered in formats from 11 to 12.7 millimeters in height are widely used in notebook computers and have also found usage in subsystems which combine a 3.5" floppy drive with a 5.25" floppy drive or a CD-ROM drive in a single unit designed to be used in a 1.625" high slot in desktop systems.

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

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

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

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

DEFINITIONS

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

Market classification

Market class is used here, arbitrarily, to differentiate captive, PCM/Distributor 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 the manufacturer's systems. Note that the term is used to describe the products, not the manufacturer; drives and cards sold to PCM/Distributor or OEM/Integrator market classes are classified accordingly.

Examples:

* Flash cards sold with a computer by IBM to computer system end users are considered captive, if internally manufactured.
* Optical disk drives manufactured and sold by Fujitsu 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/Distributor shipments are included in the noncaptive sales channel.

Examples:

* Optical drive shipments by Olympus are noncaptive, except for drives sold with systems made by the parent company or other subsidiaries.
* Shipments made by Integral Peripherals, SyQuest Technology, SanDisk or Advanced Micro Devices are noncaptive.

PCM/Distributor: Disk drives and flash cards sold in the "aftermarket" -- shipments by disk drive and flash card manufacturers to subsystem producers, value-added resellers, distributors, retail chains, mail-order firms and individual dealers. It includes drives to be connected to systems of all types, including personal computers, minicomputers and mainframes, or products sold as add-on devices by distributors and dealers.

Examples:

* Rigid disk cartridge drives such as those of Iomega or SyQuest.

* 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 which combine finished system components and software to provide complete systems for specific applications. Sales by a disk drive or flash card manufacturer to a second drive or 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 or flash card manufacturer which finally sells the product to a third party.

Examples:

* Disk drives produced by Integral Peripherals or Calluna for sale to system manufacturers.

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

Geographic classification

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

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

Examples:

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

* An OEM shipment by a Japanese drive manufacturer to a U.S. based system manufacturer is included in U.S. totals, even if the drive or 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.

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/Distributor or OEM/Integrator levels. All prices are in 1997 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 future double density versions of existing single density product 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 or product subgroups.

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/midrange computers: Drives and flash cards attached to network file servers and other midrange multiuser systems. Examples: IBM System AS/400, Compaq SystemPro, Hewlett-Packard 3000.

Personal computers: Attached to a portable or desktop personal computer intended primarily for nonconsumer applications. Examples: Dell Dimension, Toshiba Satellite series, Apple Macintosh, Compaq DeskPro.

Workstations: Single user high end workstations used for engineering, graphics, order processing/shipping, document storage and imaging, point-of-sale, medical, CAD/CAM/CAE, factory production control, law enforcement, military and other applications.

Consumer, game and hobby computers: Used in general purpose or dedicated applications systems sold primarily to consumers for nonbusiness purposes. Examples: All personal computers intended primarily for home use and all computer games and home multimedia systems.

Other applications: Any application not included above, including nonconventional uses such as intelligent fax machines, copiers, intelligent personal communication devices, data loggers and industrial equipment.

FLASH CARDS

FLASH CARDS

Coverage

Examples of flash cards in this group include:

Flash disk cards, less than 10 megabytes

Centennial Technologies	FMA05
IBM	36H3522
Kingmax Technology	AJT-004M
Kingston Technology	DP/ATA-2
Lexar Microsystems	FD0002A
SanDisk	SDP3B-4, SDCFB-4*
Seiko Epson	ATA202SD11/01, ATA502SD11/01
Toshiba	TH6SS160031AAA

Flash memory cards, less than 10 megabytes

ActionTec	FH002M-BN, FH008M-BN
Advanced Micro Devices	Am MCL004A*, AMC008DFLKA
Carry Computer	MCBF2048K2
Centennial Technologies	FL256-15-11131
Fuji Photo Film	RD3001-8
Fujitsu	MB98C81333
Hyundai Electronics	HYCFL001
Intel	iFM004A*, iMC004FLSA, iMC004FLSP
Kingmax Technology	FJN-2, FJN-8
M-Systems	FlashCard-1M, FlashCard-8M
MagicRAM	FL2MBP100
Matsushita Electric Industrial	BN-04MHFRE
Memory Card Technology	F01MX0
Mitsubishi Electric	MF81M1-GCDAT
New Media Memory	NMC00102, NMC00126
SCM Microsystems	FC004MB2
Seiko Epson	HWB257ESX0/40, HWB801S8X0/40
Simple Technology	STI-FL/2A
Smart Modular Technologies	SM9FL512KP3, SM9FL4MP35V
Toshiba	TC5816ADC* (SSFDC)
Transcend	TS4MFLASH

Flash disk cards, 10 - 25 megabytes

ActionTec	ATA-12
Centennial Technologies	FMA10
Hitachi	HB286015C2
IBM	36H1754
Lexar Microsystems	FD0016A
SanDisk	SDP3B-10, SDCFB-10*
Seiko Epson	ATA112SD11/01, ATA212SD11/01
Toshiba	TH6SS160101AAA

Flash memory cards, 10 - 25 megabytes

ActionTec	FH010M-BN, FH016M-BN
Advanced Micro Devices	AM020DFLKA
Carry Computer	MCBF16384K2
Centennial Technologies	FL16M-20-111-81
Fuji Photo Film	RD3001-16
Fujitsu	MB98A81473
Hyundai Electronics	HYCFLF16020
Intel	iMC010FLSA, iMC020FLSP
Kingmax Technology	FJN-12, FJN-16
M-Systems	FlashCard-10M, FlashCard-20M
MagicRAM	FL10MP100
Matsushita Electric Industrial	BN-16MHF3CE
Memory Card Technology	F14MX0
Mitsubishi Electric	MF816M-G9DAT, MF820M-G7DATXX
SCM Microsystems	FC020MB2
Seiko Epson	HWB111S8X0/80, HWB161S8X0/80
Simple Technology	STI-FL/16A
Smart Modular Technologies	SM9FL16MP3
Transcend	TS16MFlash

Flash disk cards, 25 - 100 megabytes

Hitachi	HB286075A1
IBM	36H1755
SanDisk	SDP3B-85
Seiko Epson	ATA412SD12/02
Toshiba	TH6SS160402AAA

Flash memory cards, 25 - 100 megabytes

Fujitsu	MB98A81573
Intel	iMC040FLSP
M-Systems	FlashCard-40M
MagicRAM	FL40MP100

Flash disk cards, more than 100 megabytes

SanDisk	SDP3B-175

*Smaller than PC Card.

The memory cards discussed in this section include removable PC Card flash cards and small form factor flash cards such as Compact Flash, Miniature Card and Solid State Floppy Disk Card (SSFDC/SmartMedia), organized as either flash disks, which inherently emulate a disk drive, or flash memory (sometimes called linear flash) which requires additional software to provide disk drive emulation. Flash memory can also provide XIP (execution in place) capability, permitting programs to execute from the card as if they were in the host system memory. Sales of memory modules other than cards are not included.

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

Market status

Flash card shipments rose 60.3% in 1996, reaching almost 1.4 million units, while 1996 revenues reached $166.6 million, a 17.5% gain. A continuing increase in average capacity also helped revenue growth. Digital cameras are providing the impetus for accelerated growth, with the imminent availability of high resolution digital cameras with megapixel sensors due to accelerate demand for higher capacity cards. While there is a preference for nonremovable flash cards in many industrial applications, there are signs of increased acceptance of flash disk cards due to their standardized interfaces and perceived lower total costs of ownership. Production of small form factor cards has been limited to a few producers because of difficulties experienced by some firms in meeting the defined standards of the trade associations that have sponsored small form factor flash cards.

80% of 1996 card shipments fell into the rapidly growing "Less than 10 megabyte" category, while 17.7% fell into the 10 to 25 megabyte range. 2.3% of the units exceeded 25 megabytes. Revenue growth in 1996 showed a similar pattern, with $84.6 million (a 50.8% share) captured by flash cards under 10 megabytes, and $63.7 million (a 38.2% share) by cards between 10 and 25 megabytes. Cards over 25 megabytes garnered $18.3 million for an 11% share. Within each capacity range, shipments are shifting to higher capacities, continuing a trend observed in earlier years.

U.S. manufacturers remain the leading producers of flash cards, retaining 67.9% of total worldwide unit shipments, a slight decrease from 1996. Asian firms continue to increase their share. Producers reporting the largest 1996 shipments include Intel, SanDisk, Toshiba and AMD.

In 1996, 64.5% of the flash cards shipped were flash memory cards, with flash disk cards accounting for the remainder. While the material overhead associated with flash disks originally made them less attractive at low capacities than flash memory, rapidly declining prices of chips used in many flash disks are starting to even out the prices and equalize the balance.

Another factor aiding flash disk cards is the relatively well standardized ATA interface, which permits easy interchange between cards and equipment of different manufacturers and product generations. Linear flash memory card software drivers may be specific to given equipment models or manufacturers. The relative performance, cost and management advantages of flash disks are even more advantageous at high capacities, where the cost of the ATA controller function becomes relatively insignificant. About 17% (240,000 units) of 1996 unit shipments were in form factors smaller than the PC Card.

In 1996, 72.4% of worldwide flash card unit shipments were made through the OEM/Integrator channel, and the share for the PCM/Distributor channel declined to 27.6% as the result of increasing OEM shipments to digital camera makers. There were no significant captive shipments, although some flash cards may be shipped on a captive basis in future years.

For flash cards under 10 megabytes in capacity, the price per megabyte averaged approximately $20 to $31 in 1996, depending upon the distribution channel used and whether the card was flash disk or flash memory. In the 10-25 megabyte class, price per megabyte ranged from about $12 to $19. Average prices are in rapid decline due to increased competition and manufacturing efficiencies resulting from rising volume. Increasing purchases of higher capacity cards has helped reduce price per megabyte.

The typical flash memory card had a capacity of 2 or 4 megabytes in 1996, while the typical flash disk card had 4-5 megabytes, but average capacity growth in each product group is beginning to accelerate as digital cameras begin to demand higher card capacity. The smaller capacity cards (under 10 megabytes) tend to be used in horizontal applications (PDAs, organizers, industrial equipment, etc.), while the higher capacity designs are more likely to be used in vertical applications in service industries such as real estate, finance and insurance. Some companies provide cards with a simplified feature set, but otherwise conforming to PCMCIA/PC Card physical, electrical and environmental specifications, in order to reduce cost by eliminating features required by PCs, but not needed for industrial applications. Low capacity cards are usually flash memory cards, as the added costs of the internal controllers in flash disk cards make them poor competitors at the low end of the market, but that situation is changing, as system manufacturers realize that the benefits and indirect cost savings of device interchange may outweigh the lower cost of linear flash memory cards.

Application platforms for PC Card flash memory cards tend towards non-personal computer environments, leaning heavily toward industrial equipment, networking equipment, telecommunications products, field survey equipment, data loggers, navigation devices and instrumentation. The more visible PDAs and mobile computers are a minor, yet growing market opportunity. The cards in the higher capacity categories are more likely to be used in mobile general purpose computers and as devices for data transfer between mobile and desktop computers. Small form factor cards, introduced in 1995, are aimed at consumer product markets.

Marketing trends

Shipments of flash cards are bounding upwards under the stimulus of sales to the digital camera market. It is not an exaggeration to note that the character of the flash card market is being profoundly changed by the digital camera, with major OEM and distribution opportunities opening for small form factor flash cards. Personal telecommunications equipment applications are also expected to provide an accelerating factor in coming years, but may require smaller form factors for full realization of the potential in this segment.

Unit shipments are expected to exceed 15 million in 2000, while revenues climb to over $443 million. However, the expected explosion is likely to be generated by the smaller form factor cards: Over 63% of shipments of cards under 10 megabytes capacity will be small form factor cards. The PDA and subnotebook markets seem to be getting their second wind in 1997, and this should help sales of PC Cards with higher capacities, since many of the newer products are expected to have an Internet orientation and will need to provide some level of local storage in many cases.

In 2000, flash cards with capacities less than 10 megabytes are expected to account for 86.5% of unit shipments, about 13 million units. Cards in the 10 to 25 megabyte category are projected to capture 10.9% (about 1.6 million units), while the 25 to 100 megabyte category will obtain a 2.6% share, or about 391,000 units. The more than 100 megabyte category is expected to garner less than a 0.1% share in 2000 due to its relatively high, though decreasing, unit cost.

Due to successful marketing efforts by SanDisk, Compact Flash style flash disk cards have won most of the digital camera design-ins, with SSFDC a distant second. However, the contest is not expected to be totally one-sided, for it will take several years for the market to decide between the competing flash memory formats, and low end next-generation cameras may tend to favor linear flash memory for cost reasons. In the long run, the desire for a universally interchangeable storage medium and declining component costs may give flash disk the edge. But just as there are multiple film sizes used today, despite the dominance of the 35 millimeter format, surely there will be niche opportunities for small PC card formats other than Compact Flash.

Captive shipments, still invisible in 1997, are expected to remain insignificant during the forecast period. Aftermarket sales of cards for cameras, PDAs and subnotebook computers will enable the PCM/Distributor sales channel to eventually close the gap with the OEM/Integrator channel, but is not expected to overtake it within the forecast period, since many equipment suppliers will purchase the cards on an OEM basis and provide their own distribution.

Technical trends

The most visible product trends anticipated for flash cards involve smaller form factors, and improvements in capacity, performance and cost per megabyte. PC Card standard dimensions are used for cards intended for industrial use, but in applications for consumer equipment, the smaller card form factors will be in the majority. There is no direct interchange capability between the competing small form factors.

Capacity: Capacity is primarily a function of chip density. A shift from 8 megabit chips to 64 megabit or larger chips is well under way, with 256 megabit chip availability anticipated within the forecast period. Some firms have set 1997 as a goal for introduction of 256 megabit chips. SanDisk has begun shipping flash disks with over 100 megabyte capacities, and several companies have indicated their intention to introduce chips with over 64 megabit density in the near future. Multilevel flash memory (MLC), where each cell can store 2 or more bits, is still in the early stages of manufacturing, but is assumed to be more widely available by 1999, producing significant reductions in cost per bit for flash memory, albeit at the expense of performance. Achieving high yield in the manufacturing process is expected to represent a major challenge and will probably be a major pacing factor in the availability of MLC chips. Adequate yields of chips capable of operation at extremes of temperature are also a challenge for MLC chip producers.

Performance: Performance gains are possible from a wider data transfer bus between the flash card and the host system, plus gains from improved device geometries. However, some techniques that increase capacity, such as multibit storage per memory cell, appear to have associated performance penalties, especially for data writes. Performance of linear flash memory in some applications may be limited by a property of flash file software systems that causes a lengthening of the average seek time after a large number of data rewrites, a characteristic that is avoided in flash disk cards. For most flash cards, write performance is substantially inferior to read performance because of the need to erase a block before overwriting it. However, this problem is often handled by writing files in clear blocks and then erasing the old files' memory blocks in the background while the card is not in use, thereby providing "virtually" equal read and write rates.

Form factor: Small form factor flash memory cards are now expected to become predominant in the market, with the Compact Flash format currently the most widely accepted by OEMs. It has done especially well in the digital camera market. Other major small form factor formats include the Miniature Card and the SmartMedia card. In mid-1997, a group of companies (including Sony, Fujitsu, Casio, Sanyo, Sharp and Olympus) announced support for a fourth format, the MemoryStick. MemoryStick dimensions are 2.8 x 21 x 50 millimeters. Other specifications include 330 to 1500 kilobyte per second write rate and 2450 kilobytes per second read rate. Minimum sector size is 8 kilobytes, useful for video and audio applications because data transfer overhead is reduced. Detailed specifications are planned for an October, 1997, announcement. Product shipments are anticipated in 1998.

For some of the small form factors, the ability of the flash card package and its contents to withstand rugged, even abusive, handling is an issue. While all of the packages currently available offer adequate shock and vibration resistance, the consumer environment (especially that associated with digital cameras) will expect and require the card to operate after abuse from spilled food and other substances, inadvertent abrasion or damage to contacts and unexpected bending or piercing events caused by being placed in a pocket or other container with unfriendly objects. Resistance to electrostatic discharge is also an issue, since the chips in some form factor designs are perceived to be more vulnerable than others to damage from electrostatic discharge.

Compatibility: Interchange compatibility for PC Card flash memory is still an issue, but has become somewhat less significant as the PC Card standard is expanded and clarified and older equipment is retired and replaced. Future systems are also expected to embed drivers for flash memory card support within the BIOS of the host system, providing additional standardization of the interface between card and host system. However, universal interchange for linear flash memory cards seems unlikely, since the cards of various manufacturers often require specific drivers unless a software flash file system is universally integrated into any equipment that might use linear flash.

PC Card flash models capable of operating with multiple voltages will also help eliminate compatibility problems. The industry is moving to cards capable of operating with either 5 volt or 3.3 volt power, while 12 volt cards are being phased out.

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

Competing Products: Where small capacities are adequate or use in a hostile environment is necessary, flash memory technology is only weakly challenged by other storage products. SRAM is more expensive and needs a backup battery, DRAM is nonvolatile and becoming less price competitive, and ferroelectric memory is still several product generations away from becoming an effective competitor. Small disk drives remain the main competitors to flash cards, for their low cost per megabyte and rapidly increasing capacities are unlikely to be matched by flash memory in any form during the next decade. The only capacity range in which flash cards and magnetic disks are likely to have any competitive overlap is in capacities under 200 megabytes, an area in which high capacity floppy drives and PC Card rigid disk drives are still active. Ferroelectric memory, with an increased number of write/erase cycles, may also become a serious flash memory competitor by the end of the decade.

Forecasting assumptions

1. Consumer use of small form factor flash cards will rapidly increase beginning in 1997 as a result of their introduction in digital cameras, intelligent pagers and other personal telecommunications equipment. Very high growth rates are expected for shipments of digital cameras, consumer oriented digital telecommunications devices and other consumer products using flash memory during the forecast period.

2. Shipments of flash cards using 256 megabit or larger chips will begin in 1999.

3. During the forecast period, no technological breakthroughs are anticipated that will drastically alter the ability of flash memory to compete against other products.

4. Yield problems for multilevel cell flash memory chips are expected to be resolved by 1999.

5. Cards using ferroelectric memory are not expected to impact the total size of the market during the forecast period, although there is a small possibility they may begin to replace flash memory towards the end of the period.

TABLE 9

CONSOLIDATED WORLDWIDE REVENUES

FLASH CARDS

REVENUE SUMMARY

	FLASH CARD REVENUES, BY SHIPMENT DESTINATION (M$)									
	1996 Revenues		Forecast							
			1997		1998		1999		2000	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
PCM/Distributor	24.7	40.6	30.3	51.5	29.2	50.7	32.4	57.0	34.0	60.8
OEM/Integrator	46.0	90.3	59.0	111.7	58.1	144.5	69.2	175.0	78.5	200.3
TOTAL U.S. REVENUES	70.7	130.9	89.3	163.2	87.3	195.2	101.6	232.0	112.5	261.1
Non-U.S. Manufacturers										
PCM/Distributor	3.8	7.9	9.3	22.3	12.4	31.5	14.6	39.5	16.4	48.8
OEM/Integrator	8.3	27.8	21.8	59.0	26.8	91.3	30.0	114.2	33.1	133.7
TOTAL NON-U.S. REVENUES	12.1	35.7	31.1	81.3	39.2	122.8	44.6	153.7	49.5	182.5
Worldwide Recap										
TOTAL WORLDWIDE REVENUES	82.8	166.6	120.4	244.5	126.5	318.0	146.2	385.7	162.0	443.6

TABLE 10

CONSOLIDATED WORLDWIDE SHIPMENTS

FLASH CARDS

SHIPMENT SUMMARY

FLASH CARD SHIPMENTS, BY SHIPMENT DESTINATION (000)

	1996 Shipments		Forecast 1997		1998		1999		2000	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
PCM/Distributor	182.5	293.2	386.2	711.5	676.8	1,203.4	965.5	1,766.7	1,249.7	2,347.0
OEM/Integrator	347.6	643.0	880.9	1,657.8	1,465.6	3,098.4	2,037.2	4,284.8	2,666.3	5,548.9
TOTAL U.S. SHIPMENTS	530.1	936.2	1,267.1	2,369.3	2,142.4	4,301.8	3,002.7	6,051.5	3,916.0	7,895.9
Non-U.S. Manufacturers										
PCM/Distributor	39.6	87.4	96.5	263.3	245.9	699.6	387.3	1,160.8	547.1	1,799.7
OEM/Integrator	91.4	353.9	225.3	920.5	592.8	2,549.8	889.6	3,902.6	1,215.2	5,350.8
TOTAL NON-U.S. SHIPMENTS	131.0	441.3	321.8	1,183.8	838.7	3,249.4	1,276.9	5,063.4	1,762.3	7,150.5
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	661.1	1,377.5	1,588.9	3,553.1	2,981.1	7,551.2	4,279.6	11,114.9	5,678.3	15,046.4

TABLE 11

CONSOLIDATED WORLDWIDE REVENUES
FLASH CARDS
PRODUCT GROUP REVIEW

REVENUE SUMMARY

WORLDWIDE REVENUES	1996		Forecast							
ALL MANUFACTURERS	Revenues		1997		1998		1999		2000	
	$M	%	$M	%	$M	%	$M	%	$M	%
FLASH CARDS	84.6	50.8%	112.4	46.0%	151.2	47.5%	180.4	46.8%	203.2	45.8%
LESS THAN 10 MEGABYTES	+28.0%		+32.9%		+34.5%		+19.3%		+12.6%	
FLASH CARDS	63.7	38.2%	95.4	39.0%	113.5	35.7%	135.4	35.1%	152.4	34.4%
10 - 25 MEGABYTES	+7.8%		+49.8%		+19.0%		+19.3%		+12.6%	
FLASH CARDS	17.5	10.5%	30.6	12.5%	42.2	13.3%	52.2	13.5%	60.1	13.5%
25 - 100 MEGABYTES	+7.4%		+74.9%		+37.9%		+23.7%		+15.1%	
FLASH CARDS	.8	.5%	6.1	2.5%	11.1	3.5%	17.7	4.6%	27.9	6.3%
MORE THAN 100 MEGABYTES	+166.7%		+662.5%		+82.0%		+59.5%		+57.6%	
Total Worldwide Revenue	166.6	100.0%	244.5	100.0%	318.0	100.0%	385.7	100.0%	443.6	100.0%
	+17.5%		+46.8%		+30.1%		+21.3%		+15.0%	

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

TABLE 12

CONSOLIDATED WORLDWIDE SHIPMENTS
FLASH CARDS
PRODUCT GROUP REVIEW

UNIT SHIPMENT SUMMARY

UNIT SHIPMENTS IN THOUSANDS	1996 Shipments Units	1996 Shipments %	Forecast 1997 Units	1997 %	1998 Units	1998 %	1999 Units	1999 %	2000 Units	2000 %
FLASH CARDS LESS THAN 10 MEGABYTES	1,101.2	80.0%	2,844.7	80.2%	6,408.0	85.0%	9,521.9	85.8%	12,995.0	86.5%
	+69.2%		+158.3%		+125.3%		+48.6%		+36.5%	
FLASH CARDS 10 - 25 MEGABYTES	243.7	17.7%	602.8	17.0%	936.9	12.4%	1,282.8	11.5%	1,634.9	10.9%
	+30.6%		+147.4%		+55.4%		+36.9%		+27.4%	
FLASH CARDS 25 - 100 MEGABYTES	32.3	2.3%	102.6	2.8%	198.9	2.6%	296.8	2.7%	391.4	2.6%
	+50.2%		+217.6%		+93.9%		+49.2%		+31.9%	
FLASH CARDS MORE THAN 100 MEGABYTES	.3	--	3.0	--	7.4	--	13.4	--	25.1	--
	+200.0%		+900.0%		+146.7%		+81.1%		+87.3%	
Total Worldwide Shipments	1,377.5	100.0%	3,553.1	100.0%	7,551.2	100.0%	11,114.9	100.0%	15,046.4	100.0%
	+60.3%		+157.9%		+112.5%		+47.2%		+35.4%	
% U.S. Manufacturers	67.9%		66.6%		56.9%		54.4%		52.4%	
Total Capacity (Terabytes)	7.8		20.7		44.0		66.9		97.2	

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

TABLE 13

FLASH CARDS, LESS THAN 10 MEGABYTES

WORLDWIDE SHIPMENTS (000)

BREAKDOWN BY PRODUCT TYPE

	1996 Shipments		Forecast 1997		Forecast 1998		Forecast 1999		Forecast 2000	
	PC Card	<PC Card	PC Card	<PC Card	PC Card	<PC Card	PC Card	<PC Card	PC Card	<PC Card
U.S. MANUFACTURERS										
PCM/Distributor	197.6	31.5	239.3	342.0	529.8	536.0	759.2	824.7	980.0	1,138.0
OEM/Integrator	370.0	101.5	395.0	858.0	906.6	1,541.2	1,242.5	2,163.3	1,556.0	2,876.0
TOTAL U.S. SHIPMENTS	567.6	133.0	634.3	1,200.0	1,436.4	2,077.2	2,001.7	2,988.0	2,536.0	4,014.0
NON-U.S. MANUFACTURERS										
PCM/Distributor	70.2	8.2	92.0	114.4	255.4	351.0	369.4	660.4	491.6	1,142.4
OEM/Integrator	232.1	90.1	324.4	479.6	732.4	1,555.6	1,126.3	2,376.1	1,519.0	3,292.0
TOTAL NON-U.S. SHIPMENTS	302.3	98.3	416.4	594.0	987.8	1,906.6	1,495.7	3,036.5	2,010.6	4,434.4
WORLDWIDE RECAP										
PCM/Distributor	267.8	39.7	331.3	456.4	785.2	887.0	1,128.6	1,485.1	1,471.6	2,280.4
	+7.2%	--	+23.7%	--	+137.0%	+94.3%	+43.7%	+67.4%	+30.4%	+53.6%
OEM/Integrator	602.1	191.6	719.4	1,337.6	1,639.0	3,096.8	2,368.8	4,539.4	3,075.0	6,168.0
	+50.1%	--	+19.5%	+598.1%	+127.8%	+131.5%	+44.5%	+46.6%	+29.8%	+35.9%
Total Shipments	869.9	231.3	1,050.7	1,794.0	2,424.2	3,983.8	3,497.4	6,024.5	4,546.6	8,448.4
	+33.7%	--	+20.8%	+675.6%	+130.7%	+122.1%	+44.3%	+51.2%	+30.0%	+40.2%
ANNUAL SHARE, BY TYPE	79.1%	20.9%	36.9%	63.1%	37.8%	62.2%	36.7%	63.3%	35.0%	65.0%
TOTAL CAPACITY (Terabytes)	3.3	.4	4.1	4.7	7.8	12.7	10.2	21.3	12.5	33.1

Note: "<PC Card" means cards smaller than the PC Card form factor.
Examples include Compact Flash, Miniature Card, SSFDC.

TABLE 14

FLASH CARDS, LESS THAN 10 MEGABYTES

WORLDWIDE PRICE PER MEGABYTE ($/MB)

PRODUCT TYPE	1996	Forecast 1997	Forecast 1998	Forecast 1999	Forecast 2000
PCM/Distributor					
PC Card	24.46	16.28	10.38	8.31	6.57
Smaller than PC Card	30.79	12.47	6.27	4.84	4.00
PCM/Distributor Average	24.95	14.39	8.23	6.19	4.81
OEM/Integrator					
PC Card	20.52	13.45	9.12	7.47	5.79
Smaller than PC Card	25.33	10.93	5.95	4.70	3.79
OEM/Integrator Average	21.21	12.06	7.06	5.53	4.31

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.

"Smaller than PC Card" means cards smaller than the PC Card form factor.

Examples include Compact Flash, Miniature Card, SSFDC.

TABLE 15

FLASH CARDS, 10 - 25 MEGABYTES

WORLDWIDE SHIPMENTS (000)

BREAKDOWN BY PRODUCT TYPE

	1996 Shipments		Forecast 1997		Forecast 1998		Forecast 1999		Forecast 2000	
	PC Card	<PC Card	PC Card	<PC Card	PC Card	<PC Card	PC Card	<PC Card	PC Card	<PC Card
U.S. MANUFACTURERS										
PCM/Distributor	56.4	2.0	70.5	48.7	104.0	12.0	132.0	18.0	159.0	24.0
OEM/Integrator	143.0	7.0	154.5	217.5	300.0	310.0	365.0	450.0	431.0	590.0
TOTAL U.S. SHIPMENTS	199.4	9.0	225.0	266.2	404.0	322.0	497.0	468.0	590.0	614.0
NON-U.S. MANUFACTURERS										
PCM/Distributor	8.4	--	18.3	24.0	25.0	40.2	38.5	56.3	49.0	72.4
OEM/Integrator	26.8	.1	54.2	15.1	75.7	70.0	94.0	129.0	111.5	198.0
TOTAL NON-U.S. SHIPMENTS	35.2	.1	72.5	39.1	100.7	110.2	132.5	185.3	160.5	270.4
WORLDWIDE RECAP										
PCM/Distributor	64.8	2.0	88.8	72.7	129.0	52.2	170.5	74.3	208.0	96.4
	+20.0%	--	+37.0%	--	+45.3%	-28.2%	+32.2%	+42.3%	+22.0%	+29.7%
OEM/Integrator	169.8	7.1	208.7	232.6	375.7	380.0	459.0	579.0	542.5	788.0
	+31.5%	+102.9%	+22.9%	--	+80.0%	+63.4%	+22.2%	+52.4%	+18.2%	+36.1%
Total Shipments	234.6	9.1	297.5	305.3	504.7	432.2	629.5	653.3	750.5	884.4
	+28.1%	+160.0%	+26.8%	--	+69.6%	+41.6%	+24.7%	+51.2%	+19.2%	+35.4%
ANNUAL SHARE, BY TYPE	96.4%	3.6%	49.4%	50.6%	54.0%	46.0%	49.1%	50.9%	45.9%	54.1%
TOTAL CAPACITY (Terabytes)	2.8	--	3.9	3.3	8.2	6.3	10.7	10.1	13.3	16.8

Note: "<PC Card" means cards smaller than the PC Card form factor.
Examples include Compact Flash, Miniature Card, SSFDC.

TABLE 16

FLASH CARDS, 10 - 25 MEGABYTES

WORLDWIDE PRICE PER MEGABYTE ($/MB)

PRODUCT TYPE	1996	Forecast 1997	1998	1999	2000
PCM/Distributor					
PC Card	18.71	14.56	10.05	8.36	7.10
Smaller than PC Card	12.85	13.46	7.87	6.40	4.58
PCM/Distributor Average	18.57	14.13	9.46	7.79	6.24
OEM/Integrator					
PC Card	16.83	13.16	7.62	6.61	5.77
Smaller than PC Card	12.09	12.10	7.09	5.78	4.15
OEM/Integrator Average	16.66	12.64	7.37	6.17	4.78

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.

"Smaller than PC Card" means cards smaller than the PC Card form factor.

Examples include Compact Flash, Miniature Card, SSFDC.

TABLE 17

FLASH CARDS, 25 - 100 MEGABYTES

WORLDWIDE SHIPMENTS (000)

BREAKDOWN BY PRODUCT TYPE

	1996 Shipments	Forecast							
		1997		1998		1999		2000	
	PC Card	PC Card	<PC Card	PC Card	<PC Card	PC Card	<PC Card	PC Card	<PC Card
U.S. MANUFACTURERS									
PCM/Distributor	5.7	10.5	--	18.6	1.5	28.2	2.5	39.8	3.5
OEM/Integrator	21.2	30.3	--	29.6	6.0	43.6	10.5	58.6	17.0
TOTAL U.S. SHIPMENTS	26.9	40.8	--	48.2	7.5	71.8	13.0	98.4	20.5
NON-U.S. MANUFACTURERS									
PCM/Distributor	.6	14.6	--	19.6	8.4	22.8	13.4	26.0	18.3
OEM/Integrator	4.8	13.8	33.4	30.8	84.4	43.0	132.8	53.0	175.2
TOTAL NON-U.S. SHIPMENTS	5.4	28.4	33.4	50.4	92.8	65.8	146.2	79.0	193.5
WORLDWIDE RECAP									
PCM/Distributor	6.3	25.1	--	38.2	9.9	51.0	15.9	65.8	21.8
	+110.0%	+298.4%	--	+52.2%	--	+33.5%	+60.6%	+29.0%	+37.1%
OEM/Integrator	26.0	44.1	33.4	60.4	90.4	86.6	143.3	111.6	192.2
	+40.5%	+69.6%	--	+37.0%	+170.7%	+43.4%	+58.5%	+28.9%	+34.1%
Total Shipments	32.3	69.2	33.4	98.6	100.3	137.6	159.2	177.4	214.0
	+50.2%	+114.2%	--	+42.5%	+200.3%	+39.6%	+58.7%	+28.9%	+34.4%
ANNUAL SHARE, BY TYPE	100.0%	67.5%	32.5%	49.6%	50.4%	46.4%	53.6%	45.3%	54.7%
TOTAL CAPACITY (Terabytes)	1.0	2.4	.9	3.8	3.9	5.6	6.7	7.6	9.7

Note: "<PC Card" means cards smaller than the PC Card form factor.
Examples include Compact Flash, Miniature Card, SSFDC.

TABLE 18

FLASH CARDS, 25 - 100 MEGABYTES

WORLDWIDE PRICE PER MEGABYTE ($/MB)

PRODUCT TYPE	1996	Forecast 1997	1998	1999	2000
PCM/Distributor					
PC Card	12.19	9.62	5.81	4.79	3.95
Smaller than PC Card	--	--	5.35	4.30	3.50
PCM/Distributor Average	12.19	9.62	5.71	4.67	3.83
OEM/Integrator					
PC Card	11.27	9.06	5.71	4.54	3.72
Smaller than PC Card	--	8.78	4.99	3.77	3.14
OEM/Integrator Average	11.27	8.95	5.28	4.05	3.34

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.

"Smaller than PC Card" means cards smaller than the PC Card form factor.

Examples include Compact Flash, Miniature Card, SSFDC.

TABLE 19

FLASH CARDS, MORE THAN 100 MEGABYTES

WORLDWIDE SHIPMENTS (000)

BREAKDOWN BY PRODUCT TYPE

	1996 Shipments	Forecast				
		--1997--	--1998--	--1999--	-------2000-------	
	PC Card	PC Card	PC Card	PC Card	PC Card	<PC Card
U.S. MANUFACTURERS						
PCM/Distributor	--	.5	1.5	2.1	2.7	--
OEM/Integrator	.3	2.5	5.0	9.9	20.0	.3
TOTAL U.S. SHIPMENTS	.3	3.0	6.5	12.0	22.7	.3
NON-U.S. MANUFACTURERS						
OEM/Integrator	--	--	.9	1.4	1.9	.2
TOTAL NON-U.S. SHIPMENTS	--	--	.9	1.4	1.9	.2
WORLDWIDE RECAP						
PCM/Distributor	--	.5	1.5	2.1	2.7	--
	--	--	+200.0%	+40.0%	+28.6%	--
OEM/Integrator	.3	2.5	5.9	11.3	21.9	.5
	+200.0%	+733.3%	+136.0%	+91.5%	+93.8%	--
Total Shipments	.3	3.0	7.4	13.4	24.6	.5
	+200.0%	+900.0%	+146.7%	+81.1%	+83.6%	--
ANNUAL SHARE, BY TYPE	100.0%	100.0%	100.0%	100.0%	98.1%	1.9%
TOTAL CAPACITY (Terabytes)	--	.5	1.1	2.1	4.0	--

Note: "<PC Card" means cards smaller than the PC Card form factor.
Examples include Compact Flash, Miniature Card, SSFDC.

TABLE 20

FLASH CARDS, MORE THAN 100 MEGABYTES

WORLDWIDE PRICE PER MEGABYTE ($/MB)

PRODUCT TYPE	1996	Forecast 1997	1998	1999	2000
PCM/Distributor					
PC Card	--	12.94	10.64	9.06	6.97
Smaller than PC Card	--	--	--	--	--
PCM/Distributor Average	--	12.94	10.64	9.06	6.97
OEM/Integrator					
PC Card	14.15	11.76	9.71	8.32	6.86
Smaller than PC Card	--	--	--	--	5.98
OEM/Integrator Average	14.15	11.76	9.71	8.32	6.85

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.

"Smaller than PC Card" means cards smaller than the PC Card form factor.

Examples include Compact Flash, Miniature Card, SSFDC.

TABLE 21

FLASH CARDS

MARKET SHARE SUMMARY
Worldwide Shipments of Noncaptive Flash Cards

	1996 Net Shipments							
	To United States Destinations				Worldwide			
	Units (000)			%	Units (000)			%
Card Manufacturers	F.Disk	F.Mem.	Total		F.Disk	F.Mem.	Total	
SanDisk	164.8	--	164.8	24.9	410.3	--	410.3	29.8
Intel	--	185.8	185.8	28.2	--	271.9	271.9	19.7
Toshiba	2.6	2.1	4.7	.7	8.0	90.1	98.1	7.1
Kingmax	--	41.0	41.0	7.2	--	75.0	75.0	5.4
Advanced Micro Dev.	--	57.2	57.2	8.6	--	72.0	72.0	5.2
Other U.S.	19.1	103.2	122.3	18.5	61.1	120.9	181.0	13.2
Other Non-U.S.	--	85.3	85.3	12.9	9.8	258.4	268.2	19.6
TOTAL	186.5	474.6	661.1	100.0	489.2	888.3	1377.5	100.0

Note: "F. Disk" means flash disk: "F. Mem." means linear flash memory.

PC CARD RIGID DISK DRIVES

PC CARD RIGID DISK DRIVES

Coverage

Examples of disk drives in this group include:

PC Card rigid disk drives, less than 500 megabytes

Calluna Technology	CT-130, CT-170, CT-260
Integral Peripherals	8085, 8170E, 8340PA

PC Card rigid disk drives, 500 megabytes - 1 gigabyte

Calluna Technology	CT-520
Integral Peripherals	8510PA

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

The first 1.8" disk drive was shipped by Integral Peripherals in mid-1991, a 21 megabyte drive which was not designed to meet the PCMCIA standard for removable Type III cards. The earliest shipments of PCMCIA Type III rigid disk drives were made in late 1992 by Integral Peripherals. The effective start for volume production of Type III drives was in the second half of 1993 for most manufacturers, including those no longer active. Most of the drives produced to date have been used in Japanese word processors, factory data collection, dedicated application pen-based computers and other specialized applications.

The expected growth in PC Card drive shipments for "personal digital assistants" and notebook computers has proven to be of minor importance so far to the growth of this product group, with the result that several of the drive manufacturers participating in the 1.8" disk drive market during the last few years have dropped out of the contest. MiniStor Peripherals, which had bet heavily on development of a distribution market for 1.8" drives, went out of business, and the firm's Singapore production equipment was purchased through bankruptcy proceedings by Momentum Peripherals, which from time to time has operated the manufacturing line to work down the available inventory of parts used in assembling 1.8" PC Card drives.

All PC Card disk 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.

Market status

The industry's expectations for this product group have dropped considerably since the beginning of the decade, with only two disk drive manufacturers still active in the area. After early expectations that the market for PC Card drives would expand beyond the specialized applications which became the initial markets, drive manufacturers have been confronted with minimal usage with "personal digital assistants", subnotebook computers and notebook computers, and continued delays in development of targeted potential new applications.

232,300 PC Card rigid disk drives were shipped in 1996, a decline from the previous year. The 1996 shipment drop was attributed to the withdrawal from the market by some of the drive manufacturers which had previously been actively attempting to develop the market, plus slower than expected development cycles for some of the newer applications for the drives. The 1997 worldwide shipment total is estimated at 355,000 drives, with sales revenues at $89.4 million.

Manufacturers of drives in this product group have found the level of sales success to be significantly below most of the forecasts made in previous years. The largest problem has been that the expected market with subnotebook computers has been much smaller than expected, due to the slow rate of progress computer manufacturers have experienced in reducing the size and weight of notebook computers, combined with the fact that PC Card drives have tended to offer capacities which have not kept up with the levels demanded for new notebook computers. 2.5" drives are used with substantially all of the notebook computers made today, chosen by system manufacturers because 2.5" drive capacities available are higher, and prices are lower, than the capacities and prices available with 1.8" PC Card drives. There is also a less aggressive pattern of reduction in size and weight for notebook computers than was previously expected, minimizing one of the key potential reasons for system manufacturers to move to PC Card disk drives.

There was a race by drive manufacturers in the early 1990's to increase drive capacities of 1.8" drives as rapidly as possible. As long as the possibility of substantial markets for 1.8" drives with notebook computers seemed imminent, manufacturers of PC Card drives moved capacities upward as rapidly as possible, reaching 340 megabytes native drive capacity by the end of 1994. Capacities in excess of 500 megabytes are now available, but there now appears to be less pressure to quickly move beyond this capacity level. The notebook computer market has moved quickly to drive capacities beyond the possible range for 1.8" drives in the near future, and the remaining manufacturers of PC Card disk drives are expected to concentrate their immediate product development efforts on products for existing market opportunities. Drives with capacities below 500 megabytes are expected to provide 83.2% of 1997's unit shipments.

After the departure of Maxtor from the 1.8" disk drive market in 1995, Integral Peripherals regained its lead in unit shipments, and in 1996 held 90.2% of the worldwide total, with 209,600 drives.

Marketing trends

DISK/TREND forecasts for this product group have again been lowered, with sales increases projected through 2000, but at levels reduced from previous expectations. 765,000 drives are forecasted for shipment in 2000, representing an average annual increase for the 1998-2000 period of 28.5%. Worldwide sales revenues for PC Card drives in 2000 are expected to reach $175.3 million. The potential additional applications for these drives still exist and continued growth is expected, even though the timetable incorporates many uncertainties. The forecasting uncertainties involve emerging applications for PC Card drives in such diverse fields as automotive mapping systems, digital cameras and telecommunication equipment. Although it is likely that PC Card disk drives will share the data storage market in each of these fields with other storage technologies, each is potentially large enough to provide a major boost to the current forecasts.

Although PC Card drives with capacities above 500 megabytes are now in production and are expected to realize significant growth during the next few years, leadership status is expected to take longer. PC Cards with capacities less than 500 megabytes are expected to retain shipment leadership until 2000. Drives with capacities over 500 megabytes will take several years to establish dominance due to the nature of the applications for which existing drives are employed, but the disk drive industry's inevitable movement to higher areal densities will also make it possible for PC Card drive manufacturers to obtain the more advanced components required to reduce the cost of higher capacity drive models. By 1998, the introduction of PC Card drives with capacities over one gigabyte are expected.

It is not clear whether disk drive manufacturers will again initiate efforts to produce a Type II PC Card, with a thickness of only 5 millimeters. The first announcement of a Type II disk drive was by Maxtor, but the drive was never delivered. Type II cards are expected to utilize only a single 1.8" disk because of size constraints, and the capacity available will be severely limited. However, the disk drive industry's areal densities are increasing very rapidly, and within a few years, it will be possible to produce Type II PC Card drives with capacities of several hundred megabytes. Current DISK/TREND forecasts do not differentiate between drives in the two card thicknesses, but it is clear that availability of Type II drives could keep overall drive shipments in the lower 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 per megabyte has already declined rapidly despite the fact that sales volume has not increased as fast as expected. By 2000, the average OEM price/megabyte for the highest capacity PC Card drives is forecasted at 38 cents.

Technical trends

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 1997-2000 time frame covered by this report. By 2000, leading edge rigid disk drives will be recording data at more than 10 gigabits per square inch, and the drives manufactured at very high production levels will utilize areal densities making it possible to store up to 5 gigabytes per 2.5" disk, or about half that capacity per 1.8" disk. If the market for PC Card drives has grown sufficiently by that time, development of production PC Card drives suitable for an entirely new range of applications would be feasible.

Disk drive manufacturers will face many interesting problems if they choose to establish production of 5 millimeter high PC Card 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 would probably be to establish volume production for critical new components such as drive and head positioning motors, head assemblies and the special packaging required for semiconductors. None of the engineering problems are impossible and many were already solved by drive manufacturers doing preliminary work on Type II drives. However, establishing high volume manufacturing capability Type II drives would require major new expenses for drive manufacturers and component suppliers, and will not be undertaken unless significant new market opportunities appear imminent.

Forecasting assumptions

1. Shipments of PC Card rigid disk drives with native capacities of more than 500 megabytes will continue, and shipments of disk drives with capacities over 1 gigabyte will start in 1999.
2. If shipments of rigid disk drives meeting the PC Card Type II standard, using cards 5 millimeters high, start during the 1997-2000 period, the overall shipments of PC Card drives will not be significantly affected.
3. Existing forecasts assume continued growth of current applications, with modest utilization of PC Card drives in new applications.

TABLE 22

CONSOLIDATED WORLDWIDE REVENUES

PC CARD DISK DRIVES

REVENUE SUMMARY

	DISK DRIVE REVENUES, BY SHIPMENT DESTINATION ($M)									
	1996 Revenues		Forecast							
			1997		1998		1999		2000	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
PCM/Distributor	13.8	18.4	21.6	28.8	26.0	35.0	25.7	33.3	19.1	26.6
OEM/Integrator	16.4	31.9	18.0	34.8	26.7	47.1	32.3	55.7	41.9	64.6
TOTAL U.S. REVENUES	30.2	50.3	39.6	63.6	52.7	82.1	58.0	89.0	61.0	91.2
Non-U.S. Manufacturers										
PCM/Distributor	.8	3.4	5.8	11.1	8.0	15.6	9.8	17.0	13.6	22.9
OEM/Integrator	1.0	1.8	8.7	14.7	14.4	23.7	24.5	40.0	39.8	61.2
TOTAL NON-U.S. REVENUES	1.8	5.2	14.5	25.8	22.4	39.3	34.3	57.0	53.4	84.1
Worldwide Recap										
TOTAL WORLDWIDE REVENUES	32.0	55.5	54.1	89.4	75.1	121.4	92.3	146.0	114.4	175.3

TABLE 23

CONSOLIDATED WORLDWIDE SHIPMENTS

PC CARD DISK DRIVES

SHIPMENT SUMMARY

	DISK DRIVE SHIPMENTS, BY SHIPMENT DESTINATION (000)									
	1996 Shipments		Forecast							
			1997		1998		1999		2000	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
PCM/Distributor	57.6	76.8	90.0	120.0	115.0	155.0	120.0	155.0	95.0	130.0
OEM/Integrator	68.3	132.8	75.0	145.0	115.0	205.0	140.0	245.0	185.0	290.0
TOTAL U.S. SHIPMENTS	125.9	209.6	165.0	265.0	230.0	360.0	260.0	400.0	280.0	420.0
Non-U.S. Manufacturers										
PCM/Distributor	3.1	12.9	19.0	38.0	30.0	60.0	40.0	70.0	55.0	95.0
OEM/Integrator	5.9	9.8	30.0	52.0	55.0	90.0	95.0	155.0	160.0	250.0
TOTAL NON-U.S. SHIPMENTS	9.0	22.7	49.0	90.0	85.0	150.0	135.0	225.0	215.0	345.0
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	134.9	232.3	214.0	355.0	315.0	510.0	395.0	625.0	495.0	765.0

TABLE 24

CONSOLIDATED WORLDWIDE REVENUES
PC CARD DISK DRIVES
PRODUCT GROUP REVIEW

REVENUE SUMMARY

WORLDWIDE REVENUES ALL MANUFACTURERS	1996 Revenues $M	1996 Revenues %	Forecast 1997 $M	1997 %	1998 $M	1998 %	1999 $M	1999 %	2000 $M	2000 %
PC CARD DISK DRIVES less than 500 Megabytes	55.5 -33.5%	100.0%	69.9 +25.9%	78.3%	80.7 +15.5%	66.6%	63.4 -21.4%	43.4%	33.3 -47.5%	19.0%
PC CARD DISK DRIVES 500 Megabytes - 1 GB	-- --	--	19.5 --	21.7%	40.7 +108.7%	33.4%	66.1 +62.4%	45.3%	85.1 +28.7%	48.5%
PC CARD DISK DRIVES 1 - 2 Gigabytes	-- --	--	-- --	--	-- --	--	16.5 --	11.3%	56.9 +244.8%	32.5%
Total Worldwide Revenue	55.5 -33.5%	100.0%	89.4 +61.1%	100.0%	121.4 +35.8%	100.0%	146.0 +20.3%	100.0%	175.3 +20.1%	100.0%

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

TABLE 25

CONSOLIDATED WORLDWIDE SHIPMENTS
PC CARD DISK DRIVES
PRODUCT GROUP REVIEW

UNIT SHIPMENT SUMMARY

UNIT SHIPMENTS IN THOUSANDS	1996 Shipments Units	1996 Shipments %	Forecast 1997 Units	1997 %	1998 Units	1998 %	1999 Units	1999 %	2000 Units	2000 %
PC CARD DISK DRIVES less than 500 Megabytes	232.3	100.0%	295.0	83.2%	365.0	71.7%	310.0	49.6%	185.0	24.2%
	-31.7%		+27.0%		+23.7%		-15.1%		-40.3%	
PC CARD DISK DRIVES 500 Megabytes - 1 GB	--	--	60.0	16.8%	145.0	28.3%	265.0	42.4%	390.0	51.0%
	--		--		+141.7%		+82.8%		+47.2%	
PC CARD DISK DRIVES 1 - 2 Gigabytes	--	--	--	--	--	--	50.0	8.0%	190.0	24.8%
	--		--		--		--		+280.0%	
Total Worldwide Shipments	232.3	100.0%	355.0	100.0%	510.0	100.0%	625.0	100.0%	765.0	100.0%
	-31.7%		+52.8%		+43.7%		+22.5%		+22.4%	
% U.S. Manufacturers	90.2%		74.6%		70.5%		64.0%		54.9%	
Total Capacity (Terabytes)	59.8		123.8		201.4		282.5		409.3	

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

TABLE 26

PC CARD DISK DRIVES, LESS THAN 500 MEGABYTES

UNIT SHIPMENT SUMMARY

	DISK DRIVE UNIT SHIPMENTS, BY SHIPMENT DESTINATION (000)									
	1996		Forecast							
	Shipments		1997		1998		1999		2000	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
PCM/Distributor	57.6	76.8	90.0	120.0	115.0	155.0	105.0	135.0	65.0	85.0
OEM/Integrator	68.3	132.8	75.0	145.0	90.0	170.0	75.0	140.0	45.0	80.0
TOTAL U.S. SHIPMENTS	125.9	209.6	165.0	265.0	205.0	325.0	180.0	275.0	110.0	165.0
Non-U.S. Manufacturers										
PCM/Distributor	3.1	12.9	7.0	18.0	10.0	25.0	10.0	20.0	5.0	10.0
OEM/Integrator	5.9	9.8	5.0	12.0	10.0	15.0	10.0	15.0	5.0	10.0
TOTAL NON-U.S. SHIPMENTS	9.0	22.7	12.0	30.0	20.0	40.0	20.0	35.0	10.0	20.0
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	134.9	232.3	177.0	295.0	225.0	365.0	200.0	310.0	120.0	185.0
Total Capacity (Terabytes)	34.6	59.8	55.9	92.6	77.3	124.9	74.4	115.0	49.4	75.7
Cumulative Shipments (Units in thousands)										
WORLDWIDE TOTAL	479.0	825.7	656.0	1,120.7	881.0	1,485.7	1,081.0	1,795.7	1,201.0	1,980.7

TABLE 27

PC CARD DISK DRIVES, 500 MEGABYTES - 1 GIGABYTE

UNIT SHIPMENT SUMMARY

	DISK DRIVE UNIT SHIPMENTS, BY SHIPMENT DESTINATION (000)									
	1996 Shipments		Forecast 1997		1998		1999		2000	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
PCM/Distributor	--	--	--	--	--	--	15.0	20.0	25.0	35.0
OEM/Integrator	--	--	--	--	25.0	35.0	50.0	85.0	90.0	140.0
TOTAL U.S. SHIPMENTS	--	--	--	--	25.0	35.0	65.0	105.0	115.0	175.0
Non-U.S. Manufacturers										
PCM/Distributor	--	--	12.0	20.0	20.0	35.0	30.0	50.0	35.0	65.0
OEM/Integrator	--	--	25.0	40.0	45.0	75.0	65.0	110.0	90.0	150.0
TOTAL NON-U.S. SHIPMENTS	--	--	37.0	60.0	65.0	110.0	95.0	160.0	125.0	215.0
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	--	--	37.0	60.0	90.0	145.0	160.0	265.0	240.0	390.0
Total Capacity (Terabytes)	--	--	19.2	31.2	47.5	76.4	77.2	130.3	115.3	190.0
Cumulative Shipments (Units in thousands)										
WORLDWIDE TOTAL	--	--	37.0	60.0	127.0	205.0	287.0	470.0	527.0	860.0

TABLE 28

PC CARD DISK DRIVES, 1 - 2 GIGABYTES

UNIT SHIPMENT SUMMARY

	DISK DRIVE UNIT SHIPMENTS, BY SHIPMENT DESTINATION (000)									
	1996 Shipments		Forecast							
			1997		1998		1999		2000	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
PCM/Distributor	--	--	--	--	--	--	--	--	5.0	10.0
OEM/Integrator	--	--	--	--	--	--	15.0	20.0	50.0	70.0
TOTAL U.S. SHIPMENTS	--	--	--	--	--	--	15.0	20.0	55.0	80.0
Non-U.S. Manufacturers										
PCM/Distributor	--	--	--	--	--	--	--	--	15.0	20.0
OEM/Integrator	--	--	--	--	--	--	20.0	30.0	65.0	90.0
TOTAL NON-U.S. SHIPMENTS	--	--	--	--	--	--	20.0	30.0	80.0	110.0
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	--	--	--	--	--	--	35.0	50.0	135.0	190.0
Total Capacity (Terabytes)	--	--	--	--	--	--	26.6	37.2	101.0	143.6
Cumulative Shipments (Units in thousands)										
WORLDWIDE TOTAL	--	--	--	--	--	--	35.0	50.0	170.0	240.0

TABLE 29

PC CARD RIGID DISK DRIVES

WORLDWIDE PRICE PER MEGABYTE ($/MB)

DISK DIAMETER	1996	Forecast 1997	Forecast 1998	Forecast 1999	Forecast 2000
Captive					
500 Megabytes or less	--	--	--	--	--
500 Megabytes - 1 Gigabyte	--	--	--	--	--
1 - 2 Gigabytes	--	--	--	--	--
PCM/Distributor					
500 Megabytes or less	.93	.76	.66	.56	.44
500 Megabytes - 1 Gigabyte	--	.67	.55	.68	.64
1 - 2 Gigabytes	--	--	--	--	.43
OEM/Integrator					
500 Megabytes or less	.92	.74	.63	.53	.43
500 Megabytes - 1 Gigabyte	--	.59	.52	.46	.40
1 - 2 Gigabytes	--	--	--	--	.38

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 30

PC CARD DISK DRIVES

APPLICATIONS SUMMARY
Percentage of Worldwide Shipments

APPLICATION	1996 Estimate Units (000)	1996 Estimate %	2000 Projection Units (000)	2000 Projection %
VERY HIGH PERFORMANCE Supercomputers and high end imaging	--	--	--	--
MAINFRAME SYSTEMS General purpose	--	--	--	--
NETWORKS/MIDRANGE SYSTEMS Midrange systems and network servers	--	--	--	--
PERSONAL COMPUTERS Business and professional, single user	215.0	92.6	--	--
WORKSTATIONS Engineering and office, single user	6.3	2.7	--	--
CONSUMER, GAME AND HOBBY COMPUTERS	--	--	--	--
OTHER APPLICATIONS	11.0	4.7	--	--
Total	232.3	100.0	--	--

TABLE 31

PC CARD RIGID DISK DRIVES

MARKET SHARE SUMMARY
Worldwide Shipments of Noncaptive Disk Drives

	1996 Net Shipments					
	To United States Destinations			Worldwide		
	Units (000)		%	Units (000)		%
Drive Manufacturers	1.8"	Total		1.8"	Total	
Integral Peripherals	125.9	125.9	93.3	209.6	209.6	90.2
Other U.S.	--	--	--	--	--	--
Other Non-U.S.	9.0	9.0	6.7	22.7	22.7	9.8
TOTAL	134.9	134.9	100.0	232.3	232.3	100.0

RIGID DISK CARTRIDGE DRIVES

RIGID DISK CARTRIDGE DRIVES

Coverage

Examples of disk drives in this group include:

5.25" disk diameter

SyQuest Technology	SQ5200C

3.5" disk diameter

Iomega	Jaz
Nomai	MCD-I, 750.c
SyQuest Technology	EZFlyer 230, SyJet

2.5" disk diameter

Avatar Systems	2250

All types of disk drives using removable media in the form of rigid disk cartridges have been included in this section. Until 1995, 5.25" disk drives provided the majority of shipments in the disk cartridge drive product group. However, SyQuest's 3.5" drives have been available since 1992, with capacities up to 1.5 gigabytes available in drives currently in production, and total shipments of 3.5" drives passed up the 5.25" form factor in 1995.

In response to the Iomega initial market success with the Zip 100 megabyte high capacity 3.5" floppy drive, SyQuest introduced in 1995 the "EZ" single head 3.5" rigid disk cartridge drive designed for very low cost, with capacity initially at 135 megabytes, followed by the 230 megabyte EZFlyer in mid-1996. The capacity range of rigid disk cartridge drives was significantly increased in December, 1995, with the Iomega introduction of the 1 gigabyte Jaz 3.5" drive, using a two disk cartridge. In response, SyQuest offered the SyJet, a 3.5" drive with a capacity of 1.5 gigabytes using a two disk cartridge, with deliveries starting in December, 1996. The race to offer higher capacities in 3.5" rigid disk cartridge drives is destined to continue, exploiting the availability of advanced heads, disks and other critical components being continually developed for fixed disk drives. There is also the possibility that the capacity leadership now held by 3.5" drives may be surpassed by 5.25" rigid disk cartridge drives, if SyQuest is able to obtain the financial resources needed to start production of the company's planned Rocket series of 5.25" drives, starting with a 4.7 gigabyte model.

Avatar Systems' 2.5" disk cartridge drives, including models combining removable disk drives with floppy drives, have been available in limited production quantities since 1993, with volume production of the current 250 megabyte models under way at the company's new Thailand plant. SyQuest also initiated a 2.5" disk cartridge drive program, with initial shipments in 1993, but has since discontinued the product. In addition, SyQuest placed considerable emphasis on development of an 80 megabyte drive in a PCMCIA Type III PC Card format, using 1.8" disks in a cartridge which could be removed from the removable drive. However, the 1.8" project was dropped in early 1996.

Market status

Although total shipments of disk cartridge drives did not reach the expected level in 1996, the increase was substantial. 1996 unit shipments topped 1 million drives for the first time, up 73.2%. 1997 shipments are forecasted to exceed 1.9 million drives in 1997, an increase of 83.4%. Sales revenues for 1996 were $237.1 million, and 1996 is expected to reach $350.4 million, new highs for the product group. The current shipment growth in this product group continues to be derived mostly from 3.5" drives, with a modest assist from 2.5" disk drives. The role of 5.25" drives continues to diminish, limited by capacities that are too low and prices that are too high, until the arrival of new high-end models, expected next year.

Rigid disk cartridge drives do not exist in an isolated market. They share the market for removable media disk drives with high capacity flexible disk drives and optical disk drives, and frequently compete for the same applications. For years the most aggressive competition for SyQuest's rigid disk cartridge drives was provided by the Iomega 5.25" high capacity Bernoulli floppy disk drive. Iomega's Bernoulli drives also increased in capacity over the years, up to 230 megabytes, with the result that SyQuest and Iomega have competed directly in both the Macintosh and IBM personal computer markets for the same graphics and desktop publishing applications. Until 1995, SyQuest's disk cartridge drives held a clear lead in these markets, due to a successful strategy of concentrating on the Macintosh market, the leader in desktop publishing. SyQuest's EZ drive series, initially with 135 and now with 230 megabytes, was intended for many of the same markets as Iomega's successful Zip high capacity floppy drive, currently at 100 megabytes with a higher capacity version expected. SyQuest's disastrous financial results during the last two years illustrate the difficulty in competing against a high capacity floppy drive optimized for low production cost with a rigid disk equivalent.

There is also a vigorous contest between 3.5" rigid disk cartridge drives and 3.5" magneto-optic drives, but the 3.5" rigid disk cartridge drives appear to be holding their own in this contest. Shipments of both types of drives are increasing, but rigid disk cartridge drives remain at higher shipment levels, due to lower prices and continuing increases in the disk capacities available. 3.5" MO drives, however, have made progress in displacing 5.25" rigid disk cartridge drives in some professional and business applications, with higher capacities and increasingly competitive prices.

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 upgrading from 44 megabytes to 88 megabytes in 1991, and 200 megabytes in 1994, the overall market growth for 5.25" rigid disk cartridge drives slowed down, as customers' appetites for even higher capacities became stronger. 5.25" drive shipments started declining in 1995 and in 1997 are projected at only 55,000 drives.

The first 2.5" disk cartridge drive shipments began in 1993. SyQuest's previously announced 2.5" drive was dropped, but Avatar Systems introduced a 2.5" rigid disk cartridge drive, with capacity now up to 250 megabytes, intended for a variety of personal computer and specialized system applications. In the meantime, SyQuest's 1.8" drive in the PCMCIA Type III form factor was one of the most unusual disk drive designs to date. It used a disk cartridge which could be removed from the drive, which, like all drives in a PCMCIA card format, was removable from the host system. SyQuest had hoped that the 1.8" low media cost would be instrumental in applications requiring multiple media units, and 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, as continuing improvements in the areal density of rigid disk drives made it possible to increase drive capacity. The program was discontinued by SyQuest in early 1996, in light of the modest growth experienced by the industry for 1.8" disk drives and shifting company priorities.

For the first time in memory, SyQuest Technology lost its leadership in shipments of disk cartridge drives in 1996. Iomega's Jaz drive captured 53.2% of the worldwide unit shipments of rigid disk cartridge drives in 1996, with an estimated 555,000 drives. SyQuest's 429,000 drives provided 41.4% of the 1996 total. In 1996, all disk cartridge drives were shipped in noncaptive market channels, primarily in the PCM/Distributor channel.

Marketing trends

The current DISK/TREND forecast for this product group expects shipments to top 5.5 million drives in 2000, with sales revenues at $879.2 million. Despite the expected availability of higher capacities for all types of disk drives in the product group, 3.5" drives are destined to maintain dominance, with 89.2% of the 2000 total. Expanding on the traditional prepress, graphics and security markets, most of the growth is expected to be derived from expanded business and professional applications, such as multimedia development, video editing and a variety of technical workstations, with only modest penetration of consumer markets.

It must be noted that all shipment forecasts for rigid disk cartridge drives must be regarded as somewhat speculative, due to the current volatile nature of the industry structure, competitive product offerings and the status of the individual competitors. The market is currently beginning a transition to increased OEM/Integrator sales, as specialized system manufacturers add higher capacity 3.5" drives to their product lines. It is clear that the drives will increase in capacity, but the timing of capacity improvements for rigid disk cartridge drives is uncertain, depending less on technical feasibility than on competitive tactics. By the end of the forecast period, it is also possible that major improvements in optical disk recording densities could provide major new competitive threats. The financial viability of certain disk drive manufacturers will also control their ability to produce planned new drives, with SyQuest being the largest question mark. After more than two years of losses, it may be difficult to maintain the industry's pace of product introductions.

Technical trends

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

Iomega's Jaz drive provides an illustration of the benefits which accrue to this product group from the much higher production levels now achieved with fixed disk drives manufactured for the desktop personal computer market. The current Jaz drive uses two 540 megabyte disks in each cartridge -- the same type of disks which were manufactured for the highest volume fixed disk drives produced in 1995. As recording capacities increase at the expected 60% per year, disks, heads and semiconductors manufactured for the industry's highest volume fixed disk drives will become available to the manufacturers of disk cartridge drives at low costs. With these components available, it is to be expected that capacities available in 3.5" disk cartridge drives will track the same upward trend, probably following fixed disk drives by a year or two.

Forecasting assumptions

1. Significant shipment increases of 3.5" and 2.5" disk cartridge drives will continue, with further increases in drive capacity available, with successful sales to both system manufacturers and the aftermarket.
2. Production for 5.25" disk cartridge drives will increase starting in 1998, with introduction of high capacity models.

TABLE 32

RIGID DISK CARTRIDGE DRIVES

REVENUE SUMMARY

	DISK DRIVE REVENUES, BY SHIPMENT DESTINATION ($M)									
	1996 Revenues		Forecast							
			1997		1998		1999		2000	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
PCM/Distributor	158.6	211.0	205.9	289.7	313.6	434.4	427.3	591.9	498.0	690.3
OEM/Integrator	9.3	11.8	35.3	41.7	63.2	74.8	99.2	117.7	126.6	150.4
TOTAL U.S. REVENUES	167.9	222.8	241.2	331.4	376.8	509.2	526.5	709.6	624.6	840.7
Non-U.S. Manufacturers										
PCM/Distributor	4.8	14.3	7.0	19.0	9.6	24.4	13.0	32.6	16.5	38.5
OEM/Integrator	--	--	--	--	--	--	--	--	--	--
TOTAL NON-U.S. REVENUES	4.8	14.3	7.0	19.0	9.6	24.4	13.0	32.6	16.5	38.5
Worldwide Recap										
TOTAL WORLDWIDE REVENUES	172.7	237.1	248.2	350.4	386.4	533.6	539.5	742.2	641.1	879.2
OEM Average Price ($000)		.203		.173		.164		.159		.151

TABLE 33

RIGID DISK CARTRIDGE DRIVES

UNIT SHIPMENT SUMMARY

	DISK DRIVE UNIT SHIPMENTS, BY SHIPMENT DESTINATION (000)									
	1996 Shipments		Forecast							
			1997		1998		1999		2000	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
PCM/Distributor	685.0	929.0	1,130.0	1,580.0	1,825.0	2,530.0	2,575.0	3,570.0	3,100.0	4,300.0
OEM/Integrator	44.0	58.0	205.0	240.0	385.0	455.0	625.0	740.0	840.0	995.0
TOTAL U.S. SHIPMENTS	729.0	987.0	1,335.0	1,820.0	2,210.0	2,985.0	3,200.0	4,310.0	3,940.0	5,295.0
Non-U.S. Manufacturers										
PCM/Distributor	19.0	57.0	35.0	95.0	55.0	140.0	80.0	200.0	105.0	245.0
OEM/Integrator	--	--	--	--	--	--	--	--	--	--
TOTAL NON-U.S. SHIPMENTS	19.0	57.0	35.0	95.0	55.0	140.0	80.0	200.0	105.0	245.0
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	748.0	1,044.0	1,370.0	1,915.0	2,265.0	3,125.0	3,280.0	4,510.0	4,045.0	5,540.0
Total Capacity (Terabytes)	549.4	716.5	1,340.7	1,853.3	2,504.5	3,434.5	4,600.7	6,298.7	7,110.7	9,686.0
Cumulative Shipments (Units in millions)										
WORLDWIDE TOTAL	3.3	5.1	4.7	7.1	6.9	10.2	10.2	14.7	14.3	20.2

TABLE 34

RIGID DISK CARTRIDGE DRIVES

WORLDWIDE REVENUES ($M)

BREAKDOWN BY DISK DIAMETER

	1996 Revenues			Forecast 1997			1998			1999			2000		
	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/Distributor	26.0	185.0	--	11.0	263.7	15.0	16.7	378.2	39.5	23.5	508.0	60.4	24.6	594.3	71.4
OEM/Integrator	--	11.1	.7	--	37.1	4.6	5.9	62.4	6.5	8.4	97.9	11.4	9.0	128.5	12.9
TOTAL U.S. REVENUES	26.0	196.1	.7	11.0	300.8	19.6	22.6	440.6	46.0	31.9	605.9	71.8	33.6	722.8	84.3
NON-U.S. MANUFACTURERS															
PCM/Distributor	--	14.3	--	--	19.0	--	--	24.4	--	--	32.6	--	--	38.5	--
TOTAL NON-U.S. REVENUES	--	14.3	--	--	19.0	--	--	24.4	--	--	32.6	--	--	38.5	--
WORLDWIDE RECAP															
PCM/Distributor	26.0	199.3	--	11.0	282.7	15.0	16.7	402.6	39.5	23.5	540.6	60.4	24.6	632.8	71.4
	-62.9%	+145.1%	--	-57.7%	+41.8%	--	+51.8%	+42.4%	+163.3%	+40.7%	+34.3%	+52.9%	+4.7%	+17.1%	+18.2%
OEM/Integrator	--	11.1	.7	--	37.1	4.6	5.9	62.4	6.5	8.4	97.9	11.4	9.0	128.5	12.9
	--	+296.4%	--	--	+234.2%	+557.1%	--	+68.2%	+41.3%	+42.4%	+56.9%	+75.4%	+7.1%	+31.3%	+13.2%
Total Revenues	26.0	210.4	.7	11.0	319.8	19.6	22.6	465.0	46.0	31.9	638.5	71.8	33.6	761.3	84.3
	-62.9%	+150.2%	--	-57.7%	+52.0%	--	+105.5%	+45.4%	+134.7%	+41.2%	+37.3%	+56.1%	+5.3%	+19.2%	+17.4%
ANNUAL SHARE, BY DIAMETER	11.0%	88.8%	.2%	3.1%	91.4%	5.5%	4.2%	87.2%	8.6%	4.3%	86.1%	9.6%	3.8%	86.7%	9.5%

TABLE 35

RIGID DISK CARTRIDGE DRIVES

WORLDWIDE SHIPMENTS (000)

BREAKDOWN BY DISK DIAMETER

	1996 Shipments			Forecast 1997			1998			1999			2000		
	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/Distributor	81.0	848.0	--	55.0	1,460.0	65.0	85.0	2,265.0	180.0	125.0	3,155.0	290.0	135.0	3,810.0	355.0
OEM/Integrator	--	55.0	3.0	--	220.0	20.0	30.0	395.0	30.0	45.0	640.0	55.0	50.0	880.0	65.0
TOTAL U.S. SHIPMENTS	81.0	903.0	3.0	55.0	1,680.0	85.0	115.0	2,660.0	210.0	170.0	3,795.0	345.0	185.0	4,690.0	420.0
NON-U.S. MANUFACTURERS															
PCM/Distributor	--	57.0	--	--	95.0	--	--	140.0	--	--	200.0	--	--	245.0	--
TOTAL NON-U.S. SHIPMENTS	--	57.0	--	--	95.0	--	--	140.0	--	--	200.0	--	--	245.0	--
WORLDWIDE RECAP															
PCM/Distributor	81.0	905.0	--	55.0	1,555.0	65.0	85.0	2,405.0	180.0	125.0	3,355.0	290.0	135.0	4,055.0	355.0
	-69.3%	+174.0%	--	-32.1%	+71.8%	--	+54.5%	+54.7%	+176.9%	+47.1%	+39.5%	+61.1%	+8.0%	+20.9%	+22.4%
OEM/Integrator	--	55.0	3.0	--	220.0	20.0	30.0	395.0	30.0	45.0	640.0	55.0	50.0	880.0	65.0
	--	+450.0%	+50.0%	--	+300.0%	+566.7%	--	+79.5%	+50.0%	+50.0%	+62.0%	+83.3%	+11.1%	+37.5%	+18.2%
Total Shipments	81.0	960.0	3.0	55.0	1,775.0	85.0	115.0	2,800.0	210.0	170.0	3,995.0	345.0	185.0	4,935.0	420.0
	-69.3%	+182.1%	+50.0%	-32.1%	+84.9%	--	+109.1%	+57.7%	+147.1%	+47.8%	+42.7%	+64.3%	+8.8%	+23.5%	+21.7%
ANNUAL SHARE, BY DIAMETER	7.8%	92.1%	.1%	2.9%	92.8%	4.3%	3.7%	89.7%	6.6%	3.8%	88.7%	7.5%	3.3%	89.2%	7.5%
TOTAL CAPACITY (Terabytes)	16.2	699.8	.5	11.0	1,821.0	21.3	92.0	3,290.0	52.5	340.0	5,872.5	86.3	869.5	8,711.5	105.0

TABLE 36

RIGID DISK CARTRIDGE DRIVES

WORLDWIDE PRICE PER MEGABYTE ($/MB)

DISK DIAMETER	1996	Forecast 1997	1998	1999	2000
Captive					
5.25"	--	--	--	--	--
3.5"	--	--	--	--	--
2.5"	--	--	--	--	--
Captive Average	--	--	--	--	--
PCM/Distributor					
5.25"	1.60	1.00	.24	.09	.03
3.5"	.29	.17	.14	.11	.08
2.5"	--	.91	.87	.83	.80
PCM/Distributor Average	.33	.19	.15	.11	.09
OEM/Integrator					
5.25"	--	--	.24	.09	.03
3.5"	.33	.15	.13	.10	.08
2.5"	1.38	.92	.86	.82	.79
OEM/Integrator Average	.35	.17	.14	.11	.08

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 37

RIGID DISK CARTRIDGE DRIVES

APPLICATIONS SUMMARY
Percentage of Worldwide Shipments

APPLICATION	1996 Estimate Units (000)	1996 Estimate %	2000 Projection Units (000)	2000 Projection %
VERY HIGH PERFORMANCE Supercomputers and high end imaging	--	--	--	--
MAINFRAME SYSTEMS General purpose	--	--	--	--
NETWORKS/MIDRANGE SYSTEMS Midrange systems and network servers	--	--	--	--
PERSONAL COMPUTERS Business and professional, single user	483.4	46.3	997.2	18.0
WORKSTATIONS Engineering and office, single user	470.8	45.1	4,210.4	76.0
CONSUMER, GAME AND HOBBY COMPUTERS	64.7	6.2	83.1	1.5
OTHER APPLICATIONS	25.1	2.4	249.3	4.5
Total	1,044.0	100.0	5,540.0	100.0

TABLE 38

RIGID DISK CARTRIDGE DRIVES

MARKET SHARE SUMMARY
Worldwide Shipments of Noncaptive Disk Drives

	1996 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	
Iomega	--	447.0	--	447.0	59.8	--	555.0	--	555.0	53.1
SyQuest Technology	53.0	227.0	--	280.0	37.4	81.0	348.0	--	429.0	41.1
Nomai	--	19.0	--	19.0	2.5	--	57.0	--	57.0	5.5
Other U.S.	--	--	2.0	2.0	.3	--	--	3.0	3.0	.3
Other Non-U.S.	--	--	--	--	--	--	--	--	--	--
TOTAL	53.0	693.0	2.0	748.0	100.0	81.0	960.0	3.0	1044.0	100.0

SMALL OPTICAL DISK DRIVES

SMALL OPTICAL DISK DRIVES

Coverage

Examples of optical disk drives in this group include:

2.5" disk diameter

Sharp	MD-PS1
Sony	MDH-10

3.5" disk diameter

Fujitsu	M2512A, M2513A, M2541S
Matsushita Electric Industrial	LF-3200, LF-3294
Mountain Optech	CS-250 R/W
Olympus Optical	640MO Turbo, MOS330E, MOS341E
Sony	RMO-S330, HS-D650

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

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

Market status

3.5" optical disk drive shipments surged upwards to over 1.2 million units in 1996, a 134.6% gain, as the result of price competition between market leaders Fujitsu and Olympus. As in previous years, the majority of the 3.5" drives shipped were consumed in the Japanese domestic market. While sales increases have been stimulated by higher capacity and aggressive pricing strategies, growth is being impacted by the availability of drives using competing technologies, notably magnetic rigid disk cartridge drives, high capacity floppies and writable CD format drives. Sony began shipments of a 2.5" drive in 1994, but shipped few units, and the product has been de-emphasized pending redesign. Sharp is planning to ship a 2.5" drive for use with a video camera.

3.5" optical disk drive shipments have also been helped by the fact that computer networks have seen limited usage in Japan, compared to the United States and European markets, providing an incentive to exchange data using 3.5" optical disks. However, with the current increase in network installation now under way in Japan, it is likely that reliance on data exchange via optical disk cartridge will diminish.

In the U.S., demand remains relatively weak as the result of severe competition from magnetic rigid disk cartridge drives, high capacity floppies and the heavy usage of networks, permitting data transfer by wire. OEM demand for 3.5" optical disk 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, remains the strongest 3.5" market segment in the U.S., but even in the Apple segment, 3.5" MO drive sales have been impacted by 3.5" magnetic disk cartridge drives, which offer higher capacity, lower prices and superior performance. Fujitsu and Olympus were again the leading 3.5" optical disk drive producers in 1996, capturing a combined unit share of over 99% of the market.

1996 sales revenues for 3.5" drives rose 60.6% to $406.4 million as a result of strong unit shipments but declining prices. 2.5" drive revenues were about $200,000. All 1996 revenues for small optical drives were generated by non-U.S. firms. The U.S. market shrank slightly to 23.9% of 1996 worldwide sales revenues, reflecting 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.

While Sony's 140 megabyte 2.5" drive requires no erase pass before writing, a feature that can be expected in other MO drives in the future, the drive's performance is much like that of a compact disk drive. Because of size, power, price, 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. Sony's announcement of a 650 megabyte 3.5" drive has also met a lukewarm reception, because the media is not interchangeable with media from the 640 megabyte drives introduced by Fujitsu and Olympus.

Marketing trends

The optical disk drive industry still lags the rigid magnetic disk drive industry in expanding the areal density of stored data. Optical drive manufacturers can't match the average 60% per year areal density growth rate of magnetic disk drives, and this lag is expected to weaken the prospects for optical drive sales relative to magnetic disk cartridge drives.

640 megabyte 3.5" optical disk drives are now shipping, but future competition with the 1 gigabyte Iomega Jaz drive, the 1.5 gigabyte SyJet drive and with higher capacity versions expected in the future, is expected to become increasingly difficult. The new MO disk drives must also compete against the 650 megabyte PD drive, the increasingly less expensive CD-R drives and CD-RW drives, and 2.6 gigabyte DVD-RAM drives expected to ship in quantity in 1998. Moderate shipment growth is projected through 1999, but it assumes a steady reduction in drive prices and a fast expansion of capacity to match competition from drives using other technologies.

Annual shipments of 3.5" MO drives are expected to peak in 1999 and then decline under the assault from drives using other technologies. However, it is possible that advanced technologies now being developed for 4.72" and 5.25" MO drives may extend the life of 3.5" MO if they are so applied. 2.5" drive shipments are expected to resume at a modest level as the result of use as an adjunct to digital photographic equipment.

Because of steadily declining prices, sales revenues for this product group are expected to peak at only $554.1 million in 1999 and subsequently decline. However, if new very high capacity drives are introduced, late in the forecast period, revenues for this product group could be substantially higher. The U.S. portion of worldwide revenues is expected to remain in the 25 to 30 percent range during the forecast period.

Applications

3.5" optical disk drives are used to provide project oriented storage on a single disk, and are often used in desktop publishing to transfer large amounts of data needed for prepress processing. They are also used for file transfer applications with video editing systems. Their capacity is large enough to make them useful as archival storage devices, but this role is being eroded by CD-R drives due to their lower media costs.

The drives have established a role as add-on devices to Apple Macintosh systems, which are frequently used for desktop publishing. In Japan and other countries where networking has not been as widely used, they have had 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 storage device in optical libraries attached to file servers in small networks. To the extent they match or exceed current CD-RW capacity and performance (and have prospects for matching or exceeding 2.6 gigabyte DVD-RAM), they have an opportunity to establish a role as a multipurpose device that can provide data distribution services, selective backup or save and restore capability, and other secondary mass storage tasks.

2.5" drives were targeted at the secondary storage market for portable and mobile computer systems. If available at a low enough price and in thin form factors, 2.5" drives could also acquire the role of a data exchange device, especially in portable systems, but no clear role for the drive in this application has yet emerged. 2.5" drives now seem poised to develop usage in consumer and hobby systems and, to a lesser extent, with notebook computers if their current deficiencies in power consumption and package size are overcome.

Technical trends

Continuing improvements in MO drive and media technology are expected to help sustain the market for small optical disk drives. Key technical issue areas include:

> Capacity: 3.5" drive capacities are expected to reach 1.3 gigabytes in 1998 and have prospects for growth to well over 2 gigabytes by the end of the decade. Fujitsu and several other firms introduced backward compatible 640 megabyte 3.5" MO drives in late 1995. Sony has also introduced a 650 megabyte 3.5" drive. Although it is not backward compatible with

earlier drives, Sony claims their approach is more amenable to future capacity and performance improvements. Capacity growth for 2.5" drives is more problematic. Because a number of the existing drives' characteristics, such as CLV rotation speed control and file format are derived from CD-ROM technology, capacity gains may be tied to DVD-RAM technology or advanced MO technology.

Capacity can be increased by the use of improved optics and shorter laser wavelength permitting smaller spots and higher BPI and TPI, reduction of track pitch, the adoption of pulse width modulation, zoned recording, improved optics providing higher numerical aperture, land and groove recording, different encoding methods and variable track pitch.

Hybrid designs incorporating elements of rigid magnetic disk drive and MO drive head design also may help expand capacity. Development efforts by companies such as TeraStor, Quinta and Sony have potential to provide significantly higher capacity on a 3.5" disk, although redesigned optical media is required for these approaches to succeed.

Performance: The optical disk drives in this group won't provide the average access times and data transfer rates of magnetic disk drives. While performance is expected to improve, it is not expected to match that of magnetic rigid disk drives within the forecast period, even if direct overwrite techniques are used. 26-28 millisecond average seek times and 7.1 millisecond average latency represent the best performance of 1997 production drives, as has been the case since 1995, with major improvements considered unlikely in the near term.

The older generations of 3.5" magneto-optical drives had an additional latency for writing operations caused by the need to erase each sector before writing. This lack of overwrite capability required that an additional complete rotation be performed before the drive is ready to write in the selected sector. The current generation of small MO drives doesn't require a separate erase pass. But the overwrite solution has come at the expense of read performance, as the direct overwrite designs tend to have longer average seek times or rotational latencies.

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.

Competing products: The SyQuest 3.5" EZFlyer 230 megabyte magnetic rigid disk cartridge drive is strong competition for 3.5", 230 megabyte MO drives. The Iomega Zip drive, although it currently offers only 100 megabytes capacity, also competes by virtue of its under $150 list price. The 640 megabyte 3.5" MO drive must compete against the Iomega Jaz and the SyQuest SyJet magnetic disk cartridge drives, both high performance drives with over a gigabyte capacity, as well as the PD drive, CD-RW drives and DVD-RAM drives expected to become available in 1998. Magnetic cartridge drive capacity is expected to grow rapidly: SyQuest has discussed a 4.7 gigabyte cartridge drive, planned for 1998.

While tape drives do not offer the performance of optical disk drives, especially when reading data, they do offer inexpensive offline storage. Newer small cartridge drives using the "Travan" format developed by 3M can compete against 3.5" MO drives where save/restore and data transfer are primary applications and performance is not a major issue. If the very high areal density drive designs now under development at various companies prove to be reliable when implemented in the form of removable media drives, then properly priced 3.5" drives using such technologies are expected to compete very strongly against tape cartridge drives.

Multigigabyte 5.25" and 3.5" magnetic fixed disk drives from Seagate, Quantum and others also negatively impact optical drive sales in those stand-alone applications where a removable disk cartridge drive is not mandatory. A typical 3.5" 2-3 gigabyte magnetic disk drive sells for half the price of a 640 megabyte 3.5" optical disk drive, has three to four times the capacity and three times better performance. And magnetic drives in the range of 18 gigabytes and up can contain as much data as a 3.5" optical drive based disk library, again at a fraction of the price and offering much higher performance.

Forecasting assumptions

1. 1.3 gigabyte 3.5" drives will begin shipping in late 1998.
2. Rewritable media of appropriate capacity will be available in adequate production quantities throughout the forecast period.
3. 3.5" drive and media prices will continue to decline during the forecast period due to improving economies of scale and competition from other technologies.

TABLE 39

SMALL OPTICAL DISK DRIVES

REVENUE SUMMARY

	DISK DRIVE REVENUES, BY SHIPMENT DESTINATION ($M)									
	1996 Revenues		Forecast 1997		1998		1999		2000	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
TOTAL U.S. REVENUES	--	--	--	--	--	--	--	--	--	--
Non-U.S. Manufacturers										
Captive	--	16.0	--	22.5	--	27.0	--	29.4	--	32.0
PCM/Distributor	45.9	309.3	55.6	393.3	54.0	417.4	58.0	421.8	48.6	375.1
OEM/Integrator	10.2	81.3	12.5	92.7	14.1	100.6	14.7	102.9	8.0	62.3
TOTAL NON-U.S. REVENUES	56.1	406.6	68.1	508.5	68.1	545.0	72.7	554.1	56.6	469.4
Worldwide Recap										
TOTAL WORLDWIDE REVENUES	56.1	406.6	68.1	508.5	68.1	545.0	72.7	554.1	56.6	469.4
OEM Average Price ($000)		.252		.231		.219		.209		.198

TABLE 40

SMALL OPTICAL DISK DRIVES

UNIT SHIPMENT SUMMARY

	DISK DRIVE UNIT SHIPMENTS, BY SHIPMENT DESTINATION (000)									
	1996 Shipments		Forecast							
			1997		1998		1999		2000	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
TOTAL U.S. SHIPMENTS	--	--	--	--	--	--	--	--	--	--
Non-U.S. Manufacturers										
Captive	--	32.0	--	45.0	--	60.0	--	70.0	--	80.0
PCM/Distributor	127.5	861.0	164.1	1,179.1	180.0	1,410.0	200.0	1,475.0	180.0	1,410.0
OEM/Integrator	40.0	322.3	53.0	400.1	64.0	459.0	70.0	492.0	40.0	314.0
TOTAL NON-U.S. SHIPMENTS	167.5	1,215.3	217.1	1,624.2	244.0	1,929.0	270.0	2,037.0	220.0	1,804.0
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	167.5	1,215.3	217.1	1,624.2	244.0	1,929.0	270.0	2,037.0	220.0	1,804.0
Cumulative Shipments (Units in millions)										
WORLDWIDE TOTAL	.5	2.6	.7	4.2	1.0	6.2	1.2	8.2	1.5	10.0

TABLE 41

SMALL OPTICAL DISK DRIVES

WORLDWIDE REVENUES ($M)

BREAKDOWN BY DISK DIAMETER

	1996 Revenues		Forecast 1997		Forecast 1998		Forecast 1999		Forecast 2000	
	3.5"	2.5"	3.5"	2.5"	3.5"	2.5"	3.5"	2.5"	3.5"	2.5"
U.S. MANUFACTURERS										
TOTAL U.S. REVENUES	--	--	--	--	--	--	--	--	--	--
NON-U.S. MANUFACTURERS										
Captive	16.0	--	22.5	--	27.0	--	29.4	--	32.0	--
PCM/Distributor	309.1	.2	378.9	14.4	402.0	15.4	406.0	15.8	359.1	16.0
OEM/Integrator	81.3	--	88.7	4.0	96.6	4.0	98.7	4.2	58.0	4.3
TOTAL NON-U.S. REVENUES	406.4	.2	490.1	18.4	525.6	19.4	534.1	20.0	449.1	20.3
WORLDWIDE RECAP										
Captive	16.0	--	22.5	--	27.0	--	29.4	--	32.0	--
	-72.4%	--	+40.6%	--	+20.0%	--	+8.9%	--	+8.8%	--
PCM/Distributor	309.1	.2	378.9	14.4	402.0	15.4	406.0	15.8	359.1	16.0
	+83.8%	--	+22.6%	--	+6.1%	+6.9%	+1.0%	+2.6%	-11.6%	+1.3%
OEM/Integrator	81.3	--	88.7	4.0	96.6	4.0	98.7	4.2	58.0	4.3
	+202.2%	--	+9.1%	--	+8.9%	--	+2.2%	+5.0%	-41.2%	+2.4%
Total Revenues	406.4	.2	490.1	18.4	525.6	19.4	534.1	20.0	449.1	20.3
	+60.6%	-50.0%	+20.6%	--	+7.2%	+5.4%	+1.6%	+3.1%	-15.9%	+1.5%
ANNUAL SHARE, BY DIAMETER	100.0%	--	96.5%	3.5%	96.5%	3.5%	96.5%	3.5%	95.8%	4.2%

TABLE 42

SMALL OPTICAL DISK DRIVES

WORLDWIDE SHIPMENTS (000)

BREAKDOWN BY DISK DIAMETER

	1996 Shipments		Forecast 1997		Forecast 1998		Forecast 1999		Forecast 2000	
	3.5"	2.5"	3.5"	2.5"	3.5"	2.5"	3.5"	2.5"	3.5"	2.5"
U.S. MANUFACTURERS										
TOTAL U.S. SHIPMENTS	--	--	--	--	--	--	--	--	--	--
NON-U.S. MANUFACTURERS										
Captive	32.0	--	45.0	--	60.0	--	70.0	--	80.0	--
PCM/Distributor	860.5	.5	1,119.1	60.0	1,340.0	70.0	1,400.0	75.0	1,330.0	80.0
OEM/Integrator	322.3	--	382.1	18.0	439.0	20.0	470.0	22.0	290.0	24.0
TOTAL NON-U.S. SHIPMENTS	1,214.8	.5	1,546.2	78.0	1,839.0	90.0	1,940.0	97.0	1,700.0	104.0
WORLDWIDE RECAP										
Captive	32.0	--	45.0	--	60.0	--	70.0	--	80.0	--
	-38.5%	--	+40.6%	--	+33.3%	--	+16.7%	--	+14.3%	--
PCM/Distributor	860.5	.5	1,119.1	60.0	1,340.0	70.0	1,400.0	75.0	1,330.0	80.0
	+110.1%	--	+30.1%	--	+19.7%	+16.7%	+4.5%	+7.1%	-5.0%	+6.7%
OEM/Integrator	322.3	--	382.1	18.0	439.0	20.0	470.0	22.0	290.0	24.0
	+471.5%	--	+18.6%	--	+14.9%	+11.1%	+7.1%	+10.0%	-38.3%	+9.1%
Total Shipments	1,214.8	.5	1,546.2	78.0	1,839.0	90.0	1,940.0	97.0	1,700.0	104.0
	+134.6%	-16.7%	+27.3%	--	+18.9%	+15.4%	+5.5%	+7.8%	-12.4%	+7.2%
ANNUAL SHARE, BY DIAMETER	100.0%	--	95.3%	4.7%	95.4%	4.6%	95.3%	4.7%	94.3%	5.7%

TABLE 43

SMALL OPTICAL DISK DRIVES

APPLICATIONS SUMMARY
Percentage of Worldwide Shipments

APPLICATION	1996 Estimate Units (000)	1996 Estimate %	2000 Projection Units (000)	2000 Projection %
VERY HIGH PERFORMANCE Supercomputers and high end imaging	--	--	--	--
MAINFRAME SYSTEMS General purpose	--	--	--	--
NETWORKS/MIDRANGE SYSTEMS Midrange systems and network servers	20.5	1.7	61.3	3.4
PERSONAL COMPUTERS Business and professional, single user	919.1	75.6	963.3	53.4
WORKSTATIONS Engineering and office, single user	243.4	20.0	698.2	38.7
CONSUMER, GAME AND HOBBY COMPUTERS	--	--	27.1	1.5
OTHER APPLICATIONS	32.3	2.7	54.1	3.0
Total	1,215.3	100.0	1,804.0	100.0

TABLE 44

SMALL OPTICAL DISK DRIVES

MARKET SHARE SUMMARY
Worldwide Shipments of Noncaptive Disk Drives

	1996 Net Shipments							
	To United States Destinations				Worldwide			
	Units (000)			%	Units (000)			%
Drive Manufacturers	3.5"	2.5"	Total		3.5"	2.5"	Total	
Fujitsu	127.0	--	127.0	75.8	770.0	--	770.0	65.1
Olympus Optical	40.0	--	40.0	23.9	410.0	--	410.0	34.6
Other U.S.	--	--	--	--	--	--	--	--
Other Non-U.S.	.5	--	.5	.3	2.8	.5	3.3	.3
TOTAL	167.5	--	167.5	100.0	1182.8	.5	1183.3	100.0

HIGH CAPACITY FLEXIBLE DISK DRIVES

HIGH CAPACITY FLEXIBLE DISK DRIVES

Coverage

Examples of flexible disk drives in this group include:

3.5" flexible disk drives

Imation	SuperDisk LS-120
Iomega	Zip 100
Matsushita Communication Ind.	Zip 100
Matsushita-Kotobuki Electronics	LS-120, LS-120 Slim*
Mitsubishi Electric	MF 357G, MF 357H*
Mitsumi Electric	UHC
O.R. Technology	FD-2120A*, FD-3120A
Swan Instruments	UHC 3130

*12.7 millimeters height, or less

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

Iomega Bernoulli principle drives: Iomega's 5.25" disk drives, which are being phased out in 1997, use the Bernoulli effect to control head/disk spacing. These are high performance drives, using flexible disks in a removable cartridge, and a sophisticated internal air flow system to maintain the proper position of the flexible disk relative to the recording head. A rotary voice coil magnetic head positioning system, in conjunction with an embedded servo, provides average seek times equivalent to those of many rigid disk drives.

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

Bernoulli principle drives weren't able to stay competitive, because the drives' complexity made cost reduction impractical and it was difficult to utilize the Bernoulli technology in the 3.5" form factor.

Iomega Zip drives: A significant new entry in the 3.5" high capacity floppy drive market appeared in 1994 with the Iomega announcement of the "Zip" 100 megabyte drive. After participating in the 21 megabyte floptical drive market and in the Optics Research joint program to develop a higher capacity version of the drive, Iomega undertook its own development program with the objective to develop a 3.5" high capacity floppy with the lowest possible cost. The Zip drive dispensed with backward compatibility, and started shipments in March, 1995, providing 100 megabyte capacity at an initial end user price of $199, since reduced to $149. After initially manufacturing the Zip drive at its factory in Roy, Utah, Iomega moved production to Penang, currently supplemented by a contract manufacturing arrangement with a Philippines supplier, plus manufacturing licenses granted to Matsushita Communication Industrial and NEC.

LS-120 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's floptical drives used a reflective servo pattern applied to the surface of 3.5" diskettes to achieve a diskette capacity of 21 megabytes in a one inch high form factor, with downward read/write compatibility for .7 and 1.44 megabyte diskettes.

In 1992, Insite engaged Matsushita-Kotobuki Electronics to manufacture the drive on a contract basis, and also licensed the floptical technology to Iomega, which introduced drives compatible with Insite's in 1992, using Chinon as a contract manufacturing source. Iomega phased out of the floptical drive market in 1994, after finding a limited market for the product. In November, 1993, O.R. Computer System Pte. Ltd., a major Singapore distributor of personal computers and peripherals, acquired control of Insite Peripherals, changed the name to O.R. Technology in 1995, and continued to sell floptical 21 megabyte drives produced by MKE until phasing them out in 1996.

In 1995, a joint program for the LS-120, a 120 megabyte version of the 3.5" floptical disk drive developed by Optics Research, Inc., in Boulder, Colorado, was announced by three companies, with MKE manufacturing the drives, 3M (now Imation) manufacturing the metal powder diskettes to be used, and Compaq Computer using the drives in personal computers. LS-120 drives are backward compatible with 720 kilobyte, 1.2 megabyte and 1.44 megabyte floppies, and conform to the standard form factor for one inch high 3.5" drives, with thinner models expected. The sponsors have also licensed Mitsubishi Electric to make the LS-120, and O.R. Technology has established a contract manufacturing arrangement with Kaifa, which will produce the drive in China.

UHC disk drives: For several years the technology required for production of higher capacity floppy drives using conventional recording techniques has been available, and numerous companies have offered floppy drives ranging in capacity from 6 to 21 megabytes, none of which were successful in the market. Swan Instruments, a California manufacturer of test equipment for the disk drive industry, announced a combination fixed/removable floppy drive with capacities over 100 megabytes in 1994, using technology licensed from Antek Peripherals, which also granted a license to Mitsumi Electric. After a dispute over licensing terms, the two companies announced an agreement in 1996, under which both companies have the right to manufacture drives in accordance with a common interchange standard, with Mitsumi initially concentrating on establishing manufacturing capability for the drives, and Swan establishing manufacturing arrangements for diskettes.

Market status

The product mix in the high capacity floppy drive product group under went a complete changeover during 1996. The surge in 3.5" floppy drive shipments produced the highest total shipments in the product group's history. Strong sales of Iomega's 100 megabyte Zip drive were supplemented later in the year with initial shipments of the competitive 3.5" LS-120 manufactured by Matsushita-Kotobuki Electronics and Mitsubishi Electric. Iomega completed final production of the 5.25" Bernoulli drive, although modest shipments continue in 1997. 3.9 million high capacity floppy drives were shipped in 1996, of which 99.3% were 3.5" models, with 1997 shipments forecasted to exceed 8.8 million drives.

The market for high capacity floppy drives was dominated by the Iomega Zip drive in 1996, with a strong lead in shipments continuing into 1997. However, the competitive situation has become more complex, with the addition of more brands and suppliers. Iomega has licensed Matsushita Communication Industrial and NEC to make Zip drives. The LS-120 consortium started with initial drive production by Matsushita-Kotobuki Electronics in the second half of 1996, supplemented by drives made by Mitsubishi Electric, and the 1997 start-up of LS-120 contract manufacturing at a Kaifa facility in China, for sale by O.R. Technology. LS-120 drives produced on a contract manufacturing basis are also now being sold by Imation under the "SuperDisk" label.

It is also expected that 1997 will see the start of production for the UHC 130 megabyte drives by Mitsumi Electric, with diskettes manufactured by a third company, for sale by Swan Instruments, as a result of a 1996 Swan/Mitsumi agreement. In addition, there is the possibility of further product introductions of other high capacity floppy formats, if the companies working on them decide to invade an already crowded battlefield.

The last of the 21 megabyte original floptical drives was shipped in 1996. Although the 21 megabyte floptical drive found a market in a variety of specialized applications, broader sales throughout the computer industry were held down due to price levels perceived as too high by both computer system manufacturers and most end users, and a drive capacity not high enough to attract a broad market.

The final chapter in the 17 year history of the Iomega Bernoulli principle drive program is being written in 1997. 28,500 5.25" Bernoulli drives were shipped in 1996, following Iomega's notification to customers of the program's termination, and the last 800 units are expected to be shipped in 1997. Iomega's Bernoulli drives have competed primarily with removable rigid disk cartridge drives and small erasable optical disk drives, rather than with low capacity flexible disk drives available in the past, due to their capacity, performance, and pricing.

Iomega was founded in 1980 to manufacture 8" drives using Bernoulli technology, after the founders terminated their IBM careers over discouragement with IBM's failure to utilize the technology they had developed. Production of the original 8" drives ended six years ago, but shipments of the firm's 5.25" Bernoulli drives continued to grow until 1993. 5.25" Bernoulli drive shipments declined slightly in 1993 and 1994, but stayed just over the 100,000 unit level until 1995.

Despite 1995 availability of the 230 megabyte model, unit shipments went down sharply. Despite sharp price reductions for Bernoulli principle drives, competition from Iomega's own 3.5" Zip high capacity floppy drives proved much more lethal than the traditional competitors, rigid disk cartridge drives and small optical disk drives.

Because of the unique characteristics of its Bernoulli drives and lack of effective second sources, Iomega 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 was lack of alternate sources for the company's drives. The products were unique, and system manufacturers, as always, were 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. were abortive.

1996 shipments of high capacity floppy drives continued to be dominated by personal computers for business applications, with 90.9% of overall unit shipments for the product group. Workstations for engineering and office usage declined to 3.2% of shipments, and consumer, game and hobby computers held 4.8%. By 2000, shipments will consist only of relatively inexpensive 3.5" drive models, and personal computers are forecasted to retain 87.5% of all shipments, with workstations down to 2.1%, and consumer computers growing to 9.6%.

Iomega's shipments of almost 3.4 million drives in 1996, mostly 3.5" Zip models, provided the company with a clear lead in noncaptive shipments for the product group, 86.3% of the worldwide total. Initial production of LS-120 drives by Matsushita-Kotobuki Electronics provided 6.2% of the total.

Marketing trends

Although slightly lower than last year's DISK/TREND forecast, the current shipment projection for high capacity floppy drives indicates a pattern of aggressive growth. During the 1998-2000 period, an average annual increase of 45.3% is forecasted, culminating in shipments of 26.6 million drives in 2000. However, average unit prices are expected to decline continually as shipments increase, with the result that total sales revenues will start to decline by the end of the forecast period. After peaking at $910.6 million in 1999, sales revenues are projected to decline to $899.2 million in 2000.

There has been extensive speculation in the computer industry about the possibility that high capacity floppy drives would replace standard 1.44 megabyte 3.5" floppy drives. The DISK/TREND forecasts do not anticipate a major decline in shipments of low capacity floppy drives during the current forecast period. It is expected that the net effect of the availability of the high capacity floppy drives will be to capture most of the growth available to the two types of floppy drives, while the growth pattern for low capacity floppy drives becomes negligible by 2000.

The key reasons for the continued viability of 1.44 megabyte floppies are that a very large portion of the work being done on personal computers is simple word processing, for which standard floppies provide cost-effective backup and interchange capabilities, and the fact that the average OEM price for high capacity floppy drives is about three and a half times higher than the OEM price for low capacity floppy drives. The DISK/TREND projections are based on the expectation that word processing will still be the most widely used PC application in 2000, and that the average OEM price difference between high capacity and low capacity floppy drives, although declining, will still be at a 2.3 ratio.

The market's reaction to the generation of 3.5" high capacity floppy drives now available will be adequate to carry shipments for this product group to the much higher levels now projected. Several computer industry trends have combined to create this response.

The continuous increase in capacities for the fixed rigid disk drives used as the basic disk for all of today's personal computers has made many users nervous about their risks in failing to preserve their data by backing it up. For many of these users in both home and business applications, the high capacity floppy now provides an inexpensive alternative to buying a tape drive, and preserves the random access capability of the disk drive. Many other users now have the functional need to keep individual projects offline to free space on their system's fixed disk drive, a pattern previously available only to users of high-end personal computers or workstations, at much higher cost. The widespread usage of graphics and desktop publishing software, CD-ROM applications, games, and downloads from the Internet have inspired many additional computer users to seek affordable removable data storage devices which are suitable to keep individual projects on individual disks, ready to be loaded into a drive when needed.

High capacity 3.5" floppy drives are expected to capture a major part of the available market created by the above trends, while coexisting in a competitive marketplace alongside rigid disk cartridge drives, small optical disk drives and tape cartridge drives. During this forecast period, it is expected that the 3.5" 100 megabyte Zip drives, the 120 megabyte LS-120 drives and others not yet in production will be increased in capacity, initially to at least 200 megabytes, then probably doubled again, and that prices will be significantly reduced as sales increase.

At the moment, the key competitors are locked in a struggle for sales momentum, with LS-120 advocates contending that backward compatibility is essential to market dominance, and Iomega saying "Not so!". If all competitive considerations were equal, including drive prices, it would be logical to expect personal computer manufacturers to choose a backward compatible high capacity floppy drive if used as a standard feature in a PC. This would be especially true in the case of notebook computers, where there is never space for two floppy drives.

However, in this contest the Zip drive had more than a year's head start, initially developing sales as an aftermarket add-on product, later supplemented by OEM adoptions by several personal computer manufacturers. Although the high capacity floppy drive field has already become a classic electronics industry standards war, the battlefield is now becoming even more complex with resolution of the Mitsumi Electric/Swan Instruments licensing problems, and the promised availability during 1997 of the planned 130 megabyte UHC model drives.

Technology trends

The two most important development objectives for high capacity floppy disk drives will be to increase diskette capacities beyond the 100-120 megabytes now available and to achieve the design simplification required for low manufacturing cost.

The head positioning systems used in these drives are critical to potential increases in capacity, as well as to keeping manufacturing costs to a minimum. The embedded servo technique used by both the Iomega Zip drive and the Mitsumi/Swan UHC drive is similar to the method employed by most of the current generation rigid disk drives. The LS-120 floptical optical tracking method is perhaps the most innovative approach, with obvious potential for greater capacity and low manufacturing costs. The reflective servo pattern is imprinted on the diskette as part of the media manufacturing process, and should increase the media manufacturing cost only slightly when high shipment levels are achieved. The overwhelming challenge for the engineers working with the floptical design will be to reduce the manufacturing cost of the drive, no small challenge when the requirements of the optical tracking method and backward compatibility are considered, both of which contribute to an increased parts count.

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

It appears that the embedded servo design, initially used in high capacity floppies with Iomega's Zip drive, has intrinsic cost advantages, when compared with the floptical design. Both types of drives will be able to utilize components designed for rigid disk drives produced at very high production volumes, and therefore available at attractive costs. And as the rigid disk drive industry continues to advance rapidly in storage capacity, high capacity floppy drives will probably benefit from being able to utilize low cost components originally developed for magnetic rigid disk drives. The challenge will be for the LS-120 drive designers to simplify the basic floptical drive design to achieve the low parts count and simplified production techniques necessary to compete on an equal basis with competitors using embedded servo technology.

Forecasting assumptions

1. Adequate production of 3.5" high capacity floppy drives will be available in the 1997-2000 period to satisfy demand, which will grow to exceed 26 million drives per year by 2000.

2. Although the higher production levels for 3.5" high capacity floppy drives projected for future years will lower the pricing differential compared to 1.44 megabyte 3.5" drives, high capacity 3.5" drives will still be priced 2 to 3 times higher at the OEM level than 1.44 megabyte drives in 2000, and will not be able to replace them as the basic floppy drive used with the majority of personal computers.

3. Shipments of 5.25" Bernoulli drives will end in 1997.

TABLE 45

HIGH CAPACITY FLEXIBLE DISK DRIVES

REVENUE SUMMARY

	DISK DRIVE REVENUES, BY SHIPMENT DESTINATION ($M)									
	1996		Forecast							
	Revenues		1997		1998		1999		2000	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
PCM/Distributor	181.0	269.8	160.2	267.1	176.0	298.3	160.8	277.2	131.8	231.4
OEM/Integrator	5.5	8.3	105.6	150.9	161.9	224.9	186.5	252.0	184.2	242.4
TOTAL U.S. REVENUES	186.5	278.1	265.8	418.0	337.9	523.2	347.3	529.2	316.0	473.8
Non-U.S. Manufacturers										
PCM/Distributor	8.3	14.0	31.8	49.9	47.4	81.9	79.0	125.6	97.9	150.6
OEM/Integrator	33.7	36.1	82.5	129.8	125.1	189.8	166.3	255.8	175.9	274.8
TOTAL NON-U.S. REVENUES	42.0	50.1	114.3	179.7	172.5	271.7	245.3	381.4	273.8	425.4
Worldwide Recap										
TOTAL WORLDWIDE REVENUES	228.5	328.2	380.1	597.7	510.4	794.9	592.6	910.6	589.8	899.2
OEM Average Price ($000)		.092		.065		.050		.041		.032

TABLE 46

HIGH CAPACITY FLEXIBLE DISK DRIVES

UNIT SHIPMENT SUMMARY

	DISK DRIVE UNIT SHIPMENTS, BY SHIPMENT DESTINATION (000)									
	1996		Forecast							
	Shipments		1997		1998		1999		2000	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
PCM/Distributor	2,180.8	3,290.8	2,465.0	4,110.0	3,260.0	5,525.0	3,655.0	6,300.0	3,765.0	6,610.0
OEM/Integrator	71.8	107.7	1,920.0	2,740.8	3,520.0	4,890.0	5,040.0	6,810.0	6,140.0	8,080.0
TOTAL U.S. SHIPMENTS	2,252.6	3,398.5	4,385.0	6,850.8	6,780.0	10,415.0	8,695.0	13,110.0	9,905.0	14,690.0
Non-U.S. Manufacturers										
PCM/Distributor	100.0	165.0	320.0	505.0	790.0	1,365.0	1,645.0	2,615.0	2,645.0	4,070.0
OEM/Integrator	346.0	375.0	1,030.0	1,530.0	2,195.0	3,330.0	3,615.0	5,560.0	5,025.0	7,850.0
TOTAL NON-U.S. SHIPMENTS	446.0	540.0	1,350.0	2,035.0	2,985.0	4,695.0	5,260.0	8,175.0	7,670.0	11,920.0
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	2,698.6	3,938.5	5,735.0	8,885.8	9,765.0	15,110.0	13,955.0	21,285.0	17,575.0	26,610.0
Cumulative Shipments (Units in millions)										
WORLDWIDE TOTAL	4.3	6.1	10.0	14.9	19.8	30.1	33.8	51.3	51.3	77.9

TABLE 47

HIGH CAPACITY FLEXIBLE DISK DRIVES

WORLDWIDE REVENUES ($M)

BREAKDOWN BY DISK DIAMETER

	1996 Revenues		Forecast 1997		Forecast 1998	Forecast 1999	Forecast 2000
	5.25"	3.5"	5.25"	3.5"	3.5"	3.5"	3.5"
U.S. MANUFACTURERS							
PCM/Distributor	8.6	261.2	--	267.1	298.3	277.2	231.4
OEM/Integrator	.9	7.4	.2	150.7	224.9	252.0	242.4
TOTAL U.S. REVENUES	9.5	268.6	.2	417.8	523.2	529.2	473.8
NON-U.S. MANUFACTURERS							
PCM/Distributor	--	14.0	--	49.9	81.9	125.6	150.6
OEM/Integrator	--	36.1	--	129.8	189.8	255.8	274.8
TOTAL NON-U.S. REVENUES	--	50.1	--	179.7	271.7	381.4	425.4
WORLDWIDE RECAP							
PCM/Distributor	8.6	275.2	--	317.0	380.2	402.8	382.0
	-61.9%	+206.8%	--	+15.2%	+19.9%	+5.9%	-5.2%
OEM/Integrator	.9	43.5	.2	280.5	414.7	507.8	517.2
	-50.0%	+424.1%	-77.8%	+544.8%	+47.8%	+22.4%	+1.9%
Total Revenues	9.5	318.7	.2	597.5	794.9	910.6	899.2
	-61.1%	+225.2%	-97.9%	+87.5%	+33.0%	+14.6%	-1.3%
ANNUAL SHARE, BY DIAMETER	2.9%	97.1%	--	100.0%	100.0%	100.0%	100.0%

TABLE 48

HIGH CAPACITY FLEXIBLE DISK DRIVES

WORLDWIDE SHIPMENTS (000)

BREAKDOWN BY DISK DIAMETER

	1996 Shipments 5.25"	1996 Shipments 3.5"	Forecast 1997 5.25"	Forecast 1997 3.5"	Forecast 1998 3.5"	Forecast 1999 3.5"	Forecast 2000 3.5"
U.S. MANUFACTURERS							
PCM/Distributor	25.8	3,265.0	--	4,110.0	5,525.0	6,300.0	6,610.0
OEM/Integrator	2.7	105.0	.8	2,740.0	4,890.0	6,810.0	8,080.0
TOTAL U.S. SHIPMENTS	28.5	3,370.0	.8	6,850.0	10,415.0	13,110.0	14,690.0
NON-U.S. MANUFACTURERS							
PCM/Distributor	--	165.0	--	505.0	1,365.0	2,615.0	4,070.0
OEM/Integrator	--	375.0	--	1,530.0	3,330.0	5,560.0	7,850.0
TOTAL NON-U.S. SHIPMENTS	--	540.0	--	2,035.0	4,695.0	8,175.0	11,920.0
WORLDWIDE RECAP							
PCM/Distributor	25.8	3,430.0	--	4,615.0	6,890.0	8,915.0	10,680.0
	-58.2%	+386.5%	--	+34.6%	+49.3%	+29.4%	+19.8%
OEM/Integrator	2.7	480.0	.8	4,270.0	8,220.0	12,370.0	15,930.0
	-55.0%	+772.7%	-70.4%	+789.6%	+92.5%	+50.5%	+28.8%
Total Shipments	28.5	3,910.0	.8	8,885.0	15,110.0	21,285.0	26,610.0
	-57.9%	+414.5%	-97.2%	+127.2%	+70.1%	+40.9%	+25.0%
ANNUAL SHARE, BY DIAMETER	.7%	99.3%	--	100.0%	100.0%	100.0%	100.0%

TABLE 49

HIGH CAPACITY FLEXIBLE DISK DRIVES

APPLICATIONS SUMMARY
Percentage of Worldwide Shipments

APPLICATION	1996 Estimate Units (000)	1996 Estimate %	2000 Projection Units (000)	2000 Projection %
VERY HIGH PERFORMANCE				
Supercomputers and high end imaging	--	--	--	--
MAINFRAME SYSTEMS				
General purpose	--	--	--	--
NETWORKS/MIDRANGE SYSTEMS				
Midrange systems and network servers	--	--	26.6	.1
PERSONAL COMPUTERS				
Business and professional, single user	3,583.2	91.0	23,283.7	87.5
WORKSTATIONS				
Engineering and office, single user	124.5	3.2	558.8	2.1
CONSUMER, GAME AND HOBBY COMPUTERS	187.5	4.8	2,554.6	9.6
OTHER APPLICATIONS	43.3	1.0	186.3	.7
Total	3,938.5	100.0	26,610.0	100.0

TABLE 50

HIGH CAPACITY FLEXIBLE DISK DRIVES

MARKET SHARE SUMMARY
Worldwide Shipments of Noncaptive Disk Drives

1996 Net Shipments

	To United States Destinations				Worldwide			
	Units (000)			%	Units (000)			%
Drive Manufacturers	5.25"	3.5"	Total		5.25"	3.5"	Total	
Iomega	27.6	2225.0	2252.6	83.5	28.5	3370.0	3398.5	86.3
Matsushita Kotobuki E.	--	220.0	220.0	8.2	--	244.0	244.0	6.2
Other U.S.	--	--	--	--	--	--	--	--
Other Non-U.S.	--	226.0	226.0	8.3	--	296.0	296.0	7.5
TOTAL	27.6	2671.0	2698.6	100.0	28.5	3910.0	3938.5	100.0

LOW CAPACITY FLEXIBLE DISK DRIVES

LOW CAPACITY FLEXIBLE DISK DRIVES

Coverage

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

8" disk diameter

Y-E Data	YD-180

5.25" disk diameter: 1.2 megabytes

Mitsumi Electric	D509V5
Samsung Electro-Mechanics	SFD-560D
Tae Il Media	TFD-510
TEAC	FD-55GFR, FD-155GF
Y-E Data	YD-380B

5.25" disk diameter: 2.4 megabytes

Y-E Data	YD-801

3.5" disk diameter: 1.2 megabytes

Mitsumi Electric	D358F2*
NEC	FD 1139C
TEAC	FD-235GF
Y-E Data	YD-686C

3.5" disk diameter: 1.44 megabytes

Alps Electric	DF 354H
Citizen	OSDA, W1DE*
Matsushita Communication Ind.	JU-227A*, JU-257A
Mitsubishi Electric	MF 355F, MF 355H*
Mitsumi Electric	D 359G*, D 359T5
NEC	FD 1231H, FD 1239H*
Samsung Electro-Mechanics	SFD-321D, SFD-321S*
S.F.R.	DS-34AC
Sony	MPF720*, MPF920
Tai Il Media	TFD-310, TFD-320
TEAC	FD-235HF, FD-04HG*, FD-05HF*
Y-E Data	YD-701B, YD-702J*

3.5" disk diameter: 2.88 megabytes

Mitsubishi Electric	MF 356F

*12.7 millimeters height, or less

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

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

The only type of microfloppy currently remaining in the low capacity floppy drive product group is the 3.5" format, which has evolved into the industry standard. All of the other microfloppy formats in the 2" to 4" diameter range which were introduced during the last 14 years have been phased out. All 3.5" drives are derived from the Sony microfloppy first shipped in 1982, with modifications to achieve logical file organization similar to the larger diskette drives which preceded it in the market.

The last of the drives with capacities of one megabyte or less, most of which were designed to maintain logical file compatibility with 5.25" drives, were phased out during the last few years. 1.2 and 1.44 megabyte 3.5" drives were announced in 1985, and are intended for use with the high density media originally proposed by Sony, which operates at up to 17,434 BPI, and uses the 135 TPI standard of today's production drives. 1.2 megabyte 3.5" drives are compatible with NEC drives used with personal computers in the domestic Japanese market. After the adoption of 1.44 megabyte drives by IBM in April, 1987, for the PS/2 systems, most major manufacturers of microfloppy drives added drives with the same capacity.

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

The 3" microfloppy format which was produced in quantity for several years has lost all of its original adherents including the last holdout, Matsushita Electronic Components, and is now out of production. 2" drives, in a data recording version of a video camera floppy, were produced during recent years by Sony, but found a limited market. Initial shipments of 2" drives with notebook computers encountered resistance from buyers who did not want to bother with interchange problems, and there were not enough applications in home computers, electronic typewriters and games to maintain growth for the 2" format. While there may eventually be a future for a 2" or smaller floppy format, most of the drive manufacturers do not appear to be interested. Mitsubishi Electric has shown a miniaturized 1.44 megabyte floppy drive in a PC Card format at trade shows during the last few years, but has also found resistance from buyers concerned with interchange considerations. The drive has not gone into production, and may evolve into higher capacity versions.

Market status

In recent years, the growth rate for low capacity floppy drives has slowed down. For many years, the majority of personal computers used in business applications utilized both 3.5" and 5.25" floppy drives to facilitate interchange of 5.25" diskettes with older personal computers. However, shipments of 5.25" floppy drives declined rapidly after 1992, as the percentage of PC buyers who needed 5.25" floppy drives for interchange dropped off. The gradual trend to delete the 3.5" floppy drive from many notebook computer models has also reduced the drive growth rate. These factors have slowed the overall growth rate for low capacity floppy drive shipments in the last few years, and the current period will be affected by these trends, plus the additional negative influences of some additional displacement by high capacity floppy drives and early inroads by "network computers", using neither rigid or flexible disk drives.

89 million low capacity floppy drives were shipped in 1989, with worldwide shipments of 95.3 million forecasted for 1997, an increase of 7.1%. Many industry participants are surprised to learn that 8" floppy drives are still in production, 24 years after introduction. 8" drive shipments are nominal, with only one manufacturer and the 1997 total estimated at 2,000 drives. 5.25" drive shipments were down to less than 1.2 million in 1996, with only 158,000 forecasted for 1997. 3.5" drives will provide 99.8% of the 1997 shipments of low capacity floppy drives.

Floppy drives less than one inch high initially became a growth product for notebook computer applications, but that trend is now dissipating, with the tendency of computer manufacturers to leave the floppy drive out of some notebook computer models, combined with the negative influence of generally higher prices for thin floppy drives. One inch high (25.4 millimeter) 3.5" floppy drives became the dominant form factor several years ago, and have shown continuing strength in the face of competition from new drives in thinner physical formats. Intense competition has come from drives with smaller heights -- initially 19 millimeters, then 17 millimeters, 15 millimeters, then in late 1991 12.7 millimeters, and more recently down to 10.9 millimeters. 3.5" floppy drives in packages 12.7 millimeters thick now constitute most of the 3.5" drive shipments for models less than one inch high, which collectively provided 13.6% of the 1996 3.5" overall total, with an expected decline in 1997, 11.8% of the overall total.

The downward trend for 3.5" floppy drive pricing continues. The reasons for the continuing price decline are pressure from system manufacturers for the lowest possible price, extensive product redesign for cost reduction, and the movement of most Japanese floppy drive manufacturing to offshore production sites with lower costs. The average OEM price for all 3.5" floppy drives was $59 in 1988, $51 in 1989, $46 in 1990, $42 in 1991, $38 in 1992, $34 in 1993, $27 in 1994, $22 in 1995, and $20 in 1996. In 1997 the overall OEM average unit price for 3.5" floppy drives is expected to be $18, with the standard one inch high models a dollar or two lower.

1.2/1.44 megabyte models continue to dominate shipments of 3.5" drives, with almost 100% of the overall 1997 shipments of 3.5" low capacity floppy drives. The 1.44 megabyte 3.5" models which originated in 1985 and are now offered by nearly all major floppy drive manufacturers have become the industry's major products, originally stimulated by IBM's 1987 adoption of 1.44 megabyte drives for PS/2 personal computers. The similar 1.2 megabyte drives are used mostly in Japan, primarily by NEC and with computers designed to be compatible with NEC's personal computer product line.

1997 is expected to be the last year of sales for the 2.88 megabyte drive, with only 13,000 units. IBM's adoption of the 2.88 megabyte microfloppy format in 1991 for numerous PS/2 personal computer models inspired a flurry of product introductions, but the 2.88 megabyte format has proven to be a failure. Most floppy drive manufacturers had expected 2.88 megabyte drives to become an important part of the industry, but shipments peaked at only 1.6 million drives in 1993, and have declined rapidly. The major negative influence holding down wider usage was the 2.88 megabyte drives' higher selling price, combined with low awareness of the drives' higher capacity among computer users. Since personal computer system manufacturers did not notice significant demand for 2.88 megabyte floppy drives, few personal computer manufacturers included them in new systems, and those that offered 2.88 megabyte drives classified them as options, not standard equipment.

Low capacity floppy drive shipments continue to be dominated by applications with business personal computers, with 92.9% of the worldwide total in 1996. However, business personal computer applications are expected to take a somewhat smaller share of 2000's total shipments, declining to 83.9%, as consumer and hobby applications rise to 14.5% of the 2000 total of low capacity floppy drive shipments.

Mitsumi Electric captured the lead in noncaptive floppy drive shipments in 1996, based primarily on strong shipments of 3.5" drives, with 16.2 million drives, 18.6% of the worldwide total. TEAC dropped to second place with 17.5 million drives, impacted by rapidly declining 5.25" drive shipments, with 17.5% of the worldwide total. Sony held third place with a 14.3% share.

Marketing trends

The long-term decline in total sales revenues for low capacity floppy drives has been caused by sinking average unit prices, combined with product mix changes, as sales have dropped for several types of drives with higher prices. The situation continues to change. In 1997, the 5.25" floppy drive is almost gone, along with the downward influence on revenues caused for several years by falling sales of the relatively high priced 5.25" drives. On the other hand, the tendency of computer manufacturers to design lightweight notebook computers without on board floppy drives is starting to reduce shipments of higher price thin 3.5" floppy drive models. Furthermore, the long-term shipment growth for the industry's basic one inch high 3.5" floppy drives is expected to be held down by competition from high capacity floppy drives.

Low capacity floppy drives are forecasted to produce total sales revenues of $1.5 billion in 2000, depressed by product mix changes and especially by continued reductions in the noncaptive average unit price for mainstream one inch high 3.5" drives. Noncaptive drive price levels are expected to continue the long-term trend to lower levels, as the result of intense competition between leading Japanese floppy drive manufacturers and the lower costs these manufacturers are achieving as they fine-tune the manufacturing facilities which have been established during recent years in the Philippines, Malaysia, Thailand, and China. The overall average unit OEM price for 3.5" floppy drives is forecasted to be only $14 in 2000.

The last 8" and 5.25" floppy drive shipments are expected in 1998. Despite continuing growth in the personal computer market, declining utilization of floppy drives in lightweight notebook computers and competitive inroads by high capacity floppy drives in both notebook and desktop personal computers will impact the growth rate for 3.5" low capacity floppy drives. In past years, the annual growth rate in shipments of floppy drives was similar to the growth rate for personal computers. But the changing usage patterns for low capacity floppy drives, combined with new competition, are expected to reduce the annual growth rate in shipments during the 1998-2000 period to 2.1%. Total shipments of 101.3 thousand are projected for 2000, representing a 0.3% increase over the previous year.

Now gaining momentum is the trend for some notebook computers to be designed without internal floppy drives, relying on other methods of interchange, such as direct or infrared connections to networks. Although the increasing population of CD-ROM drives in the personal computer and workstation markets will absorb a portion of the software distribution role traditionally held by floppies, CD-ROM penetration of these markets by itself is not expected to have a significant impact on shipments of floppy drives, which provide a unique low cost interchange medium. However, many of the high capacity 3.5" floppy drives in the 100+ megabyte range now entering the market will displace low capacity 3.5" floppy drives. Several of the announced high capacity 3.5" floppy drives will be available in packages less than one inch thick and will offer backward compatibility to low capacity diskettes, and when used will clearly be installed in lieu of a low capacity 3.5" floppy drive.

Shipments of drives with heights less than one inch are not expected to grow. Most floppy drive manufacturers have discontinued drives in the 15-19 millimeter height range. Demand for 10.9-12.7 millimeter high floppy drives is driven mostly by the continuing expansion of the notebook computer market, which now employs floppies limited to this height range. However, in addition to the direct network connections now used with selected notebook computers, some others are being packaged in ever smaller form factors, accelerating the tendency to eliminate the floppy drive in the smaller implementations, relying for interchange on network connections or on externally attached floppy drives. Shipments of drives less than one inch high is expected to decline at an annual average of 8.1% in the 1998-2000 period.

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

Technical trends

Several years ago, several floppy drive manufacturers undertook development programs to increase floppy drive capacities into the 2-5 megabyte range. Most of the programs resulted in producible products, but all failed in the marketplace due to limited industry support and high product prices. As attempts to upgrade the standard floppy disk drive configurations with increased capacity have failed, the product development target for all remaining manufacturers of low capacity floppy drives has become cost reduction. Intense activity has resulted in lower costs through reduction of electronic and mechanical parts counts, and through substitution of alternate materials.

The industry's failure to reduce costs fast enough for the 2.88 megabyte 3.5" drive prevented it from becoming a mainstream product. The biggest problem was the greater complexity and higher costs associated with the multifunction head required to provide downward compatibility with .7 and 1.44 megabyte drives. The result was 2.88 megabyte drives with selling prices twice those of standard 1.44 megabyte 3.5" floppy drives -- and a distinct lack of enthusiasm by most manufacturers of personal computers.

The next challenges for most manufacturers of 3.5" drives are packaging problems in reducing the height of the drive to meet the demand for half inch high drives -- and to hold down costs at the same time. It has been very expensive and technically difficult for most manufacturers to match competition with continually smaller drive configurations. Nevertheless, the changes have been achievable, once production of smaller motors and other key components became available. The thinner drive configurations made possible the initial announcements in 1994 of combination packages of 3.5" floppy drive/CD-ROM drive and 3.5" floppy drive/PCMCIA card slot combinations. However, the floppy drive manufacturers' attempts to retain as much of a market with manufacturers of notebook computers as possible will provide a continuing incentive to reduce the production costs of floppy drives 12.7 millimeters or less in thickness to levels much closer to those one inch high drives.

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

Forecasting assumptions

1. Shipments of 3.5" drives with heights less than one inch will continue to decline starting in 1997, and 1.44 megabyte drives will maintain shipment dominance through 2000.

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

3. 1998 will be the last year of production for 8" and 5.25" floppy drives.

4. A positive growth rate for personal computers will continue through 1999.

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

TABLE 51

LOW CAPACITY FLEXIBLE DISK DRIVES

REVENUE SUMMARY

	DISK DRIVE REVENUES, BY SHIPMENT DESTINATION ($M)									
	1996 Revenues		Forecast							
			1997		1998		1999		2000	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
TOTAL U.S. REVENUES	--	--	--	--	--	--	--	--	--	--
Non-U.S. Manufacturers										
Captive	--	141.6	22.5	153.9	25.2	150.9	26.8	144.0	27.6	136.6
PCM/Distributor	217.1	552.2	208.0	537.3	205.2	550.5	190.0	523.5	172.6	488.6
OEM/Integrator	363.8	1,128.9	438.2	1,073.5	425.8	1,029.2	413.9	961.8	393.2	894.1
TOTAL NON-U.S. REVENUES	580.9	1,822.7	668.7	1,764.7	656.2	1,730.6	630.7	1,629.3	593.4	1,519.3
Worldwide Recap										
TOTAL WORLDWIDE REVENUES	580.9	1,822.7	668.7	1,764.7	656.2	1,730.6	630.7	1,629.3	593.4	1,519.3
OEM Average Price ($000)		.020		.018		.016		.015		.014

TABLE 52

LOW CAPACITY FLEXIBLE DISK DRIVES

UNIT SHIPMENT SUMMARY

	DISK DRIVE UNIT SHIPMENTS, BY SHIPMENT DESTINATION (000)									
	1996 Shipments		Forecast							
			1997		1998		1999		2000	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
TOTAL U.S. SHIPMENTS	--	--	--	--	--	--	--	--	--	--
Non-U.S. Manufacturers										
Captive	--	1,998.0	450.0	2,940.0	535.0	3,110.0	605.0	3,190.0	665.0	3,240.0
PCM/Distributor	12,295.0	31,237.7	12,850.0	33,440.0	12,765.0	34,340.0	12,605.0	34,840.0	12,260.0	34,830.0
OEM/Integrator	19,128.4	55,770.4	25,634.0	58,953.0	26,998.0	61,851.0	28,395.0	63,020.0	29,075.0	63,280.0
TOTAL NON-U.S. SHIPMENTS	31,423.4	89,006.1	38,934.0	95,333.0	40,298.0	99,301.0	41,605.0	101,050.0	42,000.0	101,350.0
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	31,423.4	89,006.1	38,934.0	95,333.0	40,298.0	99,301.0	41,605.0	101,050.0	42,000.0	101,350.0
Cumulative Shipments (Units in millions)										
WORLDWIDE TOTAL	281.9	652.0	320.8	747.3	361.1	846.6	402.7	947.7	444.7	1,049.0

TABLE 53

LOW CAPACITY FLEXIBLE DISK DRIVES

WORLDWIDE REVENUES ($M)

BREAKDOWN BY DISK DIAMETER

	1996 Revenues			Forecast 1997			Forecast 1998			Forecast 1999	Forecast 2000
	8"	5.25"	3.5"	8"	5.25"	3.5"	8"	5.25"	3.5"	3.5"	3.5"
U.S. MANUFACTURERS											
TOTAL U.S. REVENUES	--	--	--	--	--	--	--	--	--	--	--
NON-U.S. MANUFACTURERS											
Captive	--	.9	140.7	--	.4	153.5	--	--	150.9	144.0	136.6
PCM/Distributor	--	20.0	532.2	--	1.7	535.6	--	.4	550.1	523.5	488.6
OEM/Integrator	1.1	15.6	1,112.2	.6	4.5	1,068.4	.3	1.3	1,027.6	961.8	894.1
TOTAL NON-U.S. REVENUES	1.1	36.5	1,785.1	.6	6.6	1,757.5	.3	1.7	1,728.6	1,629.3	1,519.3
WORLDWIDE RECAP											
Captive	--	.9	140.7	--	.4	153.5	--	--	150.9	144.0	136.6
	--	-74.3%	-5.6%	--	-55.6%	+9.1%	--	--	-1.7%	-4.6%	-5.1%
PCM/Distributor	--	20.0	532.2	--	1.7	535.6	--	.4	550.1	523.5	488.6
	--	-80.3%	+45.8%	--	-91.5%	+.6%	--	-76.5%	+2.7%	-4.8%	-6.7%
OEM/Integrator	1.1	15.6	1,112.2	.6	4.5	1,068.4	.3	1.3	1,027.6	961.8	894.1
	-76.6%	-78.5%	-13.5%	-45.5%	-71.2%	-3.9%	-50.0%	-71.1%	-3.8%	-6.4%	-7.0%
Total Revenues	1.1	36.5	1,785.1	.6	6.6	1,757.5	.3	1.7	1,728.6	1,629.3	1,519.3
	-80.7%	-79.5%	-.8%	-45.5%	-81.9%	-1.5%	-50.0%	-74.2%	-1.6%	-5.7%	-6.8%
ANNUAL SHARE, BY DIAMETER	.1%	2.0%	97.9%	--	.4%	99.6%	--	.1%	99.9%	100.0%	100.0%

TABLE 54

LOW CAPACITY FLEXIBLE DISK DRIVES

WORLDWIDE SHIPMENTS (000)

BREAKDOWN BY DISK DIAMETER

	1996 Shipments			Forecast 1997			1998			1999	2000
	8"	5.25"	3.5"	8"	5.25"	3.5"	8"	5.25"	3.5"	3.5"	3.5"
U.S. MANUFACTURERS											
TOTAL U.S. SHIPMENTS	--	--	--	--	--	--	--	--	--	--	--
NON-U.S. MANUFACTURERS											
Captive	--	10.0	1,988.0	--	5.0	2,935.0	--	--	3,110.0	3,190.0	3,240.0
PCM/Distributor	--	704.7	30,533.0	--	65.0	33,375.0	--	15.0	34,325.0	34,840.0	34,830.0
OEM/Integrator	4.0	478.0	55,288.4	2.0	88.0	58,863.0	1.0	25.0	61,825.0	63,020.0	63,280.0
TOTAL NON-U.S. SHIPMENTS	4.0	1,192.7	87,809.4	2.0	158.0	95,173.0	1.0	40.0	99,260.0	101,050.0	101,350.0
WORLDWIDE RECAP											
Captive	--	10.0	1,988.0	--	5.0	2,935.0	--	--	3,110.0	3,190.0	3,240.0
	--	-73.0%	+34.3%	--	-50.0%	+47.6%	--	--	+6.0%	+2.6%	+1.6%
PCM/Distributor	--	704.7	30,533.0	--	65.0	33,375.0	--	15.0	34,325.0	34,840.0	34,830.0
	--	-77.4%	+79.5%	--	-90.8%	+9.3%	--	-76.9%	+2.8%	+1.5%	--
OEM/Integrator	4.0	478.0	55,288.4	2.0	88.0	58,863.0	1.0	25.0	61,825.0	63,020.0	63,280.0
	-77.8%	-78.3%	-5.3%	-50.0%	-81.6%	+6.5%	-50.0%	-71.6%	+5.0%	+1.9%	+.4%
Total Shipments	4.0	1,192.7	87,809.4	2.0	158.0	95,173.0	1.0	40.0	99,260.0	101,050.0	101,350.0
	-81.0%	-77.7%	+14.3%	-50.0%	-86.8%	+8.4%	-50.0%	-74.7%	+4.3%	+1.8%	+.3%
ANNUAL SHARE, BY DIAMETER	--	1.3%	98.7%	--	.2%	99.8%	--	--	100.0%	100.0%	100.0%

TABLE 55

LOW CAPACITY FLEXIBLE DISK DRIVES

WORLDWIDE SHIPMENTS (000)

DRIVE HEIGHT ANALYSIS

	1996 --Shipments--		Forecast -----1997----		-----1998----		-----1999----		-----2000----	
	Units	%	Units	%	Units	%	Units	%	Units	%
U.S. MANUFACTURERS										
Total U.S.	--		--		--		--		--	
NON-U.S. MANUFACTURERS										
Captive Total	1,988.0		2,935.0		3,110.0		3,190.0		3,240.0	
Less than 1 inch	625.0	31.4%	670.0	22.8%	715.0	23.0%	685.0	21.5%	640.0	19.8%
1 inch	1,363.0	68.6%	2,265.0	77.2%	2,395.0	77.0%	2,505.0	78.5%	2,600.0	80.2%
Noncaptive Total	85,821.4		92,238.0		96,150.0		97,860.0		98,110.0	
Less than 1 inch	11,278.4	13.1%	10,555.0	11.4%	9,805.0	10.2%	8,870.0	9.1%	8,045.0	8.2%
1 inch	74,543.0	86.9%	81,683.0	88.6%	86,345.0	89.8%	88,990.0	90.9%	90,065.0	91.8%
Total Non-U.S.	87,809.4		95,173.0		99,260.0		101,050.0		101,350.0	
Less than 1 inch	11,903.4	13.6%	11,225.0	11.8%	10,520.0	10.6%	9,555.0	9.5%	8,685.0	8.6%
1 inch	75,906.0	86.4%	83,948.0	88.2%	88,740.0	89.4%	91,495.0	90.5%	92,665.0	91.4%
WORLDWIDE SHIPMENTS										
Total Worldwide Shipments	87,809.4		95,173.0		99,260.0		101,050.0		101,350.0	
	+14.3%		+8.4%		+4.3%		+1.8%		+.3%	
Less than 1 inch	11,903.4	13.6%	11,225.0	11.8%	10,520.0	10.6%	9,555.0	9.5%	8,685.0	8.6%
	+14.0%		-5.6%		-6.2%		-9.1%		-9.0%	
1 inch	75,906.0	86.4%	83,948.0	88.2%	88,740.0	89.4%	91,495.0	90.5%	92,665.0	91.4%
	+14.3%		+10.6%		+5.7%		+3.1%		+1.3%	

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

TABLE 56

LOW CAPACITY FLEXIBLE DISK DRIVES

WORLDWIDE SHIPMENTS (000)

DRIVE CAPACITY ANALYSIS

	1996 --Shipments--		Forecast -----1997----		-----1998----		-----1999----		-----2000----	
	Units	%	Units	%	Units	%	Units	%	Units	%
U.S. MANUFACTURERS										
Total U.S.	--		--		--		--		--	
NON-U.S. MANUFACTURERS										
Captive Total	1,988.0		2,935.0		3,110.0		3,190.0		3,240.0	
1.2/1.44 Megabytes	1,988.0	100.0%	2,935.0	100.0%	3,110.0	100.0%	3,190.0	100.0%	3,240.0	100.0%
Noncaptive Total	85,821.4		92,238.0		96,150.0		97,860.0		98,110.0	
.7 Megabyte or less	115.4	.1%	5.0	--	--	--	--	--	--	--
1.2/1.44 Megabytes	85,550.0	99.7%	92,220.0	100.0%	96,150.0	100.0%	97,860.0	100.0%	98,110.0	100.0%
2.88 Megabytes	156.0	.2%	13.0	--	--	--	--	--	--	--
Total Non-U.S.	87,809.4		95,173.0		99,260.0		101,050.0		101,350.0	
.7 Megabyte or less	115.4	.1%	5.0	--	--	--	--	--	--	--
1.2/1.44 Megabytes	87,538.0	99.7%	95,155.0	100.0%	99,260.0	100.0%	101,050.0	100.0%	101,350.0	100.0%
2.88 Megabytes	156.0	.2%	13.0	--	--	--	--	--	--	--
WORLDWIDE SHIPMENTS										
Total Worldwide Shipments	87,809.4		95,173.0		99,260.0		101,050.0		101,350.0	
	+14.3%		+8.4%		+4.3%		+1.8%		+.3%	
.7 Megabyte or less	115.4	.1%	5.0	--	--	--	--	--	--	--
	-57.2%		-95.6%		--		--		--	
1.2/1.44 Megabytes	87,538.0	99.7%	95,155.0	100.0%	99,260.0	100.0%	101,050.0	100.0%	101,350.0	100.0%
	+14.7%		+8.7%		+4.3%		+1.8%		+.3%	
2.88 Megabytes	156.0	.2%	13.0	--	--	--	--	--	--	--
	-41.0%		-91.6%		--		--		--	

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

TABLE 57

LOW CAPACITY FLEXIBLE DISK DRIVES

APPLICATIONS SUMMARY
Percentage of Worldwide Shipments

APPLICATION	1996 Estimate Units (000)	1996 Estimate %	2000 Projection Units (000)	2000 Projection %
VERY HIGH PERFORMANCE Supercomputers and high end imaging	--	--	--	--
MAINFRAME SYSTEMS General purpose	--	--	--	--
NETWORKS/MIDRANGE SYSTEMS Midrange systems and network servers	267.0	.3	101.3	.1
PERSONAL COMPUTERS Business and professional, single user	82,686.7	92.9	85,032.6	83.9
WORKSTATIONS Engineering and office, single user	1,967.0	2.2	1,317.6	1.3
CONSUMER, GAME AND HOBBY COMPUTERS	3,693.8	4.2	14,695.8	14.5
OTHER APPLICATIONS	391.6	.4	202.7	.2
Total	89,006.1	100.0	101,350.0	100.0

TABLE 58

LOW CAPACITY FLEXIBLE DISK DRIVES

MARKET SHARE SUMMARY
Worldwide Shipments of Noncaptive Disk Drives

	1996 Net Shipments									
	To United States Destinations					Worldwide				
	Units (000)				%	Units (000)				%
Drive Manufacturers	8"	5.25"	3.5"	Total		8"	5.25"	3.5"	Total	
Mitsumi Electric	--	--	4916.0	4916.0	15.6	--	16.7	16181.0	16197.7	18.6
TEAC	--	145.0	6628.0	6773.0	21.6	--	462.0	14730.0	15192.0	17.5
Sony	--	--	6650.0	6650.0	21.2	--	--	12480.0	12480.0	14.3
Matsushita Comm. Ind.	--	28.0	2283.0	2311.0	7.4	--	283.0	7863.0	8146.0	9.4
Mitsubishi Elictric	--	--	1846.0	1846.0	5.9	--	--	6738.0	6738.0	7.7
Alps Electric	--	--	2338.0	2338.0	7.4	--	--	6710.0	6710.0	7.7
NEC	--	15.0	2485.0	2500.0	8.0	--	62.0	5330.0	5392.0	6.2
Y-E Data	1.0	6.0	1650.0	1657.0	5.3	4.0	31.0	4128.0	4163.0	4.8
Citizen	--	--	351.0	351.0	1.1	--	--	3911.0	3911.0	4.5
Seiko Epson	--	30.0	900.0	930.0	3.0	--	150.0	2840.0	2990.0	3.4
Matsushita Elec. Ind.	--	--	513.4	513.4	1.6	--	--	2690.4	2690.4	3.1
Other U.S.	--	--	--	--	--	--	--	--	--	--
Other Non-U.S.	--	3.0	635.0	638.0	1.9	--	178.0	2220.0	2398.0	2.8
TOTAL	1.0	227.0	31195.4	31423.4	100.0	4.0	1182.7	85821.4	87008.1	100.0

FLASH CARD SPECIFICATIONS

FLASH CARD SPECIFICATIONS

Coverage

This product specification section of the Removable Data Storage report includes flash cards packaged in PC Card format and the new smaller formats, all of which are now in production or announced, arranged alphabetically by manufacturer.

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

Generic product type

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

Capacity

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

Interface

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

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.

Package

Package refers to the PC Card form factor used for the card or to a sub-PC Card packaging format such as Compact Flash, SSFDC or Miniature Card.

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.

Sector endurance, spare sectors and wearout leveling

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

Average access time

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

Internal data read rate

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

Internal data write rate

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

External transfer rate

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

Block erase time

Flash memory must be erased one block at a time, and it 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 cards with capacities over 100 megabytes have been placed in the highest capacity group.

1997 DISK/TREND product groups for flash cards included in the Removable Data Storage report

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

MANUFACTURER	ACTIONTEC	ACTIONTEC	ACTIONTEC	ACTIONTEC	ACTIONTEC
FLASH CARD MODEL	ATA-4	ATA-8	CF004M	CF008M	FH002M-BN
DISK/TREND GROUP	40	40	40	40	40
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
PRODUCT TYPE: Generic	Flash Disk	Flash Disk	Flash Disk	Flash Disk	Flash Memory
CAPACITY: Card capacity (MB)	4	8	4	8	2
CHIP CONFIGURATION:					
Chip density (Mb)			64	64	
Chip count per card			1	1	
Chip logic type	NAND	NAND	NAND	NAND	NOR
FEATURES: Package	PC Card Type I	PC Card Type I	Compact Flash	Compact Flash	PC Card Type I
Interface	PCMCIA ATA	PCMCIA ATA	PCMCIA-ATA	PCMCIA-ATA	PCMCIA 2.1
XIP	No	No	No	No	Yes
Erasable block size (KB)	.512	.512	.512	.512	
SECTOR ENDURANCE: (Kcycles)			100	100	100
PERFORMANCE:					
Avg. access time (ns)					70 (read)
Media read rate (MB/Sec)	8	8			10
Media write rate (MB/Sec)					.85
Burst transfer rate (MB/Sec)	20	20	8	8	10 (read)
Block erase time (ms)					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 42.8 x 36.4	3.3 x 42.8 x 36.4	3.3 x 54 x 85.6
OPERATING VOLTAGE:	5 V	5 V			5 V, 3.3 V 12 V option
FIRST CUSTOMER SHIPMENT	3Q96	3Q96	1997	1997	1994
COMMENTS					Intel Series 2 chips.

MANUFACTURER	ACTIONTEC	ACTIONTEC	ACTIONTEC	ACTIONTEC	ACTIONTEC
FLASH CARD MODEL	FH004M-BN	FH008M-BN	FH0256K-BN	FH0512K-BN	ATA-12
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 Disk
CAPACITY: Card capacity (MB)	4	8	.256	.512	12
CHIP CONFIGURATION: Chip density (Mb)					
Chip count per card					
Chip logic type	NOR	NOR	NOR	NOR	NAND
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I
Interface	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA-ATA
XIP	Yes	Yes	No	No	No
Erasable block size (KB)					.512
SECTOR ENDURANCE: (Kcycles)	100	100	100	100	
PERFORMANCE: Avg. access time (ns)	70 (read)	70 (read)	200	200	
Media read rate (MB/Sec)	10	10	5	5	
Media write rate (MB/Sec)	.85	.85	.125	.125	
Burst transfer rate (MB/Sec)	10 (read)	10 (read)	5	5	
Block erase time (ms)	300	300	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, 3.3 V 12 V option	5 V, 3.3 V 12 V option	5 V, 12 V	5 V, 12 V	5 V
FIRST CUSTOMER SHIPMENT	1994	1994	1994	1994	3Q96
COMMENTS	Intel Series 2 chips.	Intel Series 2 chips.	Intel Series 1 chips.	Intel Series 1 chips.	

MANUFACTURER	ACTIONTEC	ACTIONTEC	ACTIONTEC	ACTIONTEC	ACTIONTEC
FLASH CARD MODEL	ATA-16	ATA-20	CF016M	CF024M	FH010M-BN
DISK/TREND GROUP	41	41	41	41	41
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
PRODUCT TYPE: Generic	Flash Disk	Flash Disk	Flash Disk	Flash Disk	Flash Memory
CAPACITY: Card capacity (MB)	16	20	16	24	10
CHIP CONFIGURATION:					
Chip density (Mb)			64	64	
Chip count per card			2	3	
Chip logic type	NAND	NAND	NAND	NAND	NOR
FEATURES: Package	PC Card Type II	PC Card Type II	Compact Flash	Compact Flash	PC Card Type I
Interface	PCMCIA-ATA	PCMCIA-ATA	PCMCIA-ATA	PCMCIA-ATA	PCMCIA 2.1
XIP	No	No	No	No	Yes
Erasable block size (KB)	.512	.512	.512	.512	
SECTOR ENDURANCE: (Kcycles)			100	100	100
PERFORMANCE:					
Avg. access time (ns)					70 (read)
Media read rate (MB/Sec)					10
Media write rate (MB/Sec)					.85
Burst transfer rate (MB/Sec)			8	8	10 (read)
Block erase time (ms)					300
SIZE: (mm: H x W x D)	5 x 54 x 85.6	5 x 54 x 85.6	3.3 x 42.8 x 36.4	3.3 x 42.8 x 36.4	3.3 x 54 x 85.6
OPERATING VOLTAGE:	5 V	5 V			5 V, 3.3 V 12 V option
FIRST CUSTOMER SHIPMENT	3Q96	3Q96	1997	1997	1997
COMMENTS					Intel Series 2 chips.

MANUFACTURER	ACTIONTEC	ACTIONTEC	ACTIONTEC	ACTIONTEC	ACTIONTEC
FLASH CARD MODEL	FH016M-BN	FH020M-BN	FH024M-BN	ATA-32	ATA-40
DISK/TREND GROUP	41	41	41	42	42
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
PRODUCT TYPE: Generic	Flash Memory	Flash Memory	Flash Memory	Flash Disk	Flash Disk
CAPACITY: Card capacity (MB)	16	20	24	32	40
CHIP CONFIGURATION: Chip density (Mb)					
Chip count per card					
Chip logic type	NOR	NOR	NOR	NAND	NAND
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type II	PC Card Type II
Interface	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA-ATA	PCMCIA-ATA
XIP	Yes	Yes	Yes	No	No
Erasable block size (KB)				.512	.512
SECTOR ENDURANCE: (Kcycles)	100	100	100		
PERFORMANCE: Avg. access time (ns)	150 (read)	150 (read)	150 (read)		
Media read rate (MB/Sec)	10	10	10	8	8
Media write rate (MB/Sec)	.85	.85	.85		
Burst transfer rate (MB/Sec)	10 (read)	10 (read)	10 (read)	20	20
Block erase time (ms)	300	300	300		
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	5.5 x 54 x 85.6	5.5 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	5 V
FIRST CUSTOMER SHIPMENT	1997	1997	1997	1997	1997
COMMENTS	Intel Series 2+ chips.	Intel Series 2+ chips.	Intel Series 2+ chips.		

MANUFACTURER	ACTIONTEC	ACTIONTEC	ACTIONTEC	ADVANCED MICRO DEVICES	ADVANCED MICRO DEVICES
FLASH CARD MODEL	ATA-48	ATA-64	CF032M	AMC001CFLKA	AMC002CFLKA
DISK/TREND GROUP	42	42	42	40	40
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM	OEM
PRODUCT TYPE: Generic	Flash Disk	Flash Disk	Flash Disk	Flash Memory	Flash Memory
CAPACITY: Card capacity (MB)	48	64	32	1	2
CHIP CONFIGURATION: Chip density (Mb)			64	4	4
Chip count per card			4	2	4
Chip logic type	NAND	NAND	NAND	NOR	NOR
FEATURES: Package	PC Card Type II	PC Card Type II	Compact Flash	PC Card Type I	PC Card Type I
Interface	PCMCIA-ATA	PCMCIA-ATA	PCMCIA-ATA	PCMCIA 2.1	PCMCIA 2.1
XIP	No	No	No	Yes	Yes
Erasable block size (KB)	.512	.512	.512	64	64
SECTOR ENDURANCE: (Kcycles)			100	1000	1000
PERFORMANCE: Avg. access time (ns)				150	150
Media read rate (MB/Sec)	8	8		13.3	13.3
Media write rate (MB/Sec)				.125	.125
Burst transfer rate (MB/Sec)	20	20	8	--	--
Block erase time (ms)				1500	1500
SIZE: (mm: H x W x D)	5.5 x 54 x 85.6	5.5 x 54 x 85.6	3.3 x 42.8 x 36.4	3.3 x 54 x 85.6	3.3 x 54 x 85.6
OPERATING VOLTAGE:	5 V	5 V		5 V	5 V
FIRST CUSTOMER SHIPMENT	1997	1997	1997	5/94	5/94
COMMENTS					

MANUFACTURER	ADVANCED MICRO DEVICES	ADVANCED MICRO DEVICES	ADVANCED MICRO DEVICES	ADVANCED MICRO DEVICES	ADVANCED MICRO DEVICES
FLASH CARD MODEL	AMC004CFLKA	AMC004DFLKA	AMC008DFLKA	Am MC002A	Am MC004A
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
CAPACITY: Card capacity (MB)	4	4	8	2	4
CHIP CONFIGURATION:					
Chip density (Mb)	4	16	16	8	16
Chip count per card	8	2	4	2	2
Chip logic type	NOR	NOR	NOR	NOR	NOR
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type I	Miniature Card	Miniature Card
Interface	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	Mini. Card 1.1	Mini. Card 1.1
XIP	Yes	Yes	Yes	Yes	Yes
Erasable block size (KB)	64	64	64	64	64
SECTOR ENDURANCE: (Kcycles)	1000	1000	1000	1000*	1000*
PERFORMANCE:					
Avg. access time (ns)	150	150	150	150	150
Media read rate (MB/Sec)	13.3	13.3	13.3	13.3	13.3
Media write rate (MB/Sec)	.125	.25	.25	.25	.25
Burst transfer rate (MB/Sec)	--	--	--	--	--
Block erase time (ms)	1500	1000	1000	1000	1000
SIZE: (mm: H x W x D)	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.5 x 38 x 33	3.5 x 38 x 33
OPERATING VOLTAGE:	5 V	5 V	5 V	5 V	5 V
FIRST CUSTOMER SHIPMENT	5/94	7/95	7/95	4Q96	4Q96
COMMENTS				*100K minimum guaranteed.	*100K minimum guaranteed.

MANUFACTURER	ADVANCED MICRO DEVICES	ADVANCED MICRO DEVICES	ADVANCED MICRO DEVICES	ADVANCED MICRO DEVICES	ADVANCED MICRO DEVICES
FLASH CARD MODEL	Am MC008A	Am MCL002A	Am MCL004A	AM020DFLKA	AMC032DFLKA
DISK/TREND GROUP	40	40	40	41	42
MARKET	OEM	OEM	OEM	OEM	OEM
PRODUCT TYPE: Generic	Flash Memory	Flash Memory	Flash Memory	Flash Memory	Flash Memory
CAPACITY: Card capacity (MB)	8	2	4	20	32
CHIP CONFIGURATION:					
Chip density (Mb)	16	8	8	16	16
Chip count per card	4	2	4	10	16
Chip logic type	NOR	NOR	NOR	NOR	NOR
FEATURES: Package	Miniature Card	Miniature Card	Miniature Card	PC Card Type I	PC Card Type I
Interface	Mini. Card 1.1	Mini. Card 1.1	Mini. Card 1.1	PCMCIA 2.1	PCMCIA 2.1
XIP	Yes	Yes	Yes	Yes	Yes
Erasable block size (KB)	64	64	64	64	64
SECTOR ENDURANCE: (Kcycles)	1000*	1000*	1000*	1000	1000
PERFORMANCE:					
Avg. access time (ns)	150	150	150	150	150
Media read rate (MB/Sec)	13.3	13.3	13.3	13.3	13.3
Media write rate (MB/Sec)	.25	.25	.25	.25	.25
Burst transfer rate (MB/Sec)	--	--	--	--	--
Block erase time (ms)	1000	1000	1000	1000	1000
SIZE: (mm: H x W x D)	3.5 x 38 x 33	3.5 x 38 x 33	3.5 x 38 x 33	3.3 x 54 x 85.6	3.3 x 54 x 85.6
OPERATING VOLTAGE:	5 V	3 V	3 V	5 V	5 V
FIRST CUSTOMER SHIPMENT	4Q96	4Q96	4Q96	7/95	1Q97
COMMENTS	*100K minimum guaranteed.	*100K minimum guaranteed.	*100K minimum guaranteed.		

MANUFACTURER	CARRY COMPUTER	CARRY COMPUTER	CARRY COMPUTER	CARRY COMPUTER	CARRY COMPUTER
FLASH CARD MODEL	MCAT2048	MCAT4096	MCCF2048	MCCF4096	MCBF2048K2
DISK/TREND GROUP	40	40	40	40	40
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	PCM
PRODUCT TYPE: Generic	Flash Disk	Flash Disk	Flash Disk	Flash Disk	Flash Memory
CAPACITY: Card capacity (MB)	4	8	4	8	2
CHIP CONFIGURATION:					
Chip density (Mb)	16	16	16	16	1
Chip count per card	2	4	2	4	2
Chip logic type	NAND	NAND	NAND	NAND	NOR
FEATURES: Package	PC Card Type II	PC Card Type II	Compact Flash	Compact Flash	PC Card Type I
Interface	PCMCIA ATA	PCMCIA ATA	PCMCIA ATA	PCMCIA ATA	PCMCIA 2.1
XIP	No	No	No	No	Yes
Erasable block size (KB)	.512	.512	.512	.512	128*
SECTOR ENDURANCE: (Kcycles)					100
PERFORMANCE:					
Avg. access time (ns)			200	200	200
Media read rate (MB/Sec)	8	8	8	8	5
Media write rate (MB/Sec)					.2*
Burst transfer rate (MB/Sec)	20	20	20	20	5
Block erase time (ms)					1600
SIZE: (mm: H x W x D)	5 x 54 x 85.6	5 x 54 x 85.6	3.3 x 42.8 x 36.4	3.3 x 42.8 x 36.4	3.3 x 54 x 85.6
OPERATING VOLTAGE:	5 V	5 V	5 V	5 V	5 V, 12 V
FIRST CUSTOMER SHIPMENT	1996	1996	1997	1997	1994
COMMENTS					Intel Series 2 chips. *Chip pair.

MANUFACTURER	CARRY COMPUTER	CARRY COMPUTER	CARRY COMPUTER	CARRY COMPUTER	CARRY COMPUTER
FLASH CARD MODEL	MCBF4096K2	MCBF8192K2	MCAT12288	MCAT16384	MCAT20480
DISK/TREND GROUP	40	40	41	41	41
MARKET	PCM	PCM	OEM, PCM	OEM, PCM	OEM, PCM
PRODUCT TYPE: Generic	Flash Memory	Flash Memory	Flash Disk	Flash Disk	Flash Disk
CAPACITY: Card capacity (MB)	4	8	12	16	20
CHIP CONFIGURATION: Chip density (Mb)	1	1	16	16	16
Chip count per card	4	8	6	8	10
Chip logic type	NOR	NOR	NAND	NAND	NAND
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type II	PC Card Type II	PC Card Type II
Interface	PCMCIA 2.1	PCMCIA 2.1	PCMCIA ATA	PCMCIA ATA	PCMCIA ATA
XIP	Yes	Yes	No	No	No
Erasable block size (KB)	128*	128*	.512	.512	.512
SECTOR ENDURANCE: (Kcycles)	100	100			
PERFORMANCE: Avg. access time (ns)	200	200			
Media read rate (MB/Sec)	5	5	8	8	8
Media write rate (MB/Sec)	.2*	.2*			
Burst transfer rate (MB/Sec)	5	5	20	20	20
Block erase time (ms)	1600	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	5 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	1996	1996	1996
COMMENTS	Intel Series 2 chips. *Chip pair.	Intel Series 2 chips. *Chip pair.			

MANUFACTURER	CARRY COMPUTER	CENTENNIAL TECHNOLOGIES	CENTENNIAL TECHNOLOGIES	CENTENNIAL TECHNOLOGIES	CENTENNIAL TECHNOLOGIES
FLASH CARD MODEL	MCBF16384K2	FMA05	FL01M-15-111-31 Series 1	FL02M-15-111-31 Series 1	FL02M-20-111-81 Series 2
DISK/TREND GROUP	41	40	40	40	40
MARKET	PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
PRODUCT TYPE: Generic	Flash Memory	Flash Disk	Flash Memory	Flash Memory	Flash Memory
CAPACITY: Card capacity (MB)	16	5	1	2	2
CHIP CONFIGURATION:					
Chip density (Mb)	1		4	8	8
Chip count per card	16		8	8	2
Chip logic type	NOR		NOR	NOR	NOR
FEATURES: Package	PC Card Type I	PC Card Type II	PC Card Type I	PC Card Type I	PC Card Type I
Interface	PCMCIA 2.1	PCMCIA-ATA	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1
XIP	Yes	No	No	No	Yes
Erasable block size (KB)	128*				
SECTOR ENDURANCE: (Kcycles)	100		100	100	100
PERFORMANCE:					
Avg. access time (ns)	200		150	150	150
Media read rate (MB/Sec)	5				
Media write rate (MB/Sec)	.2*				
Burst transfer rate (MB/Sec)	5				
Block erase time (ms)	1600		2000	2000	1600
SIZE: (mm: H x W x D)	3.3 x 54 x 85.6		3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6
OPERATING VOLTAGE:	5 V, 12 V		5 V, 12 V	5 V, 12 V	5 V, 12 V
FIRST CUSTOMER SHIPMENT	1994		1993	1993	1994
COMMENTS	Intel Series 2 chips. *Chip pair.				

MANUFACTURER	CENTENNIAL TECHNOLOGIES	CENTENNIAL TECHNOLOGIES	CENTENNIAL TECHNOLOGIES	CENTENNIAL TECHNOLOGIES	CENTENNIAL TECHNOLOGIES
FLASH CARD MODEL	FL04M-20-111-31 Series 1	FL04M-20-111-81 Series 2	FL08M-20-111-81 Series 2	FL256-15-111-31 Series 1	FL512-15-111-31 Series 1
DISK/TREND GROUP	40	40	40	40	40
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
PRODUCT TYPE: Generic	Flash Memory	Flash Memory	Flash Memory	Flash Memory	Flash Memory
CAPACITY: Card capacity (MB)	4	4	8	.256	.512
CHIP CONFIGURATION:					
Chip density (Mb)	8	8	8	1	2
Chip count per card	16	4	8	2	4
Chip logic type	NOR	NOR	NOR	NOR	NOR
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I
Interface	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1
XIP	No	Yes	Yes	No	No
Erasable block size (KB)					
SECTOR ENDURANCE: (Kcycles)	100	100	100	100	100
PERFORMANCE:					
Avg. access time (ns)	150	150	150	150	150
Media read rate (MB/Sec)					
Media write rate (MB/Sec)					
Burst transfer rate (MB/Sec)					
Block erase time (ms)	2000	1600	1600	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	1994	1994	1994	1993	1993
COMMENTS					

MANUFACTURER	CENTENNIAL TECHNOLOGIES	CENTENNIAL TECHNOLOGIES	CENTENNIAL TECHNOLOGIES	CENTENNIAL TECHNOLOGIES	CENTENNIAL TECHNOLOGIES
FLASH CARD MODEL	FMA10	FMA20	FL16M-20-111-81 Series 2	FL20M-20-111-81 Series 2	FMA40
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 Memory	Flash Memory	Flash Disk
CAPACITY: Card capacity (MB)	10	20	16	20	40
CHIP CONFIGURATION:					
Chip density (Mb)			16	16	
Chip count per card			8	10	
Chip logic type			NOR	NOR	
FEATURES: Package	PC Card Type II	PC Card Type II	PC Card Type I	PC Card Type I	PC Card Type II
Interface	PCMCIA-ATA	PCMCIA-ATA	PCMCIA 2.1	PCMCIA 2.1	PCMCIA-ATA
XIP	No	No	Yes	Yes	No
Erasable block size (KB)					
SECTOR ENDURANCE: (Kcycles)			100	100	
PERFORMANCE:					
Avg. access time (ns)					
Media read rate (MB/Sec)					
Media write rate (MB/Sec)					
Burst transfer rate (MB/Sec)					
Block erase time (ms)			1600	1600	
SIZE: (mm: H x W x D)			3.3 x 54 x 85.6	3.3 x 54 x 85.6	
OPERATING VOLTAGE:			5 V, 12 V	5 V, 12 V	
FIRST CUSTOMER SHIPMENT					
COMMENTS					

MANUFACTURER	FUJI PHOTO FILM	FUJI PHOTO FILM	FUJI PHOTO FILM	FUJI PHOTO FILM	FUJI PHOTO FILM
FLASH CARD MODEL	RD4001-1	RD4001-2	RD4001-4	RD4001-8	RD1001-2MS
DISK/TREND GROUP	40	40	40	40	40
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
PRODUCT TYPE: Generic	Flash Disk	Flash Disk	Flash Disk	Flash Disk	Flash Memory
CAPACITY: Card capacity (MB)	1	2	4	8	2
CHIP CONFIGURATION: Chip density (Mb)					
Chip count per card					
Chip logic type	NOR	NOR	NOR	NOR	NAND
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I
Interface	PCMCIA-ATA	PCMCIA-ATA	PCMCIA-ATA	PCMCIA-ATA	PCMCIA 2.1
XIP					
Erasable block size (KB)					4
SECTOR ENDURANCE: (Kcycles)	100	100	100	100	250
PERFORMANCE: Avg. access time (ns)					200
Media read rate (MB/Sec)					2.2
Media write rate (MB/Sec)					.5
Burst transfer rate (MB/Sec)					
Block erase time (ms)					
SIZE: (mm: H x W x D)	3 x 54 x 85.6	3 x 54 x 85.6	3 x 54 x 85.6	3 x 54 x 85.6	3.3 x 54 x 85.6
OPERATING VOLTAGE:	5 V	5 V	5 V	5 V	5 V
FIRST CUSTOMER SHIPMENT	1995	1995	1995	1995	1994
COMMENTS	Atmel chips.	Atmel chips.	Atmel chips.	Atmel chips.	

MANUFACTURER	FUJI PHOTO FILM	FUJI PHOTO FILM	FUJI PHOTO FILM	FUJI PHOTO FILM	FUJI PHOTO FILM
FLASH CARD MODEL	RD1001-4MS	RD1001-8MS	RD1001-8MV	RD3001-2	RD3001-4
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
CAPACITY: Card capacity (MB)	4	8	8	2	4
CHIP CONFIGURATION: Chip density (Mb)					
Chip count per card					
Chip logic type	NAND	NAND	NAND	NOR	NOR
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I
Interface	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1
XIP					
Erasable block size (KB)	4	4	16		
SECTOR ENDURANCE: (Kcycles)	250	250	250	1000	1000
PERFORMANCE: Avg. access time (ns)	200	200	200		
Media read rate (MB/Sec)	2.2	2.2	2.7		
Media write rate (MB/Sec)	.5	.5	2.7		
Burst transfer rate (MB/Sec)					
Block erase time (ms)					
SIZE: (mm: H x W x D)	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3 x 54 x 85.6	3 x 54 x 85.6
OPERATING VOLTAGE:	5 V	5 V	5 V	5 V	5 V
FIRST CUSTOMER SHIPMENT	1994	1994	1994	1995	1995
COMMENTS				Atmel chips.	Atmel chips.

MANUFACTURER	FUJI PHOTO FILM	FUJI PHOTO FILM	FUJI PHOTO FILM	FUJI PHOTO FILM	FUJI PHOTO FILM
FLASH CARD MODEL	RD3001-8	RD1001-10MS	RD1001-16MS	RD1001-16MV	RD1001-20MS
DISK/TREND GROUP	40	41	41	41	41
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
PRODUCT TYPE: Generic	Flash Memory	Flash Memory	Flash Memory	Flash Memory	Flash Memory
CAPACITY: Card capacity (MB)	8	10	16	16	20
CHIP CONFIGURATION: Chip density (Mb)					
Chip count per card					
Chip logic type	NOR	NAND	NAND	NAND	NAND
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I
Interface	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1
XIP					
Erasable block size (KB)		4	4	16	4
SECTOR ENDURANCE: (Kcycles)	1000	250	250	250	250
PERFORMANCE: Avg. access time (ns)		200	200	200	200
Media read rate (MB/Sec)		2.2	2.2	2.7	2.2
Media write rate (MB/Sec)		.5	.5	2.7	.5
Burst transfer rate (MB/Sec)					
Block erase time (ms)					
SIZE: (mm: H x W x D)	3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6
OPERATING VOLTAGE:	5 V	5 V	5 V	5 V	5 V
FIRST CUSTOMER SHIPMENT	1995	1994	1994	1994	1994
COMMENTS	Atmel chips.				

MANUFACTURER	FUJI PHOTO FILM	FUJI PHOTO FILM	FUJI PHOTO FILM	FUJITSU	FUJITSU
FLASH CARD MODEL	RD1001-24MS	RD1001-24MV	RD3001-16	MB98A81063	MB98A81183
DISK/TREND GROUP	41	41	41	40	40
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
PRODUCT TYPE: Generic	Flash Memory	Flash Memory	Flash Memory	Flash Memory	Flash Memory
CAPACITY: Card capacity (MB)	24	24	16	1	2
CHIP CONFIGURATION: Chip density (Mb)				4	8
Chip count per card				2	2
Chip logic type	NAND	NAND	NOR	NOR	NOR
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I
Interface	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1
XIP				Yes	Yes
Erasable block size (KB)	4	16		64/128*	64/128*
SECTOR ENDURANCE: (Kcycles)	250	250	1000	100	100
PERFORMANCE: Avg. access time (ns)	200	200		180	180
Media read rate (MB/Sec)	2.2	2.7		6.6	6.6
Media write rate (MB/Sec)	.5	2.7		0.625	.125
Burst transfer rate (MB/Sec)					
Block erase time (ms)				1000	1000
SIZE: (mm: H x W x D)	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6
OPERATING VOLTAGE:	5 V	5 V	5 V	5 V	5 V
FIRST CUSTOMER SHIPMENT	1994	1994	1995	1996	4Q95
COMMENTS			Atmel chips.	*Chip pair.	*Chip pair.

MANUFACTURER	FUJITSU	FUJITSU	FUJITSU	FUJITSU	FUJITSU
FLASH CARD MODEL	MB98A81273	MB98A81373	MB98C81013	MB98C81123	MB98C81233
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
CAPACITY: Card capacity (MB)	4	8	1	2	4
CHIP CONFIGURATION:					
Chip density (Mb)	16	16	8	8	16
Chip count per card	2	4	1	2	2
Chip logic type	NOR	NOR	NOR	NOR	NOR
FEATURES: Package	PC Card Type I	PC Card Type I	Miniature Card	Miniature Card	Miniature Card
Interface	PCMCIA 2.1	PCMCIA 2.1	Mini. Card 1.1	Mini. Card 1.1	Mini. Card 1.1
XIP	Yes	Yes	Yes	Yes	Yes
Erasable block size (KB)	64/128*	64/128*	64/128	64/128	64/128
SECTOR ENDURANCE: (Kcycles)	100	100	100	100	100
PERFORMANCE:					
Avg. access time (ns)	180	180	100	100	100
Media read rate (MB/Sec)	6.6	6.6	10	10	10
Media write rate (MB/Sec)	.125	.125	.0625	.125	.125
Burst transfer rate (MB/Sec)					
Block erase time (ms)	1000	1000	1000	1000	1000
SIZE: (mm: H x W x D)	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.5 x 38 x 33	3.5 x 38 x 33	3.5 x 38 x 33
OPERATING VOLTAGE:	5 V	5 V	5 V	5 V	5 V
FIRST CUSTOMER SHIPMENT	4Q95	4Q95	3Q96	3Q96	3Q96
COMMENTS	*Chip pair.	*Chip pair.			

MANUFACTURER	FUJITSU	FUJITSU	FUJITSU	FUJITSU	FUJITSU
FLASH CARD MODEL	MB98C81333	MB98D81123	MB98D81223	MB98A81473	MB98A81573
DISK/TREND GROUP	40	40	40	41	42
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
PRODUCT TYPE: Generic	Flash Memory	Flash Memory	Flash Memory	Flash Memory	Flash Memory
CAPACITY: Card capacity (MB)	8	2	4	16	32
CHIP CONFIGURATION:					
Chip density (Mb)	16	8	8	16	16
Chip count per card	4	2	4	8	16
Chip logic type	NOR	NOR	NOR	NOR	NOR
FEATURES: Package	Miniature Card	Miniature Card	Miniature Card	PC Card Type I	PC Card Type I
Interface	Mini. Card 1.1	Mini. Card 1.1	Mini. Card 1.1	PCMCIA 2.1	PCMCIA 2.1
XIP	Yes	Yes	Yes	Yes	Yes
Erasable block size (KB)	64/128	64/128	64/128	64/128*	
SECTOR ENDURANCE: (Kcycles)	100	100	100	100	10
PERFORMANCE:					
Avg. access time (ns)	100	100	100	180	250
Media read rate (MB/Sec)	10	6.6	6.6	6.6	5
Media write rate (MB/Sec)	.125	.09	.09	.125	0.625
Burst transfer rate (MB/Sec)					
Block erase time (ms)	1000	1000	1000	1000	2000
SIZE: (mm: H x W x D)	3.5 x 38 x 33	3.5 x 38 x 33	3.5 x 38 x 33	3.3 x 54 x 85.6	3.3 x 54 x 85.6
OPERATING VOLTAGE:	5 V	3.3 V	3.3 V	5 V	5 V
FIRST CUSTOMER SHIPMENT	3Q96	3Q96	3Q96	4Q95	3Q95
COMMENTS				*Chip pair.	Not sold in US and Europe, except UK.

MANUFACTURER	HITACHI	HITACHI	HITACHI	HITACHI	HITACHI
FLASH CARD MODEL	HB286002C0	HB286004C0	HB286008C2	HB286015A1	HB286015C2
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
CAPACITY: Card capacity (MB)	2	4	8	15	15
CHIP CONFIGURATION:					
Chip density (Mb)	8	8	64	64	64
Chip count per card	2	4	1	2	2
Chip logic type	NAND	NAND	NAND	NAND	NAND
FEATURES: Package	Compact Flash	Compact Flash	Compact Flash	PC Card	Compact Flash
Interface	PCMCIA-ATA	PCMCIA-ATA	PCMCIA-ATA	PCMCIA-ATA	PCMCIA-ATA
XIP	No	No	No	No	No
Erasable block size (KB)	.512	.512	.512	.512/4.096	.512
SECTOR ENDURANCE: (Kcycles)	100	100	100	100	100
PERFORMANCE:					
Avg. access time (ns)	1	1	1	2 ms	1
Media read rate (MB/Sec)	8	8	8	8	8
Media write rate (MB/Sec)	.4	.4	.2	.25	.4
Burst transfer rate (MB/Sec)	8	8	10	8	10
Block erase time (ms)	1	1	1	1	1
SIZE: (mm: H x W x D)	3.3 x 42.8 x 36.4	3.3 x 42.8 x 36.4	3.3 x 42.8 x 36.4	5 x 54 x 85.6	3.3 x 42.8 x 36.4
OPERATING VOLTAGE:	5 V, 3.3 V	5 V, 3.3 V	5 V, 3.3 V	5 V	5 V, 3.3 V
FIRST CUSTOMER SHIPMENT	1Q97	1Q97	2Q97	3Q96	1Q97
COMMENTS					

MANUFACTURER	HITACHI	HITACHI	HITACHI	HITACHI	HITACHI
FLASH CARD MODEL	HB286030A1	HB286045A1	HB286060A1	HB286075A1	HB286030C2
DISK/TREND GROUP	42	42	42	42	42
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
PRODUCT TYPE: Generic	Flash Disk	Flash Disk	Flash Disk	Flash Disk	Flash Disk
CAPACITY: Card capacity (MB)	30	45	60	75	30
CHIP CONFIGURATION:					
Chip density (Mb)	64	64	64	64	64
Chip count per card	4	6	8	10	4
Chip logic type	AND	AND	AND	AND	NAND
FEATURES: Package	PC Card	PC Card	PC Card	PC Card	Compact Flash
Interface	PCMCIA-ATA	PCMCIA-ATA	PCMCIA-ATA	PCMCIA-ATA	PCMCIA-ATA
XIP	No	No	No	No	No
Erasable block size (KB)	.512/4.096	.512/4.096	.512/4.096	.512/4.096	.512
SECTOR ENDURANCE: (Kcycles)	100	100	100	100	100
PERFORMANCE:					
Avg. access time (ns)	2 ms	2 ms	2 ms	2 ms	1
Media read rate (MB/Sec)	8	8	8	8	8
Media write rate (MB/Sec)	.25	.25	.25	.25	.4
Burst transfer rate (MB/Sec)	8	8	8	8	10
Block erase time (ms)	1	1	1	1	1
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	3.3 x 42.8 x 36.4
OPERATING VOLTAGE:	5 V	5 V	5 V	5 V	5 V, 3.3 V
FIRST CUSTOMER SHIPMENT	3Q96	3Q96	3Q96	3Q96	2Q97
COMMENTS					

MANUFACTURER	HYUNDAI	HYUNDAI	HYUNDAI	HYUNDAI	HYUNDAI
FLASH CARD MODEL	HYCFL001	HYCFL002	HYCFLF16004	HYCFLF16008	HYCFLF16020
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
CAPACITY: Card capacity (MB)	1	2	4	8	20
CHIP CONFIGURATION:					
Chip density (Mb)	4	4	16	16	16
Chip count per card	2	4	2	4	10
Chip logic type	NOR	NOR	NOR	NOR	NOR
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I
Interface	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1
XIP					
Erasable block size (KB)	64	64	64	64	64
SECTOR ENDURANCE: (Kcycles)	100	100	100	100	100
PERFORMANCE:					
Avg. access time (ns)	150	150	150	150	150
Media read rate (MB/Sec)	6	6	6	6	6
Media write rate (MB/Sec)	.125	.125	.125	.125	.125
Burst transfer rate (MB/Sec)					
Block erase time (ms)	1000	1000	1000	1000	1000
SIZE: (mm: H x W x D)	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6
OPERATING VOLTAGE:	5V	5V	5V	5V	5V
FIRST CUSTOMER SHIPMENT	4Q96	4Q96	4Q96	4Q96	4Q96
COMMENTS					

MANUFACTURER	IBM	IBM	IBM	IBM	IBM
FLASH CARD MODEL	36H1752	36H3521	36H3522	36H1753	36H1754
DISK/TREND GROUP	40	40	40	41	41
MARKET	Captive,OEM,PCM	Captive,OEM,PCM	Captive,OEM,PCM	Captive,OEM,PCM	Captive,OEM,PCM
PRODUCT TYPE: Generic	Flash Disk	Flash Disk	Flash Disk	Flash Disk	Flash Disk
CAPACITY: Card capacity (MB)	7	2	4	10	20
CHIP CONFIGURATION:					
Chip density (Mb)	32	32	32	32	32
Chip count per card	2	1	1	3	5
Chip logic type	NAND	NAND	NAND	NAND	NAND
FEATURES: Package	PC Card Type I	PC Card Type II	PC Card Type II	PC Card Type II	PC Card Type II
Interface	PCMCIA-ATA	PCMCIA-ATA/IDE	PCMCIA-ATA/IDE	PCMCIA-ATA/IDE	PCMCIA-ATA/IDE
XIP	No	No	No	No	No
Erasable block size (KB)	4	4	4	4	4
SECTOR ENDURANCE: (Kcycles)	250	250	250	250	250
PERFORMANCE:					
Avg. access time (ns)	.8 ms	.8 ms	.8 ms	.8 ms	.8 ms
Media read rate (MB/Sec)	7	7	7		
Media write rate (MB/Sec)	1.2	1.2	1.2		
Burst transfer rate (MB/Sec)	9/4.5*	9/4.5*	9/4.5*		
Block erase time (ms)	6				
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		
OPERATING VOLTAGE:	3.3 V, 5 V	3.3 V, 5 V	3.3 V, 5 V	3.3 V, 5 V	3.3 V, 5 V
FIRST CUSTOMER SHIPMENT	5/94	1/97	1/97	3Q96	3Q96
COMMENTS	*At reduced power.	*At reduced power.	*At reduced power.		

MANUFACTURER	IBM	IBM	IBM	INTEL	INTEL
FLASH CARD MODEL	36H1755	36H1756	36H1757	iMC002FLSA Series 2	iMC002FLSC Value Series 100
DISK/TREND GROUP	42	42	42	40	40
MARKET	Captive,OEM,PCM	Captive,OEM,PCM	Captive,OEM,PCM	OEM, PCM	OEM, PCM
PRODUCT TYPE: Generic	Flash Disk	Flash Disk	Flash Disk	Flash Memory	Flash Memory
CAPACITY: Card capacity (MB)	40	60	80	2	2
CHIP CONFIGURATION:					
Chip density (Mb)	32	32	32	8	8
Chip count per card	11	15	20	2	2
Chip logic type	NAND	NAND	NAND	NOR	NOR
FEATURES: Package	PC Card Type II	PC Card II	PC Card II	PC Card Type I	PC Card Type I
Interface	PCMCIA-ATA/IDE	PCMCIA-ATA/IDE	PCMCIA-ATA/IDE	PCMCIA 2.01	PCMCIA 1.0
XIP	No	No	No	Yes	Yes
Erasable block size (KB)	4	4	4	64	64
SECTOR ENDURANCE: (Kcycles)	250	250	250	100	100
PERFORMANCE:					
Avg. access time (ns)	.8 ms	.8 ms	.8 ms	150	100
Media read rate (MB/Sec)	7	7	7	5	20
Media write rate (MB/Sec)	1.2	1.2	1.2	.2*	0.33
Burst transfer rate (MB/Sec)	9/4.5*	9/4.5*	9/4.5*	5	20
Block erase time (ms)				1600	600
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:	3.3 V, 5 V	3.3 V, 5 V	3.3 V, 5 V	5 V, 12 V	5 V
FIRST CUSTOMER SHIPMENT	1Q97	1Q97	1Q97	2Q92	4Q95
COMMENTS	*At reduced power.	*At reduced power.	*At reduced power.		

MANUFACTURER	INTEL	INTEL	INTEL	INTEL	INTEL
FLASH CARD MODEL	iMC004FLSA Series 2	iMC004FLSC Value Series 100	iMC004FLSP Series 2+	iMC008FLSC Value Series 100	iMC008FLSP Series 2+
DISK/TREND GROUP	40	40	40	40	40
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
PRODUCT TYPE: Generic	Flash Memory	Flash Memory	Flash Memory	Flash Memory	Flash Memory
CAPACITY: Card capacity (MB)	4	4	4	8	8
CHIP CONFIGURATION:					
Chip density (Mb)	8	16	16	16	16
Chip count per card	4	2	2	4	4
Chip logic type	NOR	NOR	NOR	NOR	NOR
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I
Interface	PCMCIA 2.01	PCMCIA 1.0	PCMCIA 2.01	PCMCIA 1.0	PCMCIA 2.01
XIP	Yes	Yes	Yes	Yes	Yes
Erasable block size (KB)	64	64	64	64	64
SECTOR ENDURANCE: (Kcycles)	100	100	1000	100	1000
PERFORMANCE:					
Avg. access time (ns)	150	100	150	100	150
Media read rate (MB/Sec)	5	20	13	20	13
Media write rate (MB/Sec)	.2	0.33	.85	0.33	.85
Burst transfer rate (MB/Sec)	5	20	10 (Read)	20	13 (Read)
Block erase time (ms)	1600	600	300	600	300
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	3.3 x 54 x 85.6	3.3 54 x 85.6
OPERATING VOLTAGE:	5 V, 12 V	5 V	5 V, 3.3 V 12 V option	5 V	5 V, 3.3 V 12 V option
FIRST CUSTOMER SHIPMENT	2Q92	4Q95	1Q94	4Q95	4Q94
COMMENTS					

MANUFACTURER	INTEL	INTEL	INTEL	INTEL	INTEL
FLASH CARD MODEL	iFM004A	iFM008 Series 100	iMC010FLSA Series 2	iMC020FLSA Series 2	iMC020FLSP Series 2+
DISK/TREND GROUP	40	40	41	41	41
MARKET	OEM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
PRODUCT TYPE: Generic	Flash Memory	Flash Memory	Flash Memory	Flash Memory	Flash Memory
CAPACITY: Card capacity (MB)	4	8	10	20	20
CHIP CONFIGURATION:					
Chip density (Mb)	8	16	8	8	16
Chip count per card	4	4	10	20	10
Chip logic type	NOR	NOR	NOR	NOR	NOR
FEATURES: Package	Miniature Card	Miniature Card	PC Card Type I	PC Card Type I	PC Card Type I
Interface	Minicard 1.1	Mini. Crd. 1.1	PCMCIA 2.01	PCMCIA 2.01	PCMCIA 2.01
XIP	Yes	Yes	Yes	Yes	Yes
Erasable block size (KB)	64	64	64	64	64
SECTOR ENDURANCE: (Kcycles)	100	100	100	100	1000
PERFORMANCE:					
Avg. access time (ns)	100/150	100/150	150	150	150
Media read rate (MB/Sec)	20/13*	20/13*	5	5	13
Media write rate (MB/Sec)	.25/.12*	.25/.12*	.2	.2	.85
Burst transfer rate (MB/Sec)	--		5	5	13 (Read)
Block erase time (ms)	1.1/1.8*	1.1/1.8*	1600	1600	300
SIZE: (mm: H x W x D)	3.5 x 38 x 33	3.5 x 38 x 33	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	5 V, 3.3 V	5 V, 12 V	5 V, 12 V	5 V, 3.3 V 12 V option
FIRST CUSTOMER SHIPMENT	1996	3Q97	2Q92	2Q92	1Q94
COMMENTS	Write protect switch. *5 V/3.3 V.	Write protect switch. *5 V/3.3 V.			

MANUFACTURER	INTEL	INTEL	INTEL	INTEL	KINGMAX TECHNOLOGY
FLASH CARD MODEL	iMC024FLSC Value Series 100	iMC016FLSC Value Series 100	iMC032FLSC Value Series 100	iMC040FLSP Series 2+	AJT-004M
DISK/TREND GROUP	41	42	42	42	40
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	PCM
PRODUCT TYPE: Generic	Flash Memory	Flash Memory	Flash Memory	Flash Memory	Flash Disk
CAPACITY: Card capacity (MB)	24	16	32	40	4
CHIP CONFIGURATION:					
Chip density (Mb)	16	16	16	32	
Chip count per card	12	8	16	10	
Chip logic type	NOR	NOR	NOR	NOR	
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I
Interface	PCMCIA 2.01	PCMCIA 2.01	PCMCIA 2.01	PCMCIA 2.01	PCMCIA ATA/IDE
XIP	Yes	Yes	Yes	Yes	No
Erasable block size (KB)	64	64	64	64	
SECTOR ENDURANCE: (Kcycles)	100	100	100	1000	
PERFORMANCE:					
Avg. access time (ns)	150	150	150	150	
Media read rate (MB/Sec)	20	20	20	13	
Media write rate (MB/Sec)	.99	.99	.99	.85	
Burst transfer rate (MB/Sec)	20	20	20	13 (Read)	
Block erase time (ms)	600	600	600	300	
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 x 54 x 85.6
OPERATING VOLTAGE:	5 V	5 V	5 V	5 V, 3.3 V 12 V option	5 V
FIRST CUSTOMER SHIPMENT	3Q97	2Q97	3Q97	1Q94	1996
COMMENTS					

MANUFACTURER	KINGMAX TECHNOLOGY	KINGMAX TECHNOLOGY	KINGMAX TECHNOLOGY	KINGMAX TECHNOLOGY	KINGMAX TECHNOLOGY
FLASH CARD MODEL	AJT-008M	ACF-002	ACF-004	ACF-006	ACF-008
DISK/TREND GROUP	40	40	40	40	40
MARKET	PCM	PCM	PCM	PCM	PCM
PRODUCT TYPE: Generic	Flash Disk	Flash Disk	Flash Disk	Flash Disk	Flash Disk
CAPACITY: Card capacity (MB)	8	2	4	6	8
CHIP CONFIGURATION: Chip density (Mb)					
Chip count per card					
Chip logic type		NAND	NAND	NAND	NAND
FEATURES: Package	PC Card Type I	Compact Device	Compact Flash	Compact Flash	Compact Flash
Interface	PCMCIA ATA/IDE	PCMCIA ATA/IDE	PCMCIA ATA/IDE	PCMCIA ATA/IDE	PCMCIA ATA/IDE
XIP	No	No	No	No	No
Erasable block size (KB)		.512	.512	.512	.512
SECTOR ENDURANCE: (Kcycles)		Yes	Yes	Yes	Yes
PERFORMANCE: Avg. access time (ns)					
Media read rate (MB/Sec)		2.5	2.5	2.5	2.5
Media write rate (MB/Sec)					
Burst transfer rate (MB/Sec)					
Block erase time (ms)		16.6	16.6	16.6	16.6
SIZE: (mm: H x W x D)	3.3 x 54 x 85.6	3.3 x 42.8 x 36.4	3.3 x 42.8 x 36.4	3.3 x 42.8 x 36.4	3.3 x 42.8 x 36.4
OPERATING VOLTAGE:	5 V	5 V	5 V	5 V	5 V
FIRST CUSTOMER SHIPMENT	1996	1996	1996	1996	1996
COMMENTS					

MANUFACTURER	KINGMAX TECHNOLOGY	KINGMAX TECHNOLOGY	KINGMAX TECHNOLOGY	KINGMAX TECHNOLOGY	KINGMAX TECHNOLOGY
FLASH CARD MODEL	FAC-001	FAC-002	FAC-003	FAC-004	FAC-005
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
CAPACITY: Card capacity (MB)	1	2	3	4	5
CHIP CONFIGURATION:					
Chip density (Mb)	4	4	4	4	4
Chip count per card	2	4	6	8	10
Chip logic type	NOR	NOR	NOR	NOR	NOR
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I
Interface	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1
XIP	Yes	Yes	Yes	Yes	Yes
Erasable block size (KB)	64	64	64	64	64
SECTOR ENDURANCE: (Kcycles)	1000	1000	1000	1000	1000
PERFORMANCE:					
Avg. access time (ns)	150	150	150	150	150
Media read rate (MB/Sec)	13.3	13.3	13.3	13.3	13.3
Media write rate (MB/Sec)	.125	.125	.125	.125	.125
Burst transfer rate (MB/Sec)	--	--	--	--	--
Block erase time (ms)	1500	1500	1500	1500	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	5 V	5 V	5 V	5 V
FIRST CUSTOMER SHIPMENT	1995	1995	1995	1995	1995
COMMENTS	AMD type C chips.	AMD type C chips.	AMD type C chips.	AMD type C chips.	AMD type C chips.

MANUFACTURER	KINGMAX TECHNOLOGY	KINGMAX TECHNOLOGY	KINGMAX TECHNOLOGY	KINGMAX TECHNOLOGY	KINGMAX TECHNOLOGY
FLASH CARD MODEL	FAC-006	FAC-007	FAC-008	FAD-004	FAD-008
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
CAPACITY: Card capacity (MB)	6	7	8	4	8
CHIP CONFIGURATION:					
Chip density (Mb)	4	4	4	16	16
Chip count per card	12	14	16	2	4
Chip logic type	NOR	NOR	NOR	NOR	NOR
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I
Interface	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1
XIP	Yes	Yes	Yes	Yes	Yes
Erasable block size (KB)	64	64	64	64	64
SECTOR ENDURANCE: (Kcycles)	1000	1000	1000	1000	1000
PERFORMANCE:					
Avg. access time (ns)	150	150	150	150	150
Media read rate (MB/Sec)	13.3	13.3	13.3	13.3	13.3
Media write rate (MB/Sec)	.125	.125	.125	.125	.125
Burst transfer rate (MB/Sec)	--	--	--	--	--
Block erase time (ms)	1500	1500	1500	1500	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	5 V	5 V	5 V	5 V
FIRST CUSTOMER SHIPMENT	1995	1995	1995	1996	1996
COMMENTS	AMD type C chips.	AMD type C chips.	AMD type C chips.	AMD type D chips.	AMD type D chips.

MANUFACTURER	KINGMAX TECHNOLOGY	KINGMAX TECHNOLOGY	KINGMAX TECHNOLOGY	KINGMAX TECHNOLOGY	KINGMAX TECHNOLOGY
FLASH CARD MODEL	FAD-012	FHP-001	FHP-256	FHP-512	FJA-001M
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
CAPACITY: Card capacity (MB)	12	1	.256	.512	1
CHIP CONFIGURATION:					
Chip density (Mb)	16				4
Chip count per card	8				2
Chip logic type	NOR				NOR
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I
Interface	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1
XIP	Yes				
Erasable block size (KB)	64				
SECTOR ENDURANCE: (Kcycles)	1000				
PERFORMANCE:					
Avg. access time (ns)	150				
Media read rate (MB/Sec)	13.3				
Media write rate (MB/Sec)	.125				
Burst transfer rate (MB/Sec)	--				
Block erase time (ms)	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	5 V	5 V	5 V	
FIRST CUSTOMER SHIPMENT	1996				
COMMENTS	AMD type D chips.	Atmel type chips.	Atmel type chips.	Atmel type chips.	Intel or Mitsubishi chips.

MANUFACTURER	KINGMAX TECHNOLOGY	KINGMAX TECHNOLOGY	KINGMAX TECHNOLOGY	KINGMAX TECHNOLOGY	KINGMAX TECHNOLOGY
FLASH CARD MODEL	FJA-002M	FJA-256K	FJA-512K	FJN-006	FJN-008
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
CAPACITY: Card capacity (MB)	2	.256	.512	6	8
CHIP CONFIGURATION:					
Chip density (Mb)	4	4	4	8	8
Chip count per card	4	1	1	8	8
Chip logic type	NOR	NOR	NOR	NOR	NOR
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I
Interface	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1
XIP				Yes	Yes
Erasable block size (KB)				64	64
SECTOR ENDURANCE: (Kcycles)				100	100
PERFORMANCE:					
Avg. access time (ns)				200/250	200/250
Media read rate (MB/Sec)					
Media write rate (MB/Sec)					
Burst transfer rate (MB/Sec)					
Block erase time (ms)				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
FIRST CUSTOMER SHIPMENT				1995	1995
COMMENTS	Intel or Mitsubishi chips.	Intel or Mitsubishi chips.	Intel or Mitsubishi chips.	Intel Series II type chips.	Intel Series II type chips.

MANUFACTURER	KINGMAX TECHNOLOGY	KINGMAX TECHNOLOGY	KINGMAX TECHNOLOGY	KINGMAX TECHNOLOGY	KINGMAX TECHNOLOGY
FLASH CARD MODEL	FJN-2	FJN-4	FJN-8	FJP-4	JV0124
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
CAPACITY: Card capacity (MB)	2	4	8	4	1
CHIP CONFIGURATION: Chip density (Mb)				16	
Chip count per card				2	
Chip logic type	NOR	NOR	NOR	NOR	NOR
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I
Interface	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1
XIP	Yes	Yes	Yes	Yes	Yes
Erasable block size (KB)				64	
SECTOR ENDURANCE: (Kcycles)	100	100	100	1000	
PERFORMANCE: Avg. access time (ns)	250	250	250	150	
Media read rate (MB/Sec)				.13	
Media write rate (MB/Sec)				.85	
Burst transfer rate (MB/Sec)				10 (Read)	
Block erase time (ms)				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	5 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
FIRST CUSTOMER SHIPMENT	1994	1994	1994	1994	1994
COMMENTS					

MANUFACTURER	KINGMAX TECHNOLOGY	KINGMAX TECHNOLOGY	KINGMAX TECHNOLOGY	KINGMAX TECHNOLOGY	KINGMAX TECHNOLOGY
FLASH CARD MODEL	JV0512	AJT-012M	AJT-016M	AJT-020M	ACF-015
DISK/TREND GROUP	40	41	41	41	41
MARKET	OEM, PCM	PCM	PCM	PCM	PCM
PRODUCT TYPE: Generic	Flash Memory	Flash Disk	Flash Disk	Flash Disk	Flash Disk
CAPACITY: Card capacity (MB)	.512	12	16	20	15
CHIP CONFIGURATION: Chip density (Mb)					64
Chip count per card					2
Chip logic type	NOR				NAND
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I	Compact Flash
Interface	PCMCIA 2.1	PCMCIA ATA/IDE	PCMCIA ATA/IDE	PCMCIA ATA/IDE	PCMCIA ATA/IDE
XIP	Yes	No	No	No	No
Erasable block size (KB)					.512
SECTOR ENDURANCE: (Kcycles)					
PERFORMANCE: Avg. access time (ns)	200				
Media read rate (MB/Sec)					2.5
Media write rate (MB/Sec)					
Burst transfer rate (MB/Sec)					
Block erase time (ms)					16.6
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	5 x 54 x 85.6	3.3 x 42.8 x 36.4
OPERATING VOLTAGE:	5 V	5 V	5 V	5 V	5 V
FIRST CUSTOMER SHIPMENT	1994	1996	1996	1996	1996
COMMENTS					

MANUFACTURER	KINGMAX TECHNOLOGY	KINGMAX TECHNOLOGY	KINGMAX TECHNOLOGY	KINGMAX TECHNOLOGY	KINGMAX TECHNOLOGY
FLASH CARD MODEL	FAD-016	FAD-020	FAD-024	FJN-014	FJN-10
DISK/TREND GROUP	41	41	41	41	41
MARKET	PCM	PCM	PCM	PCM	OEM, PCM
PRODUCT TYPE: Generic	Flash Memory	Flash Memory	Flash Memory	Flash Memory	Flash Memory
CAPACITY: Card capacity (MB)	16	20	24	14	10
CHIP CONFIGURATION:					
Chip density (Mb)	16	16	16	8	8
Chip count per card	8	10	12	14	10
Chip logic type	NOR	NOR	NOR	NOR	NOR
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I
Interface	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1
XIP	Yes	Yes	Yes	Yes	Yes
Erasable block size (KB)	64	64	64	64	64
SECTOR ENDURANCE: (Kcycles)	1000	1000	1000	100	100
PERFORMANCE:					
Avg. access time (ns)	150	150	150	200/250	250
Media read rate (MB/Sec)	13.3	13.3	13.3		
Media write rate (MB/Sec)	.125	.125	.125		
Burst transfer rate (MB/Sec)	--	--	--		
Block erase time (ms)	1500	1500	1500	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, 12 V
FIRST CUSTOMER SHIPMENT	1996	1996	1996	1995	1994
COMMENTS	AMD type D chips.	AMD type D chips.	AMD type D chips.	Intel Series II type chips.	

MANUFACTURER	KINGMAX TECHNOLOGY	KINGMAX TECHNOLOGY	KINGMAX TECHNOLOGY	KINGMAX TECHNOLOGY	KINGMAX TECHNOLOGY
FLASH CARD MODEL	FJN-12	FJN-16	FJP-012	FJP-016	FJP-20
DISK/TREND GROUP	41	41	41	41	41
MARKET	OEM, PCM	OEM, PCM	PCM	PCM	OEM, PCM
PRODUCT TYPE: Generic	Flash Memory	Flash Memory	Flash Memory	Flash Memory	Flash Memory
CAPACITY: Card capacity (MB)	12	16	12	16	20
CHIP CONFIGURATION: Chip density (Mb)	8	8	8	8	16
Chip count per card	12	16	12	16	
Chip logic type	NOR	NOR	NOR	NOR	NOR
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I
Interface	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1
XIP	Yes	Yes	Yes	Yes	Yes
Erasable block size (KB)	64	64	64	64	64
SECTOR ENDURANCE: (Kcycles)	100	100	100	100	1000
PERFORMANCE: Avg. access time (ns)	250	250	200/250	200/250	150
Media read rate (MB/Sec)					13
Media write rate (MB/Sec)					.85
Burst transfer rate (MB/Sec)					13 (Read)
Block erase time (ms)	1600	1600	1600	1600	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	5 x 54 x 85.6
OPERATING VOLTAGE:	5 V, 12 V	5 V, 12 V	5 V	5 V	5 V, 12 V
FIRST CUSTOMER SHIPMENT	1994	1994	1995	1995	1994
COMMENTS			Intel Series II type chips.	Intel Series II type chips.	

MANUFACTURER	KINGMAX TECHNOLOGY	KINGMAX TECHNOLOGY	KINGMAX TECHNOLOGY	KINGSTON TECHNOLOGY	KINGSTON TECHNOLOGY
FLASH CARD MODEL	FJP-24	FAD-028	FAD-032	DP-ATA/2	DP-ATA/4
DISK/TREND GROUP	41	42	42	40	40
MARKET	OEM, PCM	PCM	PCM	OEM, PCM	OEM, PCM
PRODUCT TYPE: Generic	Flash Memory	Flash Memory	Flash Memory	Flash Disk	Flash Disk
CAPACITY: Card capacity (MB)	24	28	32	2	4
CHIP CONFIGURATION:					
Chip density (Mb)	16	16	16	16	32
Chip count per card		14	16	1	1
Chip logic type	NOR	NOR	NOR	NAND	NAND
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type II	PC Card Type II
Interface	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA ATA	PCMCIA ATA
XIP	Yes	Yes	Yes	No	No
Erasable block size (KB)	64	64	64	.512	.512
SECTOR ENDURANCE: (Kcycles)	1000	1000	1000	1000	1000
PERFORMANCE:					
Avg. access time (ns)	150	150	150		
Media read rate (MB/Sec)	13	13	13	8	8
Media write rate (MB/Sec)	.85	.125	.125		
Burst transfer rate (MB/Sec)	13 (Read)			8	8
Block erase time (ms)	300	1500	1500		
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	5 x 54 x 85.6	5 x 54 x 85.6
OPERATING VOLTAGE:	5 V, 12 V	5 V	5 V	5 V	5 V
FIRST CUSTOMER SHIPMENT	1994	1996	1996	1996	1996
COMMENTS		AMD type D chips.	AMD type D chips.		

MANUFACTURER	KINGSTON TECHNOLOGY	KINGSTON TECHNOLOGY	KINGSTON TECHNOLOGY	KINGSTON TECHNOLOGY	KINGSTON TECHNOLOGY
FLASH CARD MODEL	DP-ATA/6	DP-ATA/8	DP-ATA/10	DP-ATA/16	DP-ATA/20
DISK/TREND GROUP	40	40	41	41	41
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
PRODUCT TYPE: Generic	Flash Disk	Flash Disk	Flash Disk	Flash Disk	Flash Disk
CAPACITY: Card capacity (MB)	6	8	10	16	20
CHIP CONFIGURATION:					
Chip density (Mb)	32	32	32	32	32
Chip count per card	2	2	3	4	5
Chip logic type	NAND	NAND	NAND	NAND	NAND
FEATURES: Package	PC Card Type II	PC Card Type II	PC Card Type II	PC Card Type II	PC Card Type II
Interface	PCMCIA ATA	PCMCIA ATA	PCMCIA ATA	PCMCIA ATA	PCMCIA ATA
XIP	No	No	No	No	No
Erasable block size (KB)	.512	.512	.512	.512	.512
SECTOR ENDURANCE: (Kcycles)	1000	1000	1000	1000	1000
PERFORMANCE:					
Avg. access time (ns)					
Media read rate (MB/Sec)	8	8	8	8	8
Media write rate (MB/Sec)					
Burst transfer rate (MB/Sec)	8	8	8	8	8
Block erase time (ms)					
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	1996	1996	1996	1996	1996
COMMENTS					

MANUFACTURER	LEXAR MICROSYSTEMS	LEXAR MICROSYSTEMS	LEXAR MICROSYSTEMS	LEXAR MICROSYSTEMS	LEXAR MICROSYSTEMS
FLASH CARD MODEL	FD0002A	FD0004A	FD0008A	FD0002E CompactCard 2	FD0004E CompactCard 4
DISK/TREND GROUP	40	40	40	40	40
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM	OEM
PRODUCT TYPE: Generic	Flash Disk	Flash Disk	Flash Disk	Flash Disk	Flash Disk
CAPACITY: Card capacity (MB)	2	4	8	2	4
CHIP CONFIGURATION:					
Chip density (Mb)	16	32	32	16	32
Chip count per card	1	1	2	1	1
Chip logic type	NAND	NAND	NAND	NAND	NAND
FEATURES: Package	PC Card Type II	PC Card Type II	PC Card Type II	Compact Flash	Compact Flash
Interface	PCMCIA-ATA	PCMCIA-ATA	PCMCIA-ATA	ATAPI-ATA	ATAPI-ATA
XIP	No	No	No	No	No
Erasable block size (KB)	.512	.512	.512	.512	.512
SECTOR ENDURANCE: (Kcycles)	1000	1000	1000	1000	1000
PERFORMANCE:					
Avg. access time (ns)	100*	100*	100*	100*	100*
Media read rate (MB/Sec)	8	8	8	8	8
Media write rate (MB/Sec)	1.2	1.2	1.2	1.2	1.2
Burst transfer rate (MB/Sec)	20	20	20	8	8
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 42.8 x 36.4	3.3 x 42.8 x 36.4
OPERATING VOLTAGE:	3.3 V, 5 V	3.3 V, 5 V	3.3 V, 5 V	3.3 V, 5 V	3.3 V, 5 V
FIRST CUSTOMER SHIPMENT	1996	1996	1996	2Q97	2Q97
COMMENTS	*Wake up time. Background sector erase.	*Wake up time. Background sector erase.	*Wake up time. Background sector erase.	*Wake up time. Background sector erase.	*Wake up time. Background sector erase.

MANUFACTURER	LEXAR MICROSYSTEMS	LEXAR MICROSYSTEMS	LEXAR MICROSYSTEMS	LEXAR MICROSYSTEMS	M-SYSTEMS
FLASH CARD MODEL	FD0008E CompactCard 8	FD0012A	FD0016A	FD0020A	FlashCard-1M
DISK/TREND GROUP	40	41	41	41	40
MARKET	OEM	OEM, PCM	OEM, PCM	OEM, PCM	OEM
PRODUCT TYPE: Generic	Flash Disk	Flash Disk	Flash Disk	Flash Disk	Flash Memory
CAPACITY: Card capacity (MB)	8	12	16	20	1
CHIP CONFIGURATION:					
Chip density (Mb)	32	32	32	32	8
Chip count per card	2	3	4	5	1
Chip logic type	NAND	NAND	NAND	NAND	NOR
FEATURES: Package	Compact Flash	PC Card Type II	PC Card Type II	PC Card Type II	PC Card Type I
Interface	ATAPI-ATA	PCMCIA-ATA	PCMCIA-ATA	PCMCIA-ATA	PCMCIA 2.1
XIP	No	No	No	No	Yes
Erasable block size (KB)	.512	.512	.512	.512	128
SECTOR ENDURANCE: (Kcycles)	1000	1000	1000	1000	100
PERFORMANCE:					
Avg. access time (ns)	100*	100*	100*	100*	150
Media read rate (MB/Sec)	8	8	8	8	12.5
Media write rate (MB/Sec)	1.2	1.2	1.2	1.2	.4
Burst transfer rate (MB/Sec)	8	20	20	20	
Block erase time (ms)	--				1600
SIZE: (mm: H x W x D)	3.3 x 42.8 x 36.4	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 V, 5 V	3.3 V, 5 V	3.3 V, 5 V	3.3 V, 5 V	3.3 V, 5 V
FIRST CUSTOMER SHIPMENT	2Q97	1996	1996	1996	
COMMENTS	*Wake up time. Background sector erase.	*Wake up time. Background sector erase.	*Wake up time. Background sector erase.	*Wake up time. Background sector erase.	

MANUFACTURER	M-SYSTEMS	M-SYSTEMS	M-SYSTEMS	M-SYSTEMS	M-SYSTEMS
FLASH CARD MODEL	FlashCard-2M	FlashCard-4M	FlashCard-8M	LDP-FD-1	LDP-FD-2
DISK/TREND GROUP	40	40	40	40	40
MARKET	OEM	OEM	OEM	PCM	PCM
PRODUCT TYPE: Generic	Flash Memory	Flash Memory	Flash Memory	Flash Memory	Flash Memory
CAPACITY: Card capacity (MB)	2	4	8	1	2
CHIP CONFIGURATION:					
Chip density (Mb)	8	8	8		
Chip count per card	2	4	8		
Chip logic type	NOR	NOR	NOR		
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I
Interface	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.0	PCMCIA 2.0
XIP	Yes	Yes	Yes	Yes	Yes
Erasable block size (KB)	128	128	128	64	128
SECTOR ENDURANCE: (Kcycles)	100	100	100		
PERFORMANCE:					
Avg. access time (ns)	150	150	150		
Media read rate (MB/Sec)	12.5	12.5	12.5	1.5	3.0
Media write rate (MB/Sec)	.4	.4	.4	.03	.06
Burst transfer rate (MB/Sec)					
Block erase time (ms)	1600	1600	1600		
SIZE: (mm: H x W x D)	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3 x 54 x 85.6	3 x 54 x 85.6
OPERATING VOLTAGE:	3.3 V, 5 V	3.3 V, 5 V	3.3 V, 5 V	5 V, 12 V	5 V, 12 V
FIRST CUSTOMER SHIPMENT					
COMMENTS				Software disk emulation.	Software disk emulation.

MANUFACTURER	M-SYSTEMS	M-SYSTEMS	M-SYSTEMS	M-SYSTEMS	M-SYSTEMS
FLASH CARD MODEL	LDP-FD-4	PCC-FD-2K-2	PCC-FD-2K-4	PCC-FD-2K-8	PCMCIA-FD-2
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
CAPACITY: Card capacity (MB)	4	2	4	8	2
CHIP CONFIGURATION:					
Chip density (Mb)					
Chip count per card					
Chip logic type		NAND	NAND	NAND	
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I
Interface	PCMCIA 2.0	PCMCIA 2.0	PCMCIA 2.0	PCMCIA 2.0	PCMCIA 2.0
XIP	Yes				Yes
Erasable block size (KB)	128				128
SECTOR ENDURANCE: (Kcycles)					
PERFORMANCE:					
Avg. access time (ns)		200	200	200	200
Media read rate (MB/Sec)	3.0	1.7	1.7	1.7	3.0
Media write rate (MB/Sec)	.06	.8	.8	.8	.06
Burst transfer rate (MB/Sec)		13.3	13.3	13.3	
Block erase time (ms)					
SIZE: (mm: H x W x D)	3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3 x 54 x 85.6
OPERATING VOLTAGE:	5 V, 12 V	5 V, 3.3 V	5 V, 3.3 V	5 V, 3.3 V	5 V, 12 V
FIRST CUSTOMER SHIPMENT					
COMMENTS	Software disk emulation.	Software disk emulation.	Software disk emulation.	Software disk emulation.	Software disk emulation.

MANUFACTURER	M-SYSTEMS	M-SYSTEMS	M-SYSTEMS	M-SYSTEMS	M-SYSTEMS
FLASH CARD MODEL	PCMCIA-FD-4	PCMCIA-FD-8	FlashCard-10M	FlashCard-20M	PCC-FD-2K-16
DISK/TREND GROUP	40	40	41	41	41
MARKET	PCM	PCM	OEM	OEM	PCM
PRODUCT TYPE: Generic	Flash Memory	Flash Memory	Flash Memory	Flash Memory	Flash Memory
CAPACITY: Card capacity (MB)	4	8	10	20	16
CHIP CONFIGURATION: Chip density (Mb)			8	8	
Chip count per card			10	20	
Chip logic type			NOR	NOR	NAND
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I
Interface	PCMCIA 2.0	PCMCIA 2.0	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.0
XIP	Yes	Yes	Yes	Yes	
Erasable block size (KB)	128	128	128	128	
SECTOR ENDURANCE: (Kcycles)			100	100	
PERFORMANCE: Avg. access time (ns)	200	200	150	150	200
Media read rate (MB/Sec)	3.0	3.0	12.5	12.5	1.7
Media write rate (MB/Sec)	.06	.06	.4	.4	.8
Burst transfer rate (MB/Sec)					13.3
Block erase time (ms)			1600	1600	
SIZE: (mm: H x W x D)	3 x 54 x 85.6	3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6
OPERATING VOLTAGE:	5 V, 12 V	5 V, 12 V	3.3 V, 5 V	3.3 V, 5 V	5 V, 3.3 V
FIRST CUSTOMER SHIPMENT					
COMMENTS	Software disk emulation.	Software disk emulation.			Software disk emulation.

MANUFACTURER	M-SYSTEMS	M-SYSTEMS	M-SYSTEMS	M-SYSTEMS	M-SYSTEMS
FLASH CARD MODEL	PCC-FD-2K-24	PCMCIA-FD-10	PCMCIA-FD-20	FlashCard-40M	PCC-FD-2K-32
DISK/TREND GROUP	41	41	41	42	42
MARKET	PCM	PCM	PCM	OEM	PCM
PRODUCT TYPE: Generic	Flash Memory	Flash Memory	Flash Memory	Flash Memory	Flash Memory
CAPACITY: Card capacity (MB)	24	10	20	40	32
CHIP CONFIGURATION: Chip density (Mb)				8	
Chip count per card				40	
Chip logic type	NAND			NOR	NAND
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I
Interface	PCMCIA 2.0	PCMCIA 2.0	PCMCIA 2.0	PCMCIA 2.1	PCMCIA 2.0
XIP		Yes	Yes	Yes	
Erasable block size (KB)		128	128	128	
SECTOR ENDURANCE: (Kcycles)				100	
PERFORMANCE: Avg. access time (ns)	200	200	200	150	200
Media read rate (MB/Sec)	1.7	3.0	3.0	12.5	1.7
Media write rate (MB/Sec)	.8	.06	.1	.4	.8
Burst transfer rate (MB/Sec)	13.3				13.3
Block erase time (ms)				1600	
SIZE: (mm: H x W x D)	3.3 x 54 x 85.6	3 x 54 x 85.6	3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6
OPERATING VOLTAGE:	5 V, 3.3 V	5 V, 12 V	5 V, 12 V	3.3, 5 V	5 V, 3.3 V
FIRST CUSTOMER SHIPMENT				3Q95	
COMMENTS	Software disk emulation.	Software disk emulation.	Software disk emulation.		Software disk emulation.

MANUFACTURER	M-SYSTEMS	M-SYSTEMS	M-SYSTEMS	MAGICRAM	MAGICRAM
FLASH CARD MODEL	PCC-FD-2K-40	PCC-FD-2K-64	PCMCIA-FD-40V	FL2MBP100	FL4MBP100
DISK/TREND GROUP	42	42	42	40	40
MARKET	PCM	PCM	PCM		PCM
PRODUCT TYPE: Generic	Flash Memory	Flash Memory	Flash Memory	Flash Memory	Flash Memory
CAPACITY: Card capacity (MB)	40	64	40	2	4
CHIP CONFIGURATION: Chip density (Mb)				8	8
Chip count per card				2	4
Chip logic type	NAND	NAND		NOR	NOR
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type I	PC Card I	PC Card I
Interface	PCMCIA 2.0	PCMCIA 2.0	PCMCIA 2.0	PCMCIA 2.1	PCMCIA 2.1
XIP			Yes	Yes	Yes
Erasable block size (KB)			128	128*	128*
SECTOR ENDURANCE: (Kcycles)				100	100
PERFORMANCE: Avg. access time (ns)	200	200		200	200
Media read rate (MB/Sec)	1.7	1.7		5	5
Media write rate (MB/Sec)	.8	.8		.2*	.2*
Burst transfer rate (MB/Sec)	13.3	13.3		5	5
Block erase time (ms)				1600	1600
SIZE: (mm: H x W x D)	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6
OPERATING VOLTAGE:	5 V, 3.3 V	5 V, 3.3 V	5V	5 V, 12 V	5 V, 12 V
FIRST CUSTOMER SHIPMENT				1992	1992
COMMENTS	Software disk emulation.	Software disk emulation.	Software disk emulation.	Intel Series 2 chips. *Chip pair.	Intel Series 2 chips. *Chip pair.

MANUFACTURER	MAGICRAM	MAGICRAM	MAGICRAM	MAGICRAM	MAGICRAM
FLASH CARD MODEL	FL8MBP100	FL10MP100	FL16MP100	FL20MP100	FL40MP100
DISK/TREND GROUP	40	41	41	41	42
MARKET	PCM	PCM	PCM	PCM	PCM
PRODUCT TYPE: Generic	Flash Memory	Flash Memory	Flash Memory	Flash Memory	Flash Memory
CAPACITY: Card capacity (MB)	8	10	16	20	40
CHIP CONFIGURATION: Chip density (Mb)	8	8	8	8	8
Chip count per card	8	10	16		
Chip logic type	NOR	NOR	NOR		
FEATURES: Package	PC Card I	PC Card I	PC Card I	PC Card I	PC Card 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*
SECTOR ENDURANCE: (Kcycles)	100	100	100	100	100
PERFORMANCE: Avg. access time (ns)	200	200	200	200	
Media read rate (MB/Sec)	5	5	5	5	
Media write rate (MB/Sec)	.2*	.2*	.2*	.2*	
Burst transfer rate (MB/Sec)	5	5	5	5	
Block erase time (ms)	1600	1600	1600	1600	
SIZE: (mm: H x W x D)	3.3 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	1992	1992	1992	1992	
COMMENTS	Intel Series 2 chips. *Chip pair.	Intel Series 2 chips. *Chip pair.	Intel Series 2 chips. *Chip pair.	Intel Series 2 chips. *Chip pair.	

MANUFACTURER	MATSUSHITA ELECTRIC INDUSTRIAL	MATSUSHITA ELECTRIC INDUSTRIAL	MATSUSHITA ELECTRIC INDUSTRIAL	MATSUSHITA ELECTRIC INDUSTRIAL	MATSUSHITA ELECTRIC INDUSTRIAL
FLASH CARD MODEL	BN-002AA-S	BN-004AA-S	BN-01MHFRE	BN-02MHF3CE	BN-02MHF4C
DISK/TREND GROUP	40	40	40	40	40
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
PRODUCT TYPE: Generic	Flash Disk	Flash Disk	Flash Memory	Flash Memory	Flash Memory
CAPACITY: Card capacity (MB)	2	4	1	2	2
CHIP CONFIGURATION:					
Chip density (Mb)	16	32	2	8	8
Chip count per card	1	1	4	2	2
Chip logic type	NAND	NAND	NOR	NOR	NOR
FEATURES: Package	PC Card Type II	PC Card Type II	PC Card Type I	PC Card Type I	PC Card Type I
Interface	PCMCIA ATA	PCMCIA ATA	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1
XIP	No	No	Yes	Yes	Yes
Erasable block size (KB)			256	128	128
SECTOR ENDURANCE: (Kcycles)	1000	1000	100	100	100
PERFORMANCE:					
Avg. access time (ns)	1.2	1.2	250	250	250
Media read rate (MB/Sec)	3.5	3.5	4	4	4
Media write rate (MB/Sec)	.46	.46	.625	.208	.156
Burst transfer rate (MB/Sec)	8	8	--	--	--
Block erase time (ms)			1000	1600	900
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
FIRST CUSTOMER SHIPMENT	1994	1994	1990	1995	1996
COMMENTS					Using Intel (Sharp) chips.

MANUFACTURER	MATSUSHITA ELECTRIC INDUSTRIAL	MATSUSHITA ELECTRIC INDUSTRIAL	MATSUSHITA ELECTRIC INDUSTRIAL	MATSUSHITA ELECTRIC INDUSTRIAL	MATSUSHITA ELECTRIC INDUSTRIAL
FLASH CARD MODEL	BN-02MHFCC	BN-02MHFRE	BN-04MHF3CE	BN-04MHF4C	BN-04MHFCC
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
CAPACITY: Card capacity (MB)	2	2	4	4	4
CHIP CONFIGURATION:					
Chip density (Mb)	8	2	8	16	16
Chip count per card	2	8	4	2	2
Chip logic type	NOR	NOR	NOR	NOR	NOR
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I
Interface	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1
XIP	Yes	Yes	Yes	Yes	Yes
Erasable block size (KB)	128	256	128	128	128
SECTOR ENDURANCE: (Kcycles)	100	100	100	100	100
PERFORMANCE:					
Avg. access time (ns)	250	250	250	250	250
Media read rate (MB/Sec)	4	4		4	4
Media write rate (MB/Sec)	.25	.625	.208	.156	.25
Burst transfer rate (MB/Sec)	--	--	--	--	--
Block erase time (ms)	1000	1000	1600	900	1000
SIZE: (mm: H x W x D)	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6
OPERATING VOLTAGE:	5 V	5 V, 12 V	5 V, 12 V	5 V	5 V
FIRST CUSTOMER SHIPMENT	1996	1990	1995	1996	1996
COMMENTS	Using Fujitsu (AMD) chips.			Using Intel (Sharp) chips.	Using Fujitsu (AMD) chips.

MANUFACTURER	MATSUSHITA ELECTRIC INDUSTRIAL	MATSUSHITA ELECTRIC INDUSTRIAL	MATSUSHITA ELECTRIC INDUSTRIAL	MATSUSHITA ELECTRIC INDUSTRIAL	MATSUSHITA ELECTRIC INDUSTRIAL
FLASH CARD MODEL	BN-04MHFRE	BN-08MHF3CE	BN-08MHF4C	BN-08MHFCC	BN-512HFRE
DISK/TREND GROUP	40	40	40	40	40
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
PRODUCT TYPE: Generic	Flash Memory	Flash Memory	Flash Memory	Flash Memory	Flash Memory
CAPACITY: Card capacity (MB)	4	8	4	8	.512
CHIP CONFIGURATION:					
Chip density (Mb)	2	8	16	16	2
Chip count per card	16	8	4	4	2
Chip logic type	NOR	NOR	NOR	NOR	NOR
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I
Interface	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1
XIP	Yes	Yes	Yes	Yes	Yes
Erasable block size (KB)	256	128	128	128	256
SECTOR ENDURANCE: (Kcycles)	100	100	100	100	100
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)	.625	.208	.156	.25	.625
Burst transfer rate (MB/Sec)	--	--	--	--	--
Block erase time (ms)	1000	1600	900	1000	1000
SIZE: (mm: H x W x D)	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6
OPERATING VOLTAGE:	5 V, 12 V	5 V, 12 V	5 V	5 V	5 V, 12 V
FIRST CUSTOMER SHIPMENT	1990	1995	1996	1996	1990
COMMENTS			Using Intel (Sharp) chips.	Using Fujitsu (AMD) chips.	

MANUFACTURER	MATSUSHITA ELECTRIC INDUSTRIAL	MATSUSHITA ELECTRIC INDUSTRIAL	MATSUSHITA ELECTRIC INDUSTRIAL	MATSUSHITA ELECTRIC INDUSTRIAL	MATSUSHITA ELECTRIC INDUSTRIAL
FLASH CARD MODEL	BN-010AA-L	BN-020AA-L	BN-10MHF3CE	BN-12MHF4C	BN-12MHFCC
DISK/TREND GROUP	41	41	41	41	41
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
PRODUCT TYPE: Generic	Flash Disk	Flash Disk	Flash Memory	Flash Memory	Flash Memory
CAPACITY: Card capacity (MB)	10	20	10	12	12
CHIP CONFIGURATION:					
Chip density (Mb)	16	16	8	16	16
Chip count per card	5	10	10	6	6
Chip logic type	NAND	NAND	NOR	NOR	NOR
FEATURES: Package	PC Card Type II	PC Card Type II	PC Card Type I	PC Card Type I	PC Card Type I
Interface	PCMCIA ATA	PCMCIA ATA	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1
XIP	No	No	Yes	Yes	Yes
Erasable block size (KB)			128	128	128
SECTOR ENDURANCE: (Kcycles)	1000	1000	100	100	100
PERFORMANCE:					
Avg. access time (ns)			250	250	250
Media read rate (MB/Sec)	3.5	3.5	4	4	4
Media write rate (MB/Sec)	.46	.46	.208	.156	.25
Burst transfer rate (MB/Sec)	8	8	--	--	--
Block erase time (ms)			1600	900	1000
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	5 V
FIRST CUSTOMER SHIPMENT	1994	1994	1995	1996	1996
COMMENTS				Using Intel (Sharp) chips.	Using Fujitsu (AMD) chips.

MANUFACTURER	MATSUSHITA ELECTRIC INDUSTRIAL	MATSUSHITA ELECTRIC INDUSTRIAL	MATSUSHITA ELECTRIC INDUSTRIAL	MATSUSHITA ELECTRIC INDUSTRIAL	MATSUSHITA ELECTRIC INDUSTRIAL
FLASH CARD MODEL	BN-16MHF3CE	BN-16MHF4C	BN-16MHFCC	BN-20MHF4C	BN-20MHFCC
DISK/TREND GROUP	41	41	41	41	41
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
PRODUCT TYPE: Generic	Flash Memory	Flash Memory	Flash Memory	Flash Memory	Flash Memory
CAPACITY: Card capacity (MB)	16	16	16	20	20
CHIP CONFIGURATION:					
Chip density (Mb)	8	16	16	16	16
Chip count per card	16	8	8	10	10
Chip logic type	NOR	NOR	NOR	NOR	NOR
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I
Interface	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1
XIP	Yes	Yes	Yes	Yes	Yes
Erasable block size (KB)	128	128	128	128	128
SECTOR ENDURANCE: (Kcycles)	100	100	100	100	100
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)	.208	.156	.25	.156	.25
Burst transfer rate (MB/Sec)	--	--	--	--	--
Block erase time (ms)	1600	900	1000	900	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	5 V	5 V	5 V
FIRST CUSTOMER SHIPMENT	1995	1996	1996	1996	1996
COMMENTS		Using Intel (Sharp) chips.	Using Fujitsu (AMD) chips.	Using Intel (Sharp) chips.	Using Fujitsu (AMD) chips.

MANUFACTURER	MATSUSHITA ELECTRIC INDUSTRIAL	MATSUSHITA ELECTRIC INDUSTRIAL	MATSUSHITA ELECTRIC INDUSTRIAL	MATSUSHITA ELECTRIC INDUSTRIAL	MATSUSHITA ELECTRIC INDUSTRIAL
FLASH CARD MODEL	BN-24MHFCC	BN-28MHFCC	BN-040AA-L	BN-040AB-M	BN-080AB-M
DISK/TREND GROUP	41	41	42	42	42
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
PRODUCT TYPE: Generic	Flash Memory	Flash Memory	Flash Disk	Flash Disk	Flash Disk
CAPACITY: Card capacity (MB)	24	28	40	40	80
CHIP CONFIGURATION:					
Chip density (Mb)	16	16	16	32	64
Chip count per card	12	14	20	10	10
Chip logic type	NOR	NOR	NAND	NAND	NAND
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type II	PC Card Type II	PC Card Type II
Interface	PCMCIA 2.1	PCMCIA 2.1	PCMCIA ATA	PCMCIA ATA	PCMCIA ATA
XIP	Yes	Yes	No	No	No
Erasable block size (KB)	128	128			
SECTOR ENDURANCE: (Kcycles)	100	100	1000	1000	1000
PERFORMANCE:					
Avg. access time (ns)	250	250	1.2	1.2	1.2
Media read rate (MB/Sec)	4	4	3.5	3.5	3.5
Media write rate (MB/Sec)	.25	.25	.46	.65	.65
Burst transfer rate (MB/Sec)	--	--	8	8	8
Block erase time (ms)	1000	1000			
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	5 x 54 x 85.6
OPERATING VOLTAGE:	5 V	5 V	5 V	3.3 V, 5 V	3.3 V, 5 V
FIRST CUSTOMER SHIPMENT	1996	1996	1995	1997	1997
COMMENTS	Using Fujitsu (AMD) chips.	Using Fujitsu (AMD) chips.			

MANUFACTURER	MATSUSHITA ELECTRIC INDUSTRIAL	MEMORY CARD TECHNOLOGY	MEMORY CARD TECHNOLOGY	MEMORY CARD TECHNOLOGY	MEMORY CARD TECHNOLOGY
FLASH CARD MODEL	BN-096AB-M	F01MX0	F02MX0	F04MX0	F06MX0
DISK/TREND GROUP	42	40	40	40	40
MARKET	OEM, PCM	PCM	PCM	PCM	PCM
PRODUCT TYPE: Generic	Flash Disk	Flash Memory	Flash Memory	Flash Memory	Flash Memory
CAPACITY: Card capacity (MB)	96	1	2	4	6
CHIP CONFIGURATION: Chip density (Mb)	64				
Chip count per card	12				
Chip logic type	NAND	NOR	NOR	NOR	NOR
FEATURES: Package	PC Card Type II	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I
Interface	PCMCIA ATA	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1
XIP	No				
Erasable block size (KB)					
SECTOR ENDURANCE: (Kcycles)	1000	10	100	100	100
PERFORMANCE: Avg. access time (ns)	1.2	250	200	200	200
Media read rate (MB/Sec)	3.5				
Media write rate (MB/Sec)	.65				
Burst transfer rate (MB/Sec)	8				
Block erase time (ms)					
SIZE: (mm: H x W x D)	5 x 54 x 85.6				
OPERATING VOLTAGE:	3.3 V, 5 V	5V, 12V	5V, 12V	5V, 12V	5V, 12V
FIRST CUSTOMER SHIPMENT	1997				
COMMENTS		Intel Series 1 chips.	Intel Series 2 chips.	Intel Series 2 chips.	Intel Series 2 chips.

MANUFACTURER	MEMORY CARD TECHNOLOGY	MEMORY CARD TECHNOLOGY	MEMORY CARD TECHNOLOGY	MEMORY CARD TECHNOLOGY	MEMORY CARD TECHNOLOGY
FLASH CARD MODEL	F08MX0	F256X0	F512X0	F10MX0	F12MX0
DISK/TREND GROUP	40	40	40	41	41
MARKET	PCM	PCM	PCM	PCM	PCM
PRODUCT TYPE: Generic	Flash Memory	Flash Memory	Flash Memory	Flash Memory	Flash Memory
CAPACITY: Card capacity (MB)	8	.256	.512	10	12
CHIP CONFIGURATION: Chip density (Mb)					
Chip count per card					
Chip logic type	NOR	NOR	NOR	NOR	NOR
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I
Interface	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1
XIP					
Erasable block size (KB)					
SECTOR ENDURANCE: (Kcycles)	100	10	10	100	100
PERFORMANCE: Avg. access time (ns)	200	250	250	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)					
OPERATING VOLTAGE:	5V, 12V	5V, 12V	5V, 12V	5V, 12V	5V, 12V
FIRST CUSTOMER SHIPMENT					
COMMENTS	Intel Series 2 chips.	Intel Series 1 chips.	Intel Series 1 chips.	Intel Series 2 chips.	Intel Series 2 chips.

MANUFACTURER	MEMORY CARD TECHNOLOGY	MEMORY CARD TECHNOLOGY	MITSUBISHI ELECTRIC	MITSUBISHI ELECTRIC	MITSUBISHI ELECTRIC
FLASH CARD MODEL	F14MXO	F16MXO	MF007M5-03AA	MF81M1-GBDAT	MF81M1-GCDAT
DISK/TREND GROUP	41	41	40	40	40
MARKET	PCM	PCM	OEM, PCM	OEM	OEM
PRODUCT TYPE: Generic	Flash Memory	Flash Memory	Flash Disk	Flash Memory	Flash Memory
CAPACITY: Card capacity (MB)	14	16	7.5	1	1
CHIP CONFIGURATION: Chip density (Mb)			64	1	1
Chip count per card			1	8	8
Chip logic type	NOR	NOR	AND	NOR	NOR
FEATURES: Package	PC Card Type I	PC Card Type I	Compact Flash	PC Card Type I	PC Card Type I
Interface	PCMCIA 2.1	PCMCIA 2.1	PCMCIA ATA	PCMCIA 2.01	PCMCIA 2.01
XIP			No	Yes	Yes
Erasable block size (KB)			.512		
SECTOR ENDURANCE: (Kcycles)	100	100	100	10	10
PERFORMANCE: Avg. access time (ns)	200	200	1 ms	200	200
Media read rate (MB/Sec)			8	5	5
Media write rate (MB/Sec)			.25	.0625	.0625
Burst transfer rate (MB/Sec)			8		
Block erase time (ms)			1		
SIZE: (mm: H x W x D)			3.3 x 42.8 x 36.4	3.3 x 54 x 85.6	3.3 x 54 x 85.6
OPERATING VOLTAGE:	5V, 12V	5V, 12V	5 V, 3.3 V	5 V, 12 V	5 V, 12 V
FIRST CUSTOMER SHIPMENT			1997		
COMMENTS	Intel Series 2 chips.	Intel Series 2 chips.			EEPROM attribute memory.

MANUFACTURER	MITSUBISHI ELECTRIC	MITSUBISHI ELECTRIC	MITSUBISHI ELECTRIC	MITSUBISHI ELECTRIC	MITSUBISHI ELECTRIC
FLASH CARD MODEL	MF81M1-GFDAT	MF8257-GBDAT	MF8257-GCDAT	MF8257-GFDAT	MF82M1-G7DAT
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
CAPACITY: Card capacity (MB)	1	.256	.256	.256	2
CHIP CONFIGURATION:					
Chip density (Mb)	1	1	1	1	8
Chip count per card	8	2	2	2	2
Chip logic type	NOR	NOR	NOR	NOR	NOR
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I
Interface	PCMCIA 2.1	PCMCIA 2.01	PCMCIA 2.01	PCMCIA 2.1	PCMCIA 2.1
XIP	Yes	Yes	Yes	Yes	Yes
Erasable block size (KB)	128			128	64
SECTOR ENDURANCE: (Kcycles)	1		10	1	100
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)	.0625	.0625	.0625	.0625	.111
Burst transfer rate (MB/Sec)					
Block erase time (ms)	2000			2000	800
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	20-70 degree C operating range.		EEPROM attribute memory.	20-70 degree C operating range.	EEPROM attribute memory.

MANUFACTURER	MITSUBISHI ELECTRIC	MITSUBISHI ELECTRIC	MITSUBISHI ELECTRIC	MITSUBISHI ELECTRIC	MITSUBISHI ELECTRIC
FLASH CARD MODEL	MF82M1-G9DAT	MF82M1-GBDAT	MF82M1-GCDAT	MF82M1-GFDAT	MF82M1-GGCAT
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
CAPACITY: Card capacity (MB)	2	2	2	2	2
CHIP CONFIGURATION:					
Chip density (Mb)	8	1	1	1	16
Chip count per card	2	16	16	16	1
Chip logic type	NOR	NOR	NOR	NOR	NOR
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I
Interface	PCMCIA 2.1	PCMCIA 2.01	PCMCIA 2.01	PCMCIA 2.1	PCMCIA 2.1
XIP	Yes	Yes	Yes	Yes	Yes
Erasable block size (KB)	64			128	64
SECTOR ENDURANCE: (Kcycles)	100	10	10	1	100
PERFORMANCE:					
Avg. access time (ns)	200	200	200	200	150
Media read rate (MB/Sec)	5	5	5	5	6.67
Media write rate (MB/Sec)	.111	.0625	.0625	.0625	.125
Burst transfer rate (MB/Sec)					--
Block erase time (ms)	800			2000	700
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
FIRST CUSTOMER SHIPMENT					
COMMENTS			EEPROM attribute memory.	20-70 degree C operating range.	

MANUFACTURER	MITSUBISHI ELECTRIC	MITSUBISHI ELECTRIC	MITSUBISHI ELECTRIC	MITSUBISHI ELECTRIC	MITSUBISHI ELECTRIC
FLASH CARD MODEL	MF82M1-GHCAT	MF84M1-G7DAT	MF84M1-G9DAT	MF84M1-GGCAT	MF84M1-GHCAT
DISK/TREND GROUP	40	40	40	40	40
MARKET	OEM	OEM, PCM	OEM, PCM	OEM	OEM
PRODUCT TYPE: Generic	Flash Memory	Flash Memory	Flash Memory	Flash Memory	Flash Memory
CAPACITY: Card capacity (MB)	2	4	4	4	4
CHIP CONFIGURATION:					
Chip density (Mb)	16	8	8	16	16
Chip count per card	1	4	4	2	2
Chip logic type	NOR	NOR	NOR	NOR	NOR
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I
Interface	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1
XIP	Yes	Yes	Yes	Yes	Yes
Erasable block size (KB)	64	64	64	64	64
SECTOR ENDURANCE: (Kcycles)	100	100	100	100	100
PERFORMANCE:					
Avg. access time (ns)	150	200	200	150	150
Media read rate (MB/Sec)	6.67	5	5	6.67	6.67
Media write rate (MB/Sec)	.125	.111	.111	.125	.125
Burst transfer rate (MB/Sec)	--			--	--
Block erase time (ms)	700	600	600	700	700
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		
FIRST CUSTOMER SHIPMENT		1994	1994		
COMMENTS	EEPROM attribute memory.	EEPROM attribute memory.			EEPROM attribute memory.

MANUFACTURER	MITSUBISHI ELECTRIC	MITSUBISHI ELECTRIC	MITSUBISHI ELECTRIC	MITSUBISHI ELECTRIC	MITSUBISHI ELECTRIC
FLASH CARD MODEL	MF8513-GBDAT	MF8513-GCDAT	MF8513-GFDAT	MF88M1-G7DATXX	MF88M1-G9DAT
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
CAPACITY: Card capacity (MB)	.512	.512	.512	8	8
CHIP CONFIGURATION:					
Chip density (Mb)	1	1	1	8	8
Chip count per card	4	4	4	8	8
Chip logic type	NOR	NOR	NOR	NOR	NOR
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I	
Interface	PCMCIA 2.01	PCMCIA 2.01	PCMCIA 2.1	PCMCIA 2.1	
XIP	Yes	Yes	Yes	Yes	
Erasable block size (KB)			.128	64	64
SECTOR ENDURANCE: (Kcycles)	10	10	1	100	100
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)	.0625	.0625	.0625	.111	.111
Burst transfer rate (MB/Sec)					
Block erase time (ms)			2000	600	600
SIZE: (mm: H x W x D)	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6	
OPERATING VOLTAGE:	5 V, 12 V	5 V, 12 V	5 V, 12 V	5 V, 12 V	
FIRST CUSTOMER SHIPMENT					
COMMENTS			20-70 degree C operating range.	EEPROM attribute memory.	

MANUFACTURER	MITSUBISHI ELECTRIC	MITSUBISHI ELECTRIC	MITSUBISHI ELECTRIC	MITSUBISHI ELECTRIC	MITSUBISHI ELECTRIC
FLASH CARD MODEL	MF0015M-02AF	MF015M-03AA	MF022M5-03AA	MF816M-G7DATXX	MF816M-G9DAT
DISK/TREND GROUP	41	41	41	41	41
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM
PRODUCT TYPE: Generic	Flash Disk	Flash Disk	Flash Disk	Flash Memory	Flash Memory
CAPACITY: Card capacity (MB)	15	15	22	16	10
CHIP CONFIGURATION:					
Chip density (Mb)	64	64	64	8	8
Chip count per card	2	2	3	10	10
Chip logic type	AND	AND	AND	NOR	NOR
FEATURES: Package	PC Card Type II	Compact Flash	Compact Flash	PC Card Type I	PC Card Type I
Interface	PCMCIA ATA	PCMCIA ATA	PCMCIA ATA	PCMCIA 2.1	PCMCIA 2.01
XIP	No	No	No		Yes
Erasable block size (KB)	.512	.512	.512	64	64
SECTOR ENDURANCE: (Kcycles)	100	100	100	100	100
PERFORMANCE:					
Avg. access time (ns)	1 ms	1 ms	1 ms	200	200
Media read rate (MB/Sec)	8	8	8	5	5
Media write rate (MB/Sec)	.35	.25	.25	.111	.111
Burst transfer rate (MB/Sec)	8	8	8		
Block erase time (ms)	1	1	1	600	600
SIZE: (mm: H x W x D)	5 x 54 x 85.6	3.3 x 42.8 x 36.4	3.3 x 42.8 x 36.4	3.3 x 54 x 85.6	3.3 x 54 x 85.6
OPERATING VOLTAGE:	5 V	5 V, 3.3 V	5 V, 3.3 V	5 V, 12 V	5 V, 12 V
FIRST CUSTOMER SHIPMENT	1996	1997	1997		
COMMENTS				EEPROM attribute memory.	

MANUFACTURER	MITSUBISHI ELECTRIC	MITSUBISHI ELECTRIC	MITSUBISHI ELECTRIC	MITSUBISHI ELECTRIC	MITSUBISHI ELECTRIC
FLASH CARD MODEL	MF820M-G7DATXX	MF820M-G9DAT	MF0030M-02AF	MF0045M-02AF	MF0060M-02AF
DISK/TREND GROUP	41	41	42	42	42
MARKET	OEM, PCM	OEM	OEM, PCM	OEM, PCM	OEM, PCM
PRODUCT TYPE: Generic	Flash Memory	Flash Memory	Flash Disk	Flash Disk	Flash Disk
CAPACITY: Card capacity (MB)	20	20	30	45	60
CHIP CONFIGURATION:					
Chip density (Mb)	8	8	64	64	64
Chip count per card	10	10	4	6	6
Chip logic type	NOR	NOR	AND	AND	AND
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type II	PC Card Type II	PC Card Type II
Interface	PCMCIA 2.1	PCMCIA 2.01	PCMCIA ATA	PCMCIA ATA	PCMCIA ATA
XIP		Yes	No	No	No
Erasable block size (KB)	64	64	.512	.512	.512
SECTOR ENDURANCE: (Kcycles)	100	100	100	100	100
PERFORMANCE:					
Avg. access time (ns)	200	200	1 ms	1 ms	1 ms
Media read rate (MB/Sec)	5	5	8	8	8
Media write rate (MB/Sec)	.111	.111	.25	.25	.25
Burst transfer rate (MB/Sec)			8	8	8
Block erase time (ms)	600	600	1	1	1
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	5 x 54 x 85.6
OPERATING VOLTAGE:	5 V, 12 V	5 V, 12 V	5 V	5 V	5 V
FIRST CUSTOMER SHIPMENT			1996	1996	1996
COMMENTS	Uses Intel chips. EEPROM attribute memory.				

MANUFACTURER	MITSUBISHI ELECTRIC	NEW MEDIA	NEW MEDIA	NEW MEDIA	NEW MEDIA
FLASH CARD MODEL	MF0075M-02AF	NMC00102	NMC00103	NMC00104	NMC00105
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
CAPACITY: Card capacity (MB)	75	.512	1	2	4
CHIP CONFIGURATION: Chip density (Mb)	64				
Chip count per card	10				
Chip logic type	AND	NOR	NOR	NOR	NOR
FEATURES: Package	PC Card Type II	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I
Interface	PCMCIA ATA	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1
XIP	No	Yes	Yes	Yes	Yes
Erasable block size (KB)	.512				
SECTOR ENDURANCE: (Kcycles)	100	100	100	100	100
PERFORMANCE: Avg. access time (ns)	.1 ms	150	150	150	150
Media read rate (MB/Sec)	8				
Media write rate (MB/Sec)	.25				
Burst transfer rate (MB/Sec)	8				
Block erase time (ms)	1				
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	1996	1993	1993	1993	
COMMENTS					

MANUFACTURER	NEW MEDIA	NEW MEDIA	NEW MEDIA	NEW MEDIA	SANDISK
FLASH CARD MODEL	NMC00123	NMC00124	NMC00125	NMC00126	SDIB-2
DISK/TREND GROUP	40	40	40	40	40
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
PRODUCT TYPE: Generic	Flash Memory	Flash Memory	Flash Memory	Flash Memory	Flash Disk
CAPACITY: Card capacity (MB)	.256	.512	1	2	2
CHIP CONFIGURATION: Chip density (Mb)					32
Chip count per card					1
Chip logic type	NOR	NOR	NOR	NOR	NOR
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I	1.3" IDE
Interface	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	IDE
XIP					No
Erasable block size (KB)					.512
SECTOR ENDURANCE: (Kcycles)	100	100	100	100	300
PERFORMANCE: Avg. access time (ns)	150	150	150	150	1.25
Media read rate (MB/Sec)					4
Media write rate (MB/Sec)					4
Burst transfer rate (MB/Sec)					6
Block erase time (ms)					.75
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	10.5 x 50.8 x 43.5
OPERATING VOLTAGE:	5 V	5 V	5 V	5 V	3.3 V, 5 V
FIRST CUSTOMER SHIPMENT					1996
COMMENTS					

MANUFACTURER	SANDISK	SANDISK	SANDISK	SANDISK	SANDISK
FLASH CARD MODEL	SDIB-4	SDIBT-4	SDP3B-2	SDP3B-4	SDP3B-6
DISK/TREND GROUP	40	40	40	40	40
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
PRODUCT TYPE: Generic	Flash Disk	Flash Disk	Flash Disk	Flash Disk	Flash Disk
CAPACITY: Card capacity (MB)	4	4	2	4	6
CHIP CONFIGURATION:					
Chip density (Mb)	32	32	32	32	32
Chip count per card	1	1	1	1	2
Chip logic type	NOR	NOR	NOR	NOR	NOR
FEATURES: Package	1.3" IDE	1.8" IDE	PC Card Type II	PC Card Type II	PC Card Type II
Interface	IDE	IDE	PCMCIA-ATA	PCMCIA-ATA	PCMCIA-ATA
XIP	No	No	No	No	No
Erasable block size (KB)	.512	.512	.512	.512	.512
SECTOR ENDURANCE: (Kcycles)	300	300	300	300	300
PERFORMANCE:					
Avg. access time (ns)	1.25	1.25	1.25	1.25	1.25
Media read rate (MB/Sec)	4	4	4	4	4
Media write rate (MB/Sec)	4	4	4	4	4
Burst transfer rate (MB/Sec)	6	6	6	6	6
Block erase time (ms)	.75	.75	.75	.75	.75
SIZE: (mm: H x W x D)	10.5 x 50.8 x 43.5	9.6 x 50.8 x 76.2	5 x 54 x 85.6	5 x 54 x 85.6	5 x 54 x 85.6
OPERATING VOLTAGE:	3.3 V, 5 V	3.3 V, 5 V	3.3 V, 5 V	3.3 V, 5 V	3.3 V, 5 V
FIRST CUSTOMER SHIPMENT	1996	1996	1996	1996	1996
COMMENTS					

MANUFACTURER	SANDISK	SANDISK	SANDISK	SANDISK	SANDISK
FLASH CARD MODEL	SDP3B-8	SDP3C-7	SDCFB-2	SDCFB-4	SDCFB-6
DISK/TREND GROUP	40	40	40	40	40
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
PRODUCT TYPE: Generic	Flash Disk	Flash Disk	Flash Disk	Flash Disk	Flash Disk
CAPACITY: Card capacity (MB)	8	7	2	4	6
CHIP CONFIGURATION:					
Chip density (Mb)	32	64	32	32	32
Chip count per card	2		1	1	2
Chip logic type	NOR	NOR	NOR	NOR	NOR
FEATURES: Package	PC Card Type II	PC Card II	Compact Flash	Compact Flash	Compact Flash
Interface	PCMCIA-ATA	PCMCIA-ATA	PCMCIA 2.1/IDE	PCMCIA 2.1/IDE	PCMCIA 2.1/IDE
XIP	No	No	No	No	No
Erasable block size (KB)	.512	.512	.512	.512	.512
SECTOR ENDURANCE: (Kcycles)	300		300	300	300
PERFORMANCE:					
Avg. access time (ns)	1.25	1.25	1.25	1.25	1.25
Media read rate (MB/Sec)	4	8	4	4	4
Media write rate (MB/Sec)	4	4	4	4	4
Burst transfer rate (MB/Sec)	6	8	6	6	6
Block erase time (ms)	.75		.75	.75	.75
SIZE: (mm: H x W x D)	5 x 54 x 85.6	5 x 54 x 85.6	3.3 x 42.8 x 36.4	3.3 x 42.8 x 36.4	3.3 x 42.8 x 36.4
OPERATING VOLTAGE:	3.3 V, 5 V	3.3 V, 5 V	3.3 V, 5 V	3.3 V, 5 V	3.3 V, 5 V
FIRST CUSTOMER SHIPMENT	1996		1995	1995	1995
COMMENTS					

MANUFACTURER	SANDISK	SANDISK	SANDISK	SANDISK	SANDISK
FLASH CARD MODEL	SDCFB-8	SDCFC-7	SDIB-10	SDIB-20	SDIBT-10
DISK/TREND GROUP	40	40	41	41	41
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
PRODUCT TYPE: Generic	Flash Disk	Flash Disk	Flash Disk	Flash Disk	Flash Disk
CAPACITY: Card capacity (MB)	8	7	10.4	20.9	10.4
CHIP CONFIGURATION:					
Chip density (Mb)	32	64	32	32	32
Chip count per card	2		3	6	3
Chip logic type	NOR	NOR	NOR	NOR	NOR
FEATURES: Package	Compact Flash	Compact Flash	1.3" IDE	1.3" IDE	1.8" IDE
Interface	PCMCIA 2.1/IDE	PCMCIA 2.1/IDE	IDE	IDE	IDE
XIP	No	No	No	No	No
Erasable block size (KB)	.512	.512	.512	.512	.512
SECTOR ENDURANCE: (Kcycles)	300		300	300	300
PERFORMANCE:					
Avg. access time (ns)	1.25	1.25	1.25	1.25	1.25
Media read rate (MB/Sec)	4	8	4	4	4
Media write rate (MB/Sec)	4	4	4	4	4
Burst transfer rate (MB/Sec)	6	8	6	6	6
Block erase time (ms)	.75		.75	.75	.75
SIZE: (mm: H x W x D)	3.3 x 42.8 x 36.4	3.3 x 42.8 x 36.4	10.5 x 50.8 x 43.5	10.5 x 50.8 x 43.5	9.6 x 50.8 x 76.2
OPERATING VOLTAGE:	3.3 V, 5 V	3.3 V, 5 V	3.3 V, 5 V	3.3 V, 5 V	3.3 V, 5 V
FIRST CUSTOMER SHIPMENT	1995	2Q97	1996	1996	1996
COMMENTS					

MANUFACTURER	SANDISK	SANDISK	SANDISK	SANDISK	SANDISK
FLASH CARD MODEL	SDIBT-20	SDIC-10	SDIC-20	SDP3B-10	SDP3B-20
DISK/TREND GROUP	41	41	41	41	41
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
PRODUCT TYPE: Generic	Flash Disk	Flash Disk	Flash Disk	Flash Disk	Flash Disk
CAPACITY: Card capacity (MB)	21.4	10	20	10.4	20.9
CHIP CONFIGURATION:					
Chip density (Mb)	32	64	64	32	32
Chip count per card	6	2	3	3	6
Chip logic type	NOR	NOR	NOR	NOR	NOR
FEATURES: Package	1.8" IDE	1.8" IDE	1.8" IDE	PC Card Type II	PC Card Type II
Interface	IDE	IDE	IDE	PCMCIA-ATA	PCMCIA-ATA
XIP	No	No	No	No	No
Erasable block size (KB)	.512	.512	.512	.512	.512
SECTOR ENDURANCE: (Kcycles)	300			300	300
PERFORMANCE:					
Avg. access time (ns)	1.25	1.25	1.25	1.25	1.25
Media read rate (MB/Sec)	4	8	8	4	4
Media write rate (MB/Sec)	4	4	4	4	4
Burst transfer rate (MB/Sec)	6	8	8	6	6
Block erase time (ms)	.75			.75	.75
SIZE: (mm: H x W x D)	9.6 x 50.8 x 76.2	10 x 54 x 85.6	10 x 54 x 85.6	5 x 54 x 85.6	5 x 54 x 85.6
OPERATING VOLTAGE:	3.3 V, 5 V	3.3 V, 5 V	3.3 V, 5 V	3.3 V, 5 V	3.3 V, 5 V
FIRST CUSTOMER SHIPMENT	1996			1996	1996
COMMENTS					

MANUFACTURER	SANDISK	SANDISK	SANDISK	SANDISK	SANDISK
FLASH CARD MODEL	SDP3C-10	SDP3C-20	SDCFB-10	SDCFB-15	SDCFB-20
DISK/TREND GROUP	41	41	41	41	41
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
PRODUCT TYPE: Generic	Flash Disk	Flash Disk	Flash Disk	Flash Disk	Flash Disk
CAPACITY: Card capacity (MB)	10	20	10.4	15	20
CHIP CONFIGURATION:					
Chip density (Mb)	64	64	32	32	32
Chip count per card			3	4	6
Chip logic type	NOR	NOR	NOR	NOR	NOR
FEATURES: Package	PC Card II	PC Card II	Compact Flash	Compact Flash	Compact Flash
Interface	PCMCIA-ATA	PCMCIA-ATA	PCMCIA 2.1/IDE	PCMCIA 2.1/IDE	PCMCIA 2.1/IDE
XIP	No	No	No	No	No
Erasable block size (KB)	.512	.512	.512	.512	.512
SECTOR ENDURANCE: (Kcycles)			300	300	300
PERFORMANCE:					
Avg. access time (ns)	1.25	1.25	1.25	1.25	1.25
Media read rate (MB/Sec)	8	8	4	4	4
Media write rate (MB/Sec)	4	4	4	4	4
Burst transfer rate (MB/Sec)	8	8	6	6	6
Block erase time (ms)			.75	.75	.75
SIZE: (mm: H x W x D)	5 x 54 x 85.6	5 x 54 x 85.6	3.3 x 42.8 x 36.4	3.3 x 42.8 x 36.4	3.3 x 42.8 x 36.4
OPERATING VOLTAGE:	3.3 V, 5 V	3.3 V, 5 V	3.3 V, 5 V	3.3 V, 5 V	3.3 V, 5 V
FIRST CUSTOMER SHIPMENT			1995	1995	2Q97
COMMENTS					

MANUFACTURER	SANDISK	SANDISK	SANDISK	SANDISK	SANDISK
FLASH CARD MODEL	SDCFB-24	SDCFC-10	SDCFC-20	SDIB-40	SDIB-80
DISK/TREND GROUP	41	41	41	42	42
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
PRODUCT TYPE: Generic	Flash Disk	Flash Disk	Flash Disk	Flash Disk	Flash Disk
CAPACITY: Card capacity (MB)	24	10.4	20	41.9	83.8
CHIP CONFIGURATION:					
Chip density (Mb)	32	64	64	32	32
Chip count per card	8			12	24
Chip logic type	NOR	NOR	NOR	NOR	NOR
FEATURES: Package	Compact Flash	Compact Flash	Compact Flash	1.3" IDE	1.3" IDE
Interface	PCMCIA 2.1/IDE	PCMCIA 2.1/IDE	PCMCIA 2.1/IDE	IDE	IDE
XIP	No	No	No	No	No
Erasable block size (KB)	.512	.512	.512	.512	.512
SECTOR ENDURANCE: (Kcycles)	300			300	300
PERFORMANCE:					
Avg. access time (ns)	1.25	1.25	1.25	1.25	1.25
Media read rate (MB/Sec)	4	8	8	4	4
Media write rate (MB/Sec)	4	4	4	4	4
Burst transfer rate (MB/Sec)	6	8	8	6	6
Block erase time (ms)	.75			.75	.75
SIZE: (mm: H x W x D)	3.3 x 42.8 x 36.4	3.3 x 42.8 x 36.4	3.3 x 42.8 x 36.4	10.5 x 50.8 x 43.5	10.5 x 50.8 x 43.5
OPERATING VOLTAGE:	3.3 V, 5 V	3.3 V, 5 V	3.3 V, 5 V	3.3 V, 5 V	3.3 V, 5 V
FIRST CUSTOMER SHIPMENT	2Q97			1996	1996
COMMENTS					

MANUFACTURER	SANDISK	SANDISK	SANDISK	SANDISK	SANDISK
FLASH CARD MODEL	SDIBT-40	SDIBT-60	SDIC-40	SDIC-80	SDP3B-40
DISK/TREND GROUP	42	42	42	42	42
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
PRODUCT TYPE: Generic	Flash Disk	Flash Disk	Flash Disk	Flash Disk	Flash Disk
CAPACITY: Card capacity (MB)	42.8	62.9	40	80	41.9
CHIP CONFIGURATION:					
Chip density (Mb)	32	32	64	64	32
Chip count per card	12	16	6	10	12
Chip logic type	NOR	NOR	NOR	NOR	NOR
FEATURES: Package	1.8" IDE	1.8" IDE	1.8" IDE	1.8" IDE	PC Card Type II
Interface	IDE	IDE	IDE	IDE	PCMCIA-ATA
XIP	No	No	No	No	No
Erasable block size (KB)	.512	.512	.512	.512	.512
SECTOR ENDURANCE: (Kcycles)	300	300			300
PERFORMANCE:					
Avg. access time (ns)	1.25	1.25	1.25	1.25	1.25
Media read rate (MB/Sec)	4	4	8	8	4
Media write rate (MB/Sec)	4	4	4	4	4
Burst transfer rate (MB/Sec)	6	6	8	8	6
Block erase time (ms)	.75	.75			.75
SIZE: (mm: H x W x D)	9.6 x 50.8 x 76.2	9.6 x 50.8 x 76.2	10 x 54 x 85.6	10 x 54 x 85.6	5 x 54 x 85.6
OPERATING VOLTAGE:	3.3 V, 5 V	3.3 V, 5 V	3.3 V, 5 V	3.3 V, 5 V	3.3 V, 5 V
FIRST CUSTOMER SHIPMENT	1996	1996			1996
COMMENTS					

MANUFACTURER	SANDISK	SANDISK	SANDISK	SANDISK	SANDISK
FLASH CARD MODEL	SDP3B-60	SDP3B-85	SDP3C-40	SDP3C-60	SDP3C-85
DISK/TREND GROUP	42	42	42	42	42
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
PRODUCT TYPE: Generic	Flash Disk	Flash Disk	Flash Disk	Flash Disk	Flash Disk
CAPACITY: Card capacity (MB)	60.1	85.1	41.1	60.1	85.1
CHIP CONFIGURATION:					
Chip density (Mb)	32	32	64	64	64
Chip count per card	18	24			
Chip logic type	NOR	NOR	NOR	NOR	NOR
FEATURES: Package	PC Card Type II	PC Card Type II	PC Card II	PC Card II	PC Card 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
SECTOR ENDURANCE: (Kcycles)	300	300			
PERFORMANCE:					
Avg. access time (ns)	1.25	1.25	1.25	1.25	1.25
Media read rate (MB/Sec)	4	4	8	8	8
Media write rate (MB/Sec)	4	4	4	4	4
Burst transfer rate (MB/Sec)	6	6	8	8	8
Block erase time (ms)	.75	.75			
SIZE: (mm: H x W x D)	5 x 54 x 86	5 x 54 x 86	5 x 54 x 85.6	5 x 54 x 85.6	5 x 54 x 85.6
OPERATING VOLTAGE:	5 V, 3.3 V	5 V, 3.3 V	3.3 V, 5 V	3.3 V, 5 V	3.3 V, 5 V
FIRST CUSTOMER SHIPMENT	1996	4Q95			
COMMENTS					

MANUFACTURER	SANDISK	SANDISK	SANDISK	SANDISK	SANDISK
FLASH CARD MODEL	SDIB-140	SDIC-140	SDIC-240	SDP3C-150	SDP3B-110
DISK/TREND GROUP	43	43	43	43	43
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
PRODUCT TYPE: Generic	Flash Disk	Flash Disk	Flash Disk	Flash Disk	Flash Disk
CAPACITY: Card capacity (MB)	140.7	140	240	150.2	110.1
CHIP CONFIGURATION:					
Chip density (Mb)	32	64	64	64	32
Chip count per card	42	20	32		
Chip logic type	NOR	NOR	NOR	NOR	NOR
FEATURES: Package	1.8" IDE	1.8" IDE	1.8" IDE	PC Card II	PC Card TypeIII
Interface	IDE	IDE	IDE	PCMCIA-ATA	PCMCIA-ATA
XIP	No	No	No	No	No
Erasable block size (KB)	.512	.512	.512	.512	.512
SECTOR ENDURANCE: (Kcycles)	300				300
PERFORMANCE:					
Avg. access time (ns)	1.25	1.25	1.25	1.25	1.25
Media read rate (MB/Sec)	4	8	8	8	4
Media write rate (MB/Sec)	4	4	4	4	4
Burst transfer rate (MB/Sec)	6	8	8	8	6
Block erase time (ms)	.75				.75
SIZE: (mm: H x W x D)	9.6 x 50.8 x 76.2	10 x 54 x 85.6	10 x 54 x 85.6	5 x 54 x 85.6	10 x 54 x 85.6
OPERATING VOLTAGE:	3.3 V, 5 V	3.3 V, 5 V	3.3 V, 5 V	3.3 V, 5 V	3.3 V, 5 V
FIRST CUSTOMER SHIPMENT	1996				3Q96
COMMENTS					

MANUFACTURER	SANDISK	SANDISK	SANDISK	SCM MICROSYSTEMS	SCM MICROSYSTEMS
FLASH CARD MODEL	SDP3B-175	SDP3B-220	SDP3C-300	FC001MB1	FC002MB2
DISK/TREND GROUP	43	43	43	40	40
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	PCM	PCM
PRODUCT TYPE: Generic	Flash Disk	Flash Disk	Flash Disk	Flash Memory	Flash Memory
CAPACITY: Card capacity (MB)	175.3	220.2	300.2	1	2
CHIP CONFIGURATION:					
Chip density (Mb)	32	32	64		8
Chip count per card		28			2
Chip logic type	NOR	NOR	NOR	NOR	NOR
FEATURES: Package	PC Card TypeIII	PC Card TypeIII	PC Card III	PC Card Type I	PC Card Type I
Interface	PCMCIA-ATA	PCMCIA-ATA	PCMCIA-ATA	PCMCIA 2.1	PCMCIA 2.1
XIP	No	No	No		
Erasable block size (KB)	.512	.512	.512		
SECTOR ENDURANCE: (Kcycles)	300	300		10	100
PERFORMANCE:					
Avg. access time (ns)	1.25	1.25	1.25	200/250	170/200
Media read rate (MB/Sec)	4	4	8		
Media write rate (MB/Sec)	4	4	4		
Burst transfer rate (MB/Sec)	6	6	8		
Block erase time (ms)	1.5	1.5		2000	1500
SIZE: (mm: H x W x D)	10 x 54 x 85.6	10 x 54 x 85.6	10 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6
OPERATING VOLTAGE:	3.3 V, 5 V	3.3 V, 5 V	3.3 V, 5 V	5 V, 12 V	5 V, 12 V
FIRST CUSTOMER SHIPMENT	3Q96	3Q97		4Q94	4Q94
COMMENTS				Intel chips.	Intel chips.

MANUFACTURER	SCM MICROSYSTEMS	SCM MICROSYSTEMS	SCM MICROSYSTEMS	SCM MICROSYSTEMS	SCM MICROSYSTEMS
FLASH CARD MODEL	FC004MB2	FC256KB	FC512KB	FC010MB2	FC020MB2
DISK/TREND GROUP	40	40	40	41	41
MARKET	PCM	PCM	PCM	PCM	PCM
PRODUCT TYPE: Generic	Flash Memory	Flash Memory	Flash Memory	Flash Memory	Flash Memory
CAPACITY: Card capacity (MB)	4	.256	.512	10	20
CHIP CONFIGURATION:					
Chip density (Mb)	8			8	8
Chip count per card	4			10	20
Chip logic type	NOR	NOR	NOR	NOR	NOR
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I
Interface	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1
XIP					
Erasable block size (KB)					
SECTOR ENDURANCE: (Kcycles)	100	10	10	100	100
PERFORMANCE: Avg. access time (ns)	170/200	200/250	200/250	170/200	170/200
Media read rate (MB/Sec)					
Media write rate (MB/Sec)					
Burst transfer rate (MB/Sec)					
Block erase time (ms)	1500	2000	2000	1500	1500
SIZE: (mm: H x W x D)	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6
OPERATING VOLTAGE:	5 V, 12 V	5 V, 12 V	5 V, 12 V	5 V, 12 V	5 V, 12 V
FIRST CUSTOMER SHIPMENT	4Q94	4Q94	4Q94	1995	1995
COMMENTS	Intel chips.	Intel chips.	Intel chips.	Intel chips.	Intel chips.

MANUFACTURER	SEIKO EPSON	SEIKO EPSON	SEIKO EPSON	SEIKO EPSON	SEIKO EPSON
FLASH CARD MODEL	ATA202SD11/01	ATA502SD11/01	Mini-2 FLASH-PACKER	Mini-4 FLASH-PACKER	SDP5-2-5 FLASH-PACKER
DISK/TREND GROUP	40	40	40	40	40
MARKET	OEM, PCM	OEM, PCM	PCM	PCM	PCM
PRODUCT TYPE: Generic	Flash Disk	Flash Disk	Flash Disk	Flash Disk	Flash Disk
CAPACITY: Card capacity (MB)	2.6	5.2	2	4	2.6
CHIP CONFIGURATION: Chip density (Mb)	32	32	32	32	32
Chip count per card	1	2			
Chip logic type	NOR	NOR	NOR	NOR	NOR
FEATURES: Package	PC Card Type II	PC Card Type II	PC Card TypeII*	PC Card TypeII*	PC Card Type II
Interface	PCMCIA-ATA	PCMCIA-ATA	PCMCIA 2.0	PCMCIA 2.0	PCMCIA 2.0
XIP	No	No	No	No	No
Erasable block size (KB)	.512	.512	.512	.512	.512
SECTOR ENDURANCE: (Kcycles)	200	200	300	300	200
PERFORMANCE: Avg. access time (ns)	1.25 ms	1.25 ms	1.25 ms	1.25 ms	1.25 ms
Media read rate (MB/Sec)	.625	.625	.625	.625	.625
Media write rate (MB/Sec)	.075	.075	.075	.075	.075
Burst transfer rate (MB/Sec)			6	6	6
Block erase time (ms)	.75	.75	.75	.75	2
SIZE: (mm: H x W x D)	5 x 54 x 85.6	5 x 54 x 85.6	5 x 36.4 x 42.8	5 x 36.4 x 42.8	5 x 54 x 85.6
OPERATING VOLTAGE:	5 V	5 V	3.3 V, 5 V	3.3 V, 5 V	5 V
FIRST CUSTOMER SHIPMENT			1995	1995	1995
COMMENTS	Made by SanDisk	Made by SanDisk	*Fits into Type II adapter. Sold in Japan. Made by SanDisk	*Fits into Type II adapter. Sold in Japan. Made by SanDisk	Made by SanDisk Sold in Japan.

MANUFACTURER	SEIKO EPSON	SEIKO EPSON	SEIKO EPSON	SEIKO EPSON	SEIKO EPSON
FLASH CARD MODEL	SDP5-5 SDP5HP-5 FLASH-PACKER	HWB101ESX0/40	HWB201ESX0/40	HWB201S8X0/40	HWB257ESX0/40
DISK/TREND GROUP	40	40	40	40	40
MARKET	PCM	OEM	OEM	OEM	OEM
PRODUCT TYPE: Generic	Flash Disk	Flash Memory	Flash Memory	Flash Memory	Flash Memory
CAPACITY: Card capacity (MB)	5.2	.512	1	1	.128
CHIP CONFIGURATION: Chip density (Mb)	32				
Chip count per card					
Chip logic type	NOR	NOR	NOR	NOR	NOR
FEATURES: Package	PC Card Type II	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I
Interface	PCMCIA 2.0	PCMCIA 2.01	PCMCIA 2.01	PCMCIA 2.01	PCMCIA 2.01
XIP	No				
Erasable block size (KB)	.512				
SECTOR ENDURANCE: (Kcycles)	200				
PERFORMANCE: Avg. access time (ns)	1.25 ms	200	200	200	200
Media read rate (MB/Sec)	.625				
Media write rate (MB/Sec)	.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	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				
FIRST CUSTOMER SHIPMENT	1995				
COMMENTS	Made by SanDisk Sold in Japan.				

MANUFACTURER	SEIKO EPSON	SEIKO EPSON	SEIKO EPSON	SEIKO EPSON	SEIKO EPSON
FLASH CARD MODEL	HWB401ESX0/40	HWB401S8X0/40	HWB513ESX0/40	HWB801S8X0/40	ATA112SD11/01
DISK/TREND GROUP	40	40	40	40	41
MARKET	OEM	OEM	OEM	OEM	OEM, PCM
PRODUCT TYPE: Generic	Flash Memory	Flash Memory	Flash Memory	Flash Memory	Flash Disk
CAPACITY: Card capacity (MB)	2	2	.256	4	10.4
CHIP CONFIGURATION: Chip density (Mb)					32
Chip count per card					
Chip logic type	NOR	NOR	NOR	NOR	NOR
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type II
Interface	PCMCIA 2.01	PCMCIA 2.01	PCMCIA 2.01	PCMCIA 2.01	PCMCIA-ATA
XIP					No
Erasable block size (KB)					
SECTOR ENDURANCE: (Kcycles)					200
PERFORMANCE: Avg. access time (ns)	200	200	200	200	1.25 ms
Media read rate (MB/Sec)					.625
Media write rate (MB/Sec)					.075
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	5 x 54 x 85.6
OPERATING VOLTAGE:					5 V
FIRST CUSTOMER SHIPMENT					
COMMENTS					Made by SanDisk

MANUFACTURER	SEIKO EPSON	SEIKO EPSON	SEIKO EPSON	SEIKO EPSON	SEIKO EPSON
FLASH CARD MODEL	ATA212SD11/01	Mini-10 FLASH-PACKER	Mini-15 FLASH-PACKER	SDP5-10 SDP5HP-10 FLASH-PACKER	SDP5-20 SDP5HP-20 FLASH-PACKER
DISK/TREND GROUP	41	41	41	41	41
MARKET	OEM, PCM	PCM	PCM	PCM	PCM
PRODUCT TYPE: Generic	Flash Disk	Flash Disk	Flash Disk	Flash Disk	Flash Disk
CAPACITY: Card capacity (MB)	20.9	10.4	15.7	10.4	20.9
CHIP CONFIGURATION: Chip density (Mb)		32	32		
Chip count per card					
Chip logic type	NOR	NOR	NOR	NOR	NOR
FEATURES: Package	PC Card Type II	PC Card TypeII*	PC Card TypeII*	PC Card Type II	PC Card Type II
Interface	PCMCIA-ATA	PCMCIA 2.0	PCMCIA 2.0	PCMCIA 2.0	PCMCIA 2.0
XIP	No	No	No	No	No
Erasable block size (KB)		.512	.512	.512	.512
SECTOR ENDURANCE: (Kcycles)	200	300	300	200	200
PERFORMANCE: Avg. access time (ns)	1.25 ms	1.25 ms	1.25 ms	1.25 ms	1.25 ms
Media read rate (MB/Sec)	.625	.625	.625	.625	.625
Media write rate (MB/Sec)	.075	.075	.075	.075	.075
Burst transfer rate (MB/Sec)		6	6	6	6
Block erase time (ms)		.75	.75	2	2
SIZE: (mm: H x W x D)	5 x 54 x 85.6	5 x 36.4 x 42.8	5 x 36.4 x 42.8	5 x 54 x 85.6	5 x 54 x 85.6
OPERATING VOLTAGE:	5 V	3.3 V, 5 V	3.3 V, 5 V	5 V	5 V
FIRST CUSTOMER SHIPMENT		1995	1995	1995	1995
COMMENTS	Made by SanDisk	*Fits into Type II adapter. Sold in Japan. Made by SanDisk	*Fits into Type II adapter. Sold in Japan. Made by SanDisk	Made by SanDisk Sold in Japan.	Made by SanDisk Sold in Japan.

MANUFACTURER	SEIKO EPSON	SEIKO EPSON	SEIKO EPSON	SEIKO EPSON	SHARP
FLASH CARD MODEL	HWB111S8X0/80	HWB161S8X0/80	ATA412SD12/02	SDP5-40 SDP5HP-40 FLASH-PACKER	ID-340-1
DISK/TREND GROUP	41	41	42	42	40
MARKET	OEM	OEM	OEM, PCM	PCM	PCM
PRODUCT TYPE: Generic	Flash Memory	Flash Memory	Flash Disk	Flash Disk	Flash Memory
CAPACITY: Card capacity (MB)	10	16	40	41.9	1
CHIP CONFIGURATION: Chip density (Mb)			16		
Chip count per card					
Chip logic type	NOR	NOR	NOR	NOR	NOR
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type II	PC Card Type II	Miniature Card
Interface	PCMCIA 2.01	PCMCIA 2.01	PCMCIA-ATA	PCMCIA 2.0	Minicard 1.1
XIP			No	No	Yes
Erasable block size (KB)			.512	.512	64
SECTOR ENDURANCE: (Kcycles)			200	200	100
PERFORMANCE: Avg. access time (ns)	200	200	1.25 ms	1.25 ms	150/100*
Media read rate (MB/Sec)			.625	.625	13/20*
Media write rate (MB/Sec)			.075	.075	.12/.25*
Burst transfer rate (MB/Sec)				6	--
Block erase time (ms)				2	1.8/1.1*
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	3.5 x 38 x 33
OPERATING VOLTAGE:			5 V	5 V	3.3 V, 5 V
FIRST CUSTOMER SHIPMENT			1994	1995	2Q97
COMMENTS			Made by SanDisk	Made by SanDisk Sold in Japan.	**Chip pair. *At 5V.

MANUFACTURER	SHARP	SHARP	SHARP	SIMPLE TECHNOLOGY	SIMPLE TECHNOLOGY
FLASH CARD MODEL	ID-340-2	ID-340-4	ID-340-8	STI-ATAFL/2	STI-ATAFL/4
DISK/TREND GROUP	40	40	40	40	40
MARKET	PCM	PCM	PCM	OEM, PCM	PCM
PRODUCT TYPE: Generic	Flash Memory	Flash Memory	Flash Memory	Flash Disk	Flash Disk
CAPACITY: Card capacity (MB)	2	4	8	2	4
CHIP CONFIGURATION:					
Chip density (Mb)	8	8			16
Chip count per card	2	4			2
Chip logic type	NOR	NOR	NOR	NAND	
FEATURES: Package	Miniature Card	Miniature Card	Miniature Card	PC Card Type II	PC Card Type II
Interface	Minicard 1.1	Minicard 1.1	Minicard 1.1	PCMCIA-ATA	PCMCIA ATA
XIP	Yes	Yes	Yes	No	
Erasable block size (KB)	64	64	64		
SECTOR ENDURANCE: (Kcycles)	100	100	100		
PERFORMANCE:					
Avg. access time (ns)	150/100*	150/100*	150/100*		
Media read rate (MB/Sec)	13/20*	13/20*	13/20*	8	8
Media write rate (MB/Sec)	.12/.25*	.12/.25*	.12/.25*		
Burst transfer rate (MB/Sec)	--	--	--	20	20
Block erase time (ms)	1.8/1.1*	1.8/1.1*	1.8/1.1*		
SIZE: (mm: H x W x D)	3.5 x 38 x 33	3.5 x 38 x 33	3.5 x 38 x 33	5 x 54 x 85.6	5 x 54 x 85.6
OPERATING VOLTAGE:	3.3 V, 5 V	3.3 V, 5 V	3.3 V, 5 V	5 V	5 V
FIRST CUSTOMER SHIPMENT	4Q96	4Q96	2Q97		
COMMENTS	**Chip pair. *At 5V.	**Chip pair. *At 5V.	**Chip pair. *At 5V.		

MANUFACTURER	SIMPLE TECHNOLOGY	SIMPLE TECHNOLOGY	SIMPLE TECHNOLOGY	SIMPLE TECHNOLOGY	SIMPLE TECHNOLOGY
FLASH CARD MODEL	STI-ATAFL/6	STI-ATAFL/8	STI-ATACF/4	STI-ATACF/8	STI-FL/1A
DISK/TREND GROUP	40	40	40	40	40
MARKET	OEM, PCM	PCM	PCM	PCM	PCM
PRODUCT TYPE: Generic	Flash Disk	Flash Disk	Flash Disk	Flash Disk	Flash Memory
CAPACITY: Card capacity (MB)	6	8	4	8	1
CHIP CONFIGURATION: Chip density (Mb)		16	16	16	
Chip count per card		4	2	4	6
Chip logic type	NAND		NOR	NOR	
FEATURES: Package	PC Card Type II	PC Card Type II	Compact Flash	Compact Flash	PC Card Type I
Interface	PCMCIA-ATA	PCMCIA ATA	PCMCIA 2.1/IDE	PCMCIA 2.1/IDE	PCMCIA 2.0
XIP	No		No	No	
Erasable block size (KB)			.512	.512	
SECTOR ENDURANCE: (Kcycles)			300	300	100
PERFORMANCE: Avg. access time (ns)			1.25	1.25	200
Media read rate (MB/Sec)	8	8	4	4	5
Media write rate (MB/Sec)			6	6	
Burst transfer rate (MB/Sec)	20	20	.75	.75	
Block erase time (ms)					
SIZE: (mm: H x W x D)	5 x 54 x 85.6	5 x 54 x 85.6	3.3 x 36.4 x 42.8	3.3 x 36.4 x 42.8	3.3 x 54 x 85.6
OPERATING VOLTAGE:	5 V	5 V	3.3 V, 5 V	3.3 V, 5 V	5 V, 12 V
FIRST CUSTOMER SHIPMENT					
COMMENTS					

MANUFACTURER	SIMPLE TECHNOLOGY	SIMPLE TECHNOLOGY	SIMPLE TECHNOLOGY	SIMPLE TECHNOLOGY	SIMPLE TECHNOLOGY
FLASH CARD MODEL	STI-FL/256K	STI-FL/2A	STI-FL/4A	STI-FL/512	STI-FL/6A
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
CAPACITY: Card capacity (MB)	.256	2	4	.512	6
CHIP CONFIGURATION: Chip density (Mb)		1	1		
Chip count per card	2	2	4	4	6
Chip logic type		NOR	NOR		
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I
Interface	PCMCIA 2.0	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.0	PCMCIA 2.0
XIP					
Erasable block size (KB)					
SECTOR ENDURANCE: (Kcycles)	100	100	100	100	100
PERFORMANCE: Avg. access time (ns)	200	5	5	200	200
Media read rate (MB/Sec)	5	.100	.100	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
OPERATING VOLTAGE:	5 V, 12 V			5 V, 12 V	5 V, 12 V
FIRST CUSTOMER SHIPMENT					
COMMENTS					

MANUFACTURER	SIMPLE TECHNOLOGY	SIMPLE TECHNOLOGY	SIMPLE TECHNOLOGY	SIMPLE TECHNOLOGY	SIMPLE TECHNOLOGY
FLASH CARD MODEL	STI-FL/8A	STI-ATAFL/10	STI-ATAFL/12	STI-ATAFL/16	STI-ATAFL/20
DISK/TREND GROUP	40	41	41	41	41
MARKET	PCM	OEM, PCM	PCM	PCM	PCM
PRODUCT TYPE: Generic	Flash Memory	Flash Disk	Flash Disk	Flash Disk	Flash Disk
CAPACITY: Card capacity (MB)	8	10	12	16	20
CHIP CONFIGURATION: Chip density (Mb)	1		10	16	16
Chip count per card	8		6	8	10
Chip logic type	NOR	NAND			
FEATURES: Package	PC Card Type I	PC Card Type II	PC Card Type II	PC Card Type II	PC Card Type II
Interface	PCMCIA 2.1	PCMCIA-ATA	PCMCIA ATA	PCMCIA ATA	PCMCIA ATA
XIP		No			
Erasable block size (KB)					
SECTOR ENDURANCE: (Kcycles)	100				
PERFORMANCE: Avg. access time (ns)	5				
Media read rate (MB/Sec)	.100	8	8	8	8
Media write rate (MB/Sec)					
Burst transfer rate (MB/Sec)		20	20	20	20
Block erase time (ms)					
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
OPERATING VOLTAGE:		5 V	5 V	5 V	5 V
FIRST CUSTOMER SHIPMENT					
COMMENTS					

MANUFACTURER	SIMPLE TECHNOLOGY	SIMPLE TECHNOLOGY	SIMPLE TECHNOLOGY	SIMPLE TECHNOLOGY	SIMPLE TECHNOLOGY
FLASH CARD MODEL	STI-FL/10A	STI-FL/12A	STI-FL/14A	STI-FL/16A	STI-ATAFL/32
DISK/TREND GROUP	41	41	41	41	42
MARKET	PCM	PCM	PCM	PCM	OEM, PCM
PRODUCT TYPE: Generic	Flash Memory	Flash Memory	Flash Memory	Flash Memory	Flash Disk
CAPACITY: Card capacity (MB)	10	12	14	16	32
CHIP CONFIGURATION: Chip density (Mb)	1			1	
Chip count per card	10	12	14	16	
Chip logic type	NOR			NOR	NAND
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type II
Interface	PCMCIA 2.1	PCMCIA 2.0	PCMCIA 2.0	PCMCIA 2.1	PCMCIA-ATA
XIP					No
Erasable block size (KB)					
SECTOR ENDURANCE: (Kcycles)	100	100	100	100	
PERFORMANCE: Avg. access time (ns)	5	200	200	5	
Media read rate (MB/Sec)	.100	5	5	.100	8
Media write rate (MB/Sec)					
Burst transfer rate (MB/Sec)					20
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		5 x 54 x 85.6
OPERATING VOLTAGE:		5 V, 12 V	5 V, 12 V		5 V
FIRST CUSTOMER SHIPMENT					
COMMENTS					

MANUFACTURER	SIMPLE TECHNOLOGY	SMART MODULAR TECHNOLOGIES	SMART MODULAR TECHNOLOGIES	SMART MODULAR TECHNOLOGIES	SMART MODULAR TECHNOLOGIES
FLASH CARD MODEL	STI-ATAFL/40	SM9FLATA04	SM9FLATA04-RNSI	SM9FLATA08	SM9FLATA08-RNSI
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 Disk	Flash Disk	Flash Disk	Flash Disk
CAPACITY: Card capacity (MB)	40	4	4	8	8
CHIP CONFIGURATION: Chip density (Mb)					
Chip count per card					
Chip logic type	NAND	NAND	NAND	NAND	NAND
FEATURES: Package	PC Card Type II	PC Card Type II	PC Card Type II	PC Card Type II	PC Card Type II
Interface	PCMCIA-ATA	PCMCIA-ATA	PCMCIA-ATA	PCMCIA-ATA	PCMCIA-ATA
XIP	No				
Erasable block size (KB)					
SECTOR ENDURANCE: (Kcycles)					
PERFORMANCE: Avg. access time (ns)					
Media read rate (MB/Sec)	8	8	8	8	8
Media write rate (MB/Sec)					
Burst transfer rate (MB/Sec)	20				
Block erase time (ms)					
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
OPERATING VOLTAGE:	5 V	5 V	5 V	5 V	5 V
FIRST CUSTOMER SHIPMENT					
COMMENTS					

MANUFACTURER	SMART MODULAR TECHNOLOGIES	SMART MODULAR TECHNOLOGIES	SMART MODULAR TECHNOLOGIES	SMART MODULAR TECHNOLOGIES	SMART MODULAR TECHNOLOGIES
FLASH CARD MODEL	SM9CFATA02	SM9CFATA04	SM9CFATA08	SM9FA1018	SM9FA1023
DISK/TREND GROUP	40	40	40	40	40
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
PRODUCT TYPE: Generic	Flash Disk	Flash Disk	Flash Disk	Flash Memory	Flash Memory
CAPACITY: Card capacity (MB)	2	4	8	1	2
CHIP CONFIGURATION:					
Chip density (Mb)	16	32	64	4	16
Chip count per card	1	1	1	2	1
Chip logic type	NAND	NAND	NAND	NAND	NAND
FEATURES: Package	Compact Flash	Compact Flash	Compact Flash	PC Card Type I	PC Card Type I
Interface	PCMCIA-ATA	PCMCIA-ATA	PCMCIA-ATA	PCMCIA 2.1	PCMCIA 2.1
XIP	No	No	No		
Erasable block size (KB)	.512	.512	.512	128	128
SECTOR ENDURANCE: (Kcycles)					
PERFORMANCE:					
Avg. access time (ns)				200	80
Media read rate (MB/Sec)	8	8	8		
Media write rate (MB/Sec)					
Burst transfer rate (MB/Sec)					
Block erase time (ms)					
SIZE: (mm: H x W x D)	3.3 x 36.4 x 42.8	3.3 x 36.4 x 42.8	3.3 x 36.4 x 42.8	3.3 x 54 x 85.6	3.3 x 54 x 85.6
OPERATING VOLTAGE:				5 V, 12 V	5 V, 12 V
FIRST CUSTOMER SHIPMENT					
COMMENTS				5 V or 12 V program voltage	5 V or 12 V program voltage

MANUFACTURER	SMART MODULAR TECHNOLOGIES	SMART MODULAR TECHNOLOGIES	SMART MODULAR TECHNOLOGIES	SMART MODULAR TECHNOLOGIES	SMART MODULAR TECHNOLOGIES
FLASH CARD MODEL	SM9FA1028	SM9FA1048	SM9FA10481P320V	SM9FA2043	SM9FA2048
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
CAPACITY: Card capacity (MB)	2	4	4	4	12
CHIP CONFIGURATION:					
Chip density (Mb)	8	16	16	16	
Chip count per card	2	2	2	2	4
Chip logic type	NAND	NAND	NAND	NAND	NAND
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I
Interface	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1
XIP					
Erasable block size (KB)	128	128	128	128	128
SECTOR ENDURANCE: (Kcycles)					
PERFORMANCE:					
Avg. access time (ns)	200	200	200	80	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	3.3 V, 5 V, 12 V	5 V, 12 V	5 V, 12 V
FIRST CUSTOMER SHIPMENT					
COMMENTS	5 V or 12 V program voltage	5 V or 12 V program voltage		5 V or 12 V program voltage	5 V or 12 V program voltage

MANUFACTURER	SMART MODULAR TECHNOLOGIES	SMART MODULAR TECHNOLOGIES	SMART MODULAR TECHNOLOGIES	SMART MODULAR TECHNOLOGIES	SMART MODULAR TECHNOLOGIES
FLASH CARD MODEL	SM9FA2088	SM9FA20881P320V	SM9FA3063	SM9FA3068	SM9FA4083
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
CAPACITY: Card capacity (MB)	8	8	6	12	8
CHIP CONFIGURATION:					
Chip density (Mb)	16	16	16		16
Chip count per card	4	4	3	6	4
Chip logic type	NAND	NAND	NAND	NAND	NAND
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I
Interface	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1
XIP					
Erasable block size (KB)	128	128	128	128	128
SECTOR ENDURANCE: (Kcycles)					
PERFORMANCE:					
Avg. access time (ns)	200	200	80	200	80
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	3.3 V, 5 V, 12 V	5 V, 12 V	5 V, 12 V	5 V, 12 V
FIRST CUSTOMER SHIPMENT					
COMMENTS	5 V or 12 V program voltage		5 V or 12 V program voltage	5 V or 12 V program voltage	5 V or 12 V program voltage

MANUFACTURER	SMART MODULAR TECHNOLOGIES	SMART MODULAR TECHNOLOGIES	SMART MODULAR TECHNOLOGIES	SMART MODULAR TECHNOLOGIES	SMART MODULAR TECHNOLOGIES
FLASH CARD MODEL	SM9FA4088	SM9FL1MP3 SM9FL1MP35V	SM9FL256KP3 SM9FL256KP35V	SM9FL2MP3 SM9FL2MP35V	SM9FL4MP3 SM9FL4MP35V
DISK/TREND GROUP	40	40	40	40	40
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
PRODUCT TYPE: Generic	Flash Memory	Flash Memory	Flash Memory	Flash Memory	Flash Memory
CAPACITY: Card capacity (MB)	12	1	.256	2	4
CHIP CONFIGURATION: Chip density (Mb)					
Chip count per card	8				
Chip logic type	NAND	NOR	NOR	NOR	NOR
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I
Interface	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1
XIP					
Erasable block size (KB)	128				
SECTOR ENDURANCE: (Kcycles)					
PERFORMANCE: Avg. access time (ns)	200	150/200/250	150/200/250	150/200/250	150/200/250
Media read rate (MB/Sec)					
Media write rate (MB/Sec)					
Burst transfer rate (MB/Sec)					
Block erase time (ms)					
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		1992	1992	1992	1992
COMMENTS	5 V or 12 V program voltage	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	SMART MODULAR TECHNOLOGIES	SMART MODULAR TECHNOLOGIES
FLASH CARD MODEL	SM9FL512KP3 SM9FL512KP35V	SM9FL8MP3 SM9FL8MP35V	SM9FLAMC02	SM9FLAMC04	SM9FLAMC08
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
CAPACITY: Card capacity (MB)	.512	8	2	4	8
CHIP CONFIGURATION: Chip density (Mb)					
Chip count per card					
Chip logic type	NOR	NOR	NAND	NAND	NAND
FEATURES: Package	PC Card Type I	PC Card Type I	Miniature Card	Miniature Card	Miniature Card
Interface	PCMCIA 2.1	PCMCIA 2.1	Mini. Card 1.1	Mini. Card 1.1	Mini. Card 1.1
XIP			No	No	No
Erasable block size (KB)					
SECTOR ENDURANCE: (Kcycles)					
PERFORMANCE: Avg. access time (ns)	150/200/250	150/200/250			
Media read rate (MB/Sec)			10/6	10/6	10/6
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			
OPERATING VOLTAGE:	5 V, 12 V	5 V, 12 V	3.3 V, 5 V	3.3 V, 5 V	3.3 V, 5 V
FIRST CUSTOMER SHIPMENT	1992	1992			
COMMENTS	5V is 5 volt unit.	5V is 5 volt unit.			

MANUFACTURER	SMART MODULAR TECHNOLOGIES	SMART MODULAR TECHNOLOGIES	SMART MODULAR TECHNOLOGIES	SMART MODULAR TECHNOLOGIES	SMART MODULAR TECHNOLOGIES
FLASH CARD MODEL	SM9FLATA12	SM9FLATA16	SM9FLATA20	SM9FLATA24	SM9CFATA16
DISK/TREND GROUP	41	41	41	41	41
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
PRODUCT TYPE: Generic	Flash Disk	Flash Disk	Flash Disk	Flash Disk	Flash Disk
CAPACITY: Card capacity (MB)	12	16	20	24	16
CHIP CONFIGURATION: Chip density (Mb)					
Chip count per card					
Chip logic type	NAND	NAND	NAND	NAND	NAND
FEATURES: Package	PC Card Type II	PC Card Type II	PC Card Type II	PC Card Type II	Compact Flash
Interface	PCMCIA-ATA	PCMCIA-ATA	PCMCIA-ATA	PCMCIA-ATA	PCMCIA-ATA
XIP					
Erasable block size (KB)					
SECTOR ENDURANCE: (Kcycles)					
PERFORMANCE: Avg. access time (ns)					
Media read rate (MB/Sec)	8	8	8	8	
Media write rate (MB/Sec)					
Burst transfer rate (MB/Sec)					
Block erase time (ms)					
SIZE: (mm: H x W x D)					
OPERATING VOLTAGE:	5 V	5 V	5 V	5 V	
FIRST CUSTOMER SHIPMENT					
COMMENTS					

MANUFACTURER	SMART MODULAR TECHNOLOGIES	SMART MODULAR TECHNOLOGIES	SMART MODULAR TECHNOLOGIES	SMART MODULAR TECHNOLOGIES	SMART MODULAR TECHNOLOGIES
FLASH CARD MODEL	SM9FA3128	SM9FA31281P320V	SM9FA4168	SM9FA41681P320V	SM9FA5103
DISK/TREND GROUP	41	41	41	41	41
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
PRODUCT TYPE: Generic	Flash Memory	Flash Memory	Flash Memory	Flash Memory	Flash Memory
CAPACITY: Card capacity (MB)	12	12	16	16	10
CHIP CONFIGURATION:					
Chip density (Mb)	16	16		16	16
Chip count per card	6	6	8	8	5
Chip logic type	NAND	NAND	NAND	NAND	NAND
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I
Interface	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1
XIP					
Erasable block size (KB)	128	128	128	128	128
SECTOR ENDURANCE: (Kcycles)					
PERFORMANCE:					
Avg. access time (ns)	200	200	200	200	80
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	3.3 V, 5 V, 12 V	5 V, 12 V	3.3 V, 5 V, 12 V	5 V, 12 V
FIRST CUSTOMER SHIPMENT					
COMMENTS	5 V or 12 V program voltage		5 V or 12 V program voltage		5 V or 12 V program voltage

MANUFACTURER	SMART MODULAR TECHNOLOGIES	SMART MODULAR TECHNOLOGIES	SMART MODULAR TECHNOLOGIES	SMART MODULAR TECHNOLOGIES	SMART MODULAR TECHNOLOGIES
FLASH CARD MODEL	SM9FA5108	SM9FA5208	SM9FA52081P320V	SM9FA6128	SM9FA6248
DISK/TREND GROUP	41	41	41	41	41
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
PRODUCT TYPE: Generic	Flash Memory	Flash Memory	Flash Memory	Flash Memory	Flash Memory
CAPACITY: Card capacity (MB)	12	20	20	12	24
CHIP CONFIGURATION: Chip density (Mb)			16	8	
Chip count per card	10	10	10	12	12
Chip logic type	NAND	NAND	NAND	NAND	NAND
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I
Interface	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1
XIP					
Erasable block size (KB)	128	128	128	128	128
SECTOR ENDURANCE: (Kcycles)					
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:	5 V, 12 V	5 V, 12 V	3.3 V, 5 V, 12 V	5 V, 12 V	5 V, 12 V
FIRST CUSTOMER SHIPMENT					
COMMENTS	5 V or 12 V program voltage	5 V or 12 V program voltage		5 V or 12 V program voltage	5 V or 12 V program voltage

MANUFACTURER	SMART MODULAR TECHNOLOGIES	SMART MODULAR TECHNOLOGIES	SMART MODULAR TECHNOLOGIES	SMART MODULAR TECHNOLOGIES	SMART MODULAR TECHNOLOGIES
FLASH CARD MODEL	SM9FA62481P520V	SM9FA7123	SM9FA7143	SM9FA7148	SM9FA8163
DISK/TREND GROUP	41	41	41	41	41
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
PRODUCT TYPE: Generic	Flash Memory	Flash Memory	Flash Memory	Flash Memory	Flash Memory
CAPACITY: Card capacity (MB)	24	12	14	14	16
CHIP CONFIGURATION:					
Chip density (Mb)	16	16	16	8	16
Chip count per card	12	6	7	14	8
Chip logic type	NAND	NAND	NAND	NAND	NAND
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I
Interface	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1
XIP					
Erasable block size (KB)	128	128	128	128	128
SECTOR ENDURANCE: (Kcycles)					
PERFORMANCE:					
Avg. access time (ns)	200	80	80	200	80
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:	3.3 V, 5 V, 12 V	5 V, 12 V	5 V, 12 V	5 V, 12 V	5 V, 12 V
FIRST CUSTOMER SHIPMENT					
COMMENTS		5 V or 12 V program voltage	5 V or 12 V program voltage	5 V or 12 V program voltage	5 V or 12 V program voltage

MANUFACTURER	SMART MODULAR TECHNOLOGIES	SMART MODULAR TECHNOLOGIES	SMART MODULAR TECHNOLOGIES	SMART MODULAR TECHNOLOGIES	SMART MODULAR TECHNOLOGIES
FLASH CARD MODEL	SM9FA8168	SM9FL16MP3 SM9FL16MP35V	SM9FLATA32	SM9FLATA40	SM9FLATA48
DISK/TREND GROUP	41	41	42	42	42
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
PRODUCT TYPE: Generic	Flash Memory	Flash Memory	Flash Disk	Flash Disk	Flash Disk
CAPACITY: Card capacity (MB)	16	16	32	40	40
CHIP CONFIGURATION:					
Chip density (Mb)	8				
Chip count per card	16				
Chip logic type	NAND	NOR	NAND	NAND	NAND
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type II	PC Card Type II	PC Card Type II
Interface	PCMCIA 2.1	PCMCIA 2.1	PCMCIA-ATA	PCMCIA-ATA	PCMCIA-ATA
XIP					
Erasable block size (KB)	128				
SECTOR ENDURANCE: (Kcycles)					
PERFORMANCE:					
Avg. access time (ns)	200	150/200/250			
Media read rate (MB/Sec)			8	8	8
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			
OPERATING VOLTAGE:	5 V, 12 V	5 V, 12 V	5 V	5 V	5 V
FIRST CUSTOMER SHIPMENT		1992			
COMMENTS	5 V or 12 V program voltage				

MANUFACTURER	SMART MODULAR TECHNOLOGIES	SMART MODULAR TECHNOLOGIES	SMART MODULAR TECHNOLOGIES	SMART MODULAR TECHNOLOGIES	SMART MODULAR TECHNOLOGIES
FLASH CARD MODEL	SM9FLATA56	SM9FLATA64	SM9FLATA80	SM9FLATA96	SM9FA7288
DISK/TREND GROUP	42	42	42	42	42
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
PRODUCT TYPE: Generic	Flash Disk	Flash Disk	Flash Disk	Flash Disk	Flash Memory
CAPACITY: Card capacity (MB)	56	64	80	96	28
CHIP CONFIGURATION: Chip density (Mb)					
Chip count per card					14
Chip logic type	NAND	NAND	NAND	NAND	NAND
FEATURES: Package	PC Card Type II	PC Card Type II	PC Card Type II	PC Card Type II	PC Card Type I
Interface	PCMCIA-ATA	PCMCIA-ATA	PCMCIA-ATA	PCMCIA-ATA	PCMCIA 2.1
XIP					
Erasable block size (KB)					128
SECTOR ENDURANCE: (Kcycles)					
PERFORMANCE: Avg. access time (ns)					200
Media read rate (MB/Sec)	8	8	8	8	
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
OPERATING VOLTAGE:	5 V	5 V	5 V	5 V	5 V, 12 V
FIRST CUSTOMER SHIPMENT					
COMMENTS					5 V or 12 V program voltage

MANUFACTURER	SMART MODULAR TECHNOLOGIES	SMART MODULAR TECHNOLOGIES	TOSHIBA	TOSHIBA	TOSHIBA
FLASH CARD MODEL	SM9FA8328	SM9FLATA112	TH6SS160031AAA	TH6SS160051AAA	TC5816ADC
DISK/TREND GROUP	42	43	40	40	40
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
PRODUCT TYPE: Generic	Flash Memory	Flash Disk	Flash Disk	Flash Disk	Flash Memory
CAPACITY: Card capacity (MB)	32	112	3	5	2.0625
CHIP CONFIGURATION:					
Chip density (Mb)	16		16	16	16
Chip count per card	16		2	3	1
Chip logic type	NAND	NAND	NAND	NAND	NAND
FEATURES: Package	PC Card Type I	PC Card Type II	PC Card Type I	PC Card Type I	SSFDC
Interface	PCMCIA 2.1	PCMCIA-ATA	PCMCIA-ATA	PCMCIA-ATA	SSFDC
XIP			No	No	No
Erasable block size (KB)	128		8 x .512	8 x .512	4
SECTOR ENDURANCE: (Kcycles)			250	250	250
PERFORMANCE:					
Avg. access time (ns)	200		300	300	25000
Media read rate (MB/Sec)		8			5.7
Media write rate (MB/Sec)					.8
Burst transfer rate (MB/Sec)			8	8	
Block erase time (ms)			6-100	6-100	6
SIZE: (mm: H x W x D)	3.3 x 54 x 85.6		3.3 x 54 x 85.6	3.3 x 54 x 85.6	.76 x 37 x 45
OPERATING VOLTAGE:	5 V	5 V	5 V	5 V	5 V
FIRST CUSTOMER SHIPMENT			4Q94	4Q94	2Q96
COMMENTS					

MANUFACTURER	TOSHIBA	TOSHIBA	TOSHIBA	TOSHIBA	TOSHIBA
FLASH CARD MODEL	TC5832ADC	TC58V32ADC	TC58V64DC	TH6SS160101AAA	TH6SS160201AAA
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 Disk
CAPACITY: Card capacity (MB)	4	4	8	10	20
CHIP CONFIGURATION:					
Chip density (Mb)	32	32	64	16	16
Chip count per card	1	1	1	6	11
Chip logic type	NAND	NAND	NAND	NAND	NAND
FEATURES: Package	SSFDC	SSFDC	SSFDC	PC Card Type I	PC Card Type I
Interface	SSFDC	SSFDC	SSFDC	PCMCIA-ATA	PCMCIA-ATA
XIP	No	No	No	No	No
Erasable block size (KB)	8	8	16	8 x .512	8 x .512
SECTOR ENDURANCE: (Kcycles)	250	250	250	250	250
PERFORMANCE:					
Avg. access time (ns)	10000	10000	10000	300	300
Media read rate (MB/Sec)					
Media write rate (MB/Sec)	1.75	1.75	1.75		
Burst transfer rate (MB/Sec)	20	20	20	8	8
Block erase time (ms)	6	6	6	6-100	6-100
SIZE: (mm: H x W x D)	.76 x 37 x 45	.76 x 37 x 45	.76 x 37 x 45	3.3 x 54 x 85.6	3.3 x 54 x 85.6
OPERATING VOLTAGE:	5 V	3.3 V	3.3 V	5 V	5 V
FIRST CUSTOMER SHIPMENT	2Q96	2Q96	3Q97	4Q94	4Q94
COMMENTS					

MANUFACTURER	TOSHIBA	TOSHIBA	TRANSCEND	TRANSCEND	TRANSCEND
FLASH CARD MODEL	TH6SS160302AAA	TH6SS160402AAA	TS12MFlashA	TS4MFlashA	TS8MFlashA
DISK/TREND GROUP	42	42	40	40	40
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
PRODUCT TYPE: Generic	Flash Disk	Flash Disk	Flash Disk	Flash Disk	Flash Disk
CAPACITY: Card capacity (MB)	30	40	12	4	8
CHIP CONFIGURATION:					
Chip density (Mb)	16	16			
Chip count per card	16	21			
Chip logic type	NAND	NAND	NAND	NAND	NAND
FEATURES: Package	PC Card Type II	PC Card Type II	PC Card Type I	PC Card Type I	PC Card Type I
Interface	PCMCIA-ATA	PCMCIA-ATA	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1
XIP	No	No	No	No	No
Erasable block size (KB)	8 x .512	8 x .512	.512	.512	.512
SECTOR ENDURANCE: (Kcycles)	250	250			
PERFORMANCE:					
Avg. access time (ns)	300	300			
Media read rate (MB/Sec)					
Media write rate (MB/Sec)					
Burst transfer rate (MB/Sec)	8	8			
Block erase time (ms)	6-100	6-100			
SIZE: (mm: H x W x D)	5 x 54 x 85.6	5 x 54 x 85.6	3.3 x 34.6 x 85.6	3.3 x 34.6 x 85.6	3.3 x 34.6 x 85.6
OPERATING VOLTAGE:	5 V	5 V	5 V	5 V	5 V
FIRST CUSTOMER SHIPMENT	4Q94	4Q94	1996	1996	1996
COMMENTS					

MANUFACTURER	TRANSCEND	TRANSCEND	TRANSCEND	TRANSCEND	TRANSCEND
FLASH CARD MODEL	TS2MFlash	TS4MFlash	TS8MFlash	TS16MFlashA	TS20MFlashA
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 Disk
CAPACITY: Card capacity (MB)	2	4	8	16	20
CHIP CONFIGURATION:					
Chip density (Mb)					
Chip count per card					
Chip logic type				NAND	NAND
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I
Interface	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1
XIP				No	No
Erasable block size (KB)				.512	.512
SECTOR ENDURANCE: (Kcycles)					
PERFORMANCE:					
Avg. access time (ns)					
Media read rate (MB/Sec)					
Media write rate (MB/Sec)					
Burst transfer rate (MB/Sec)					
Block erase time (ms)					
SIZE: (mm: H x W x D)	3.3 x 34.6 x 85.6	3.3 x 34.6 x 85.6	3.3 x 34.6 x 85.6	3.3 x 34.6 x 85.6	3.3 x 34.6 x 85.6
OPERATING VOLTAGE:				5 V	5 V
FIRST CUSTOMER SHIPMENT	3Q95	3Q95	3Q95	1996	1996
COMMENTS					

MANUFACTURER	TRANSCEND	TRANSCEND			
FLASH CARD MODEL	TS10MFlash	TS16MFlash			
DISK/TREND GROUP	41	41			
MARKET	OEM, PCM	OEM, PCM			
PRODUCT TYPE: Generic	Flash Memory	Flash Memory			
CAPACITY: Card capacity (MB)	10	16			
CHIP CONFIGURATION: Chip density (Mb)					
Chip count per card					
Chip logic type					
FEATURES: Package	PC Card Type I	PC Card Type I			
Interface	PCMCIA 2.1	PCMCIA 2.1			
XIP					
Erasable block size (KB)					
SECTOR ENDURANCE: (Kcycles)					
PERFORMANCE: Avg. access time (ns)					
Media read rate (MB/Sec)					
Media write rate (MB/Sec)					
Burst transfer rate (MB/Sec)					
Block erase time (ms)					
SIZE: (mm: H x W x D)	3.3 x 34.6 x 85.6	3.3 x 34.6 x 85.6			
OPERATING VOLTAGE:					
FIRST CUSTOMER SHIPMENT	3Q95	3Q95			
COMMENTS					

PC CARD RIGID DISK DRIVE SPECIFICATIONS

PC CARD RIGID DISK DRIVE SPECIFICATIONS

Coverage

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

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

Capacities

Formatted native capacity has been used to determine the appropriate DISK/TREND product group for each drive in this product group, with specific formatted capacities indicated by "F".

Interfaces

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

Average access time

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

Transfer rate

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

Accuracy

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

1997 DISK/TREND product groups for PC Card rigid disk drives included in the Removable Data Storage report

Group number	Drives included
2.	PC Card rigid disk drives, less than 500 megabytes
3.	PC Card rigid disk drives, 500 megabytes - 1 gigabyte
4.	PC Card rigid disk drives, 1 - 2 gigabytes

MANUFACTURER	CALLUNA TECHNOLOGY	CALLUNA TECHNOLOGY	CALLUNA TECHNOLOGY	CALLUNA TECHNOLOGY	CALLUNA TECHNOLOGY
DRIVE	CT-130MC CT-131FD callunacard	CT-170MC CT-171FD callunacard	CT-260MC CT-260FD callunacard	CT-260RM CT-260FM callunacard	CT-520RM CR-520FM callunacard
DISK/TREND GROUP	2	2	2	2	3
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
MEDIA: Disk diameter	48 mm	48 mm	48 mm	48 mm	48 mm
Recording medium	Thin Film*	Thin Film*	Thin Film*	Thin Film*	Thin Film*
DRIVE: Heads	Thin Film	Thin Film	Thin Film	MR Thin Film	MR Thin Film
Interface	PCMCIA-ATA	PCMCIA-ATA	PCMCIA-ATA	PCMCIA-ATA	PCMCIA-ATA
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	--	--	--	--	--
REMOVABLE	F: 130	F: 170	F: 260	F: 260	F: 520
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	2	4
Tracks per surface	1958	1768	1958	2576	2576
Track density (TPI)	4400	4400	4400	6000	6000
Maximum linear density (BPI) (FCI)	82391 61793	58082 43561	82391 61793	118285 88714	118285 88714
Areal density (Mb/square inch)	362.5	255.6	362.5	709.7	709.7
Recording code	1,7 RLL	1,7 RLL	1,7 RLL	1,7 RLL	1,7 RLL
Rotational speed (RPM)	4800	4800	4800	4800	4800
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Embedded	Embedded	Embedded	Embedded	Embedded
Average positioning time (msec)	16	16	16	12	12
Average rotational delay (msec)	6.25	6.25	6.25	6.25	6.25
Average access time (msec)	22.25	22.25	22.25	18.25	18.25
Data transfer rate (MBytes/sec) Internal, min/max External	2.3/4.5 11.1	1.8/3.1 11.1	2.3/4.5 11.1	3.4/6.4 20.0	3.4/6.4 20.0
SIZE: (mm) H x W x D	10.5 x 54 x 85.6	10.5 x 54 x 85.6	10.5 x 54 x 85.6	10.5 x 54 x 85.6	10.5 x 54 x 85.6
FIRST CUSTOMER SHIPMENT	5/94	9/94	3/95	3Q97	1Q97
COMMENTS	PCMCIA Type III *Carbon disk. CT-131FD is 50 pin IDE version	PCMCIA Type III *Carbon disk. CT-171FD is 50 pin IDE version	PCMCIA Type III *Carbon disk. CT-260FD is 50 pin IDE version	PCMCIA Type III *Glass disk. CT-260FM is 50 pin IDE version	PCMCIA Type III *Glass disk. CT-520FM is 50 pin IDE version

MANUFACTURER	INTEGRAL PERIPHERALS	INTEGRAL PERIPHERALS	INTEGRAL PERIPHERALS	INTEGRAL PERIPHERALS	SEIKO EPSON
DRIVE	8085 Viper 85	8170E Viper 170E	8340PA Viper 340	8510PA Viper 510	EHDD170 Hard Disk Card
DISK/TREND GROUP	2	2	2	3	2
MARKET	OEM	OEM	OEM	OEM	PCM
MEDIA: Disk diameter	48 mm	48 mm	48 mm	48 mm	48 mm
Recording medium	Thin Film*	Thin Film*	Thin Film*	Thin Film	Thin Film*
DRIVE: Heads	Thin Film	Thin Film	Thin Film	MR	Thin Film
Interface	PCMCIA-ATA	PCMCIA-ATA	PCMCIA-ATA	PCMCIA-ATA	PCMCIA-ATA
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	--	--	--	--	--
REMOVABLE	F: 85.6	F: 170.8	F: 341.1	F: 510	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	1	2	4	4	4
Tracks per surface	2000	2000	2000	2600	1370
Track density (TPI)	5100	5100	5100	6660	3800
Maximum linear density (BPI) (FCI)	123600 92700	123600 92700	123600 92700	118000 89000	84000 63000
Areal density (Mb/square inch)	630.4	630.4	630.4	785.9	319.2
Recording code	1,7 PRML	1,7 PRML	1,7 PRML	1,7 PRML	1,7 RLL
Rotational speed (RPM)	4500	4500	4500	4500	4500
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Embedded	Embedded	Embedded	Embedded	Embedded
Average positioning time (msec)	12	12	12	13	12
Average rotational delay (msec)	6.7	6.7	6.7	5.77	6.7
Average access time (msec)	18.7	18.7	18.7	18.77	18.7
Data transfer rate (MBytes/sec) Internal, min/max External	--/5.7 16.0	--/5.7 16.0	--/5.7 16.0	--/6.5 16.0	 12.0
SIZE: (mm) H x W x D	10.5 x 54 x 85.6	10.5 x 54 x 85.6	10.5 x 54 x 85.6	10.5 x 54 x 85.6	10.5 x 54 x 85.6
FIRST CUSTOMER SHIPMENT	2/97	7/94	7/94		3/94
COMMENTS	PCMCIA Type III Ramp loaded heads. *Untextured disks.	PCMCIA Type III Ramp loaded heads. *Untextured disks.	PCMCIA Type III Ramp loaded heads. *Untextured disks.	PCMCIA Type III Ramp loaded heads.	PCMCIA Type III Ramp loaded heads. *Untextured disks. Mfg by Integral Peripherals.

RIGID DISK CARTRIDGE DRIVE SPECIFICATIONS

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 capacities are given for all drives with embedded controllers, such as SCSI or IDE. Specific formatted capacities are indicated by "F". Capacities per track are listed for drives without 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.

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.

Transfer rate

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

Accuracy

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

1997 DISK/TREND product groups for rigid disk cartridge drives included in the Removable Data Storage report

Group number	Drives included
1.	Rigid disk cartridge drives

MANUFACTURER	AVATAR PERIPHERALS	AVATAR PERIPHERALS	AVATAR PERIPHERALS	IOMEGA	NOMAI
DRIVE	2250i Shark	250 Shark	3250i Shark	Jaz 1GB SCSI	750.c
DISK/TREND GROUP	1	1	1	1	1
MARKET	OEM	PCM	OEM	OEM, PCM	OEM, PCM
MEDIA: Disk diameter	65 mm	65 mm	65 mm	95 mm	95 mm
Recording medium	Thin Film*	Thin Film*	Thin Film*	Thin Film	Thin Film
DRIVE: Heads	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
Interface	IDE	Parallel Port	IDE	SCSI-2	SCSI-2,Par.Port
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	--	--	--	--	--
REMOVABLE	F: 249.5	F: 249.5	F: 249.5	F: 540/1,070	F: 750
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	2	4	2
Tracks per surface	2404	2404	2404	4204	
Track density (TPI)	4300	4300	4300	4301	5500
Maximum linear density (BPI) (FCI)	98500 73875	98500 73875	98500 73875	89178 66884	100000
Areal density (Mb/square inch)	423.6	423.6	423.6	383.6	550.0
Recording code	1,7 RLL	1,7 RLL	1,7 RLL	1,7 RLL	8,9 PRML
Rotational speed (RPM)	3805	3805	3805	5400	4500
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Embedded	Embedded	Embedded	Embedded	Embedded
Average positioning time (msec)	12	12	12	10 RD/12 WR	10
Average rotational delay (msec)	7.9	7.9	7.9	5.6	6.6
Average access time (msec)	19.9	19.9	19.9	15.6 RD/17.6 WR	16.6
Data transfer rate (MBytes/sec) Internal, min/max External	--/2.5 13.3 DMA Mode 1	--/2.5 1.2	--/2.5 13.3 DMA Mode 1	3.5/6.7 10.0 synch. 5.0 asynch.	4.1/8.8 10.0
SIZE: (mm) H x W x D	17.5 x 72.6 x 119.6	25.4 x 89 x 140	17.5 x 72.4 x 119.6	25.4 x 101.6 x 149.9	33 x 109 x 180
FIRST CUSTOMER SHIPMENT	9/96	4/97	9/96	4Q95	4/97
COMMENTS	Removable data cartridge. *Glass disk.	Removable data cartridge. *Glass disk.	Removable data cartridge. *Glass disk.		

MANUFACTURER	NOMAI	SYQUEST TECHNOLOGY	SYQUEST TECHNOLOGY	SYQUEST TECHNOLOGY	SYQUEST TECHNOLOGY
DRIVE	MCD-I	SQ5200C	EZFlyer 230A	EZFlyer 230P	EZFlyer 230S
DISK/TREND GROUP	1	1	1	1	1
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
MEDIA: Disk diameter	95 mm	130 mm	95 mm	95 mm	95 mm
Recording medium	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
DRIVE: Heads	Thin Film	Ferrite	Thin Film	Thin Film	Thin Film
Interface	SCSI-2, IDE	SCSI-2	IDE	Parallel Port	SCSI
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	--	--	--	--	--
REMOVABLE	F: 540	F: 200	F: 230	F: 230	F: 230
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	1	1	1
Tracks per surface		2260	4192	4192	4192
Track density (TPI)	4250	1875	4200	4200	4200
Maximum linear density (BPI) (FCI)	100000	49820 37365	77800 58400	77800 58400	77800 58400
Areal density (Mb/square inch)	425.0	93.4	326.8	326.8	326.8
Recording code	8,9 PRML	1,7 RLL	1,7 RLL	1,7 RLL	1,7 RLL
Rotational speed (RPM)	4500	3220	3600	3600	3600
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Embedded	Embedded	Embedded	Embedded	Embedded
Average positioning time (msec)	10	18	13.5	13.5	13.5
Average rotational delay (msec)	6.6	9.32	8.3	8.3	8.3
Average access time (msec)	16.6	27.32	21.8	21.8	21.8
Data transfer rate (MBytes/sec) Internal, min/max External	 4.1/8.8 10.0	 2.6/3.6 5.0 synch. 3.0 asynch.	 10.0 synch. 5.0 asynch.	 1.25	 10.0 synch. 5.0 asynch.
SIZE: (mm) H x W x D	25.4 x 102 x 150	41.3 x 146.1 x 203.2	25.4 x 101.6 x 146.0	39.4 x 137.9 x 184.2	39.4 x 137.9 x 184.2
FIRST CUSTOMER SHIPMENT	4Q95	2Q94	3/97	6/96	6/96
COMMENTS		Removable data cartridge. Read/write compatible with 44 MB, 88 MB & 200 MB cart.	Removable data cartridge. Internal model.	Removable data cartridge. External model.	Removable data cartridge. Internal model.

MANUFACTURER	SYQUEST TECHNOLOGY	SYQUEST TECHNOLOGY	SYQUEST TECHNOLOGY	SYQUEST TECHNOLOGY	
DRIVE	SyJet IAi	SyJet ISE	SyJet ISi	SyJet IPE	
DISK/TREND GROUP	1	1	1	1	
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	
MEDIA: Disk diameter	95 mm	95 mm	95 mm	95 mm	
Recording medium	Thin Film	Thin Film	Thin Film	Thin Film	
DRIVE: Heads	Thin Film	Thin Film	Thin Film	Thin Film	
Interface	IDE	SCSI-2	SCSI-2	Parallel Port	
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	--	--	--	--	
REMOVABLE	F: 1,500	F: 1,500	F: 1,500	F: 1,500	
Capacity per track (Bytes)	Varies by zone	Varies by zone	Varies by zone	Varies by zone	
Data surfaces per spindle	4	4	4	4	
Tracks per surface	5241	5241	5241	5241	
Track density (TPI)	5400	5400	5400	5400	
Maximum linear density (BPI) (FCI)	108000 121000	108000 121000	108000 121000	108000 121000	
Areal density (Mb/square inch)	583.2	583.2	583.2	583.2	
Recording code	PRML	PRML	PRML	PRML	
Rotational speed (RPM)	5400	5400	5400	5400	
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)	12	12	12	12	
Average rotational delay (msec)	5.6	5.6	5.6	5.5	
Average access time (msec)	17.6	17.6	17.6	17.5	
Data transfer rate (MBytes/sec) Internal, min/max External	5.5/11.5 16.6 PIO Mode 4	5.5/11.5 10.0 synch. 5.0 asynch.	5.5/11.5 10.0 synch. 5.0 asynch.	5.5/11.5	
SIZE: (mm) H x W x D	25.4 x 101.6 x 149.3	38.1 x 133 x 200	25.4 x 101.6 x 149.3	38.1 x 133 x 200	
FIRST CUSTOMER SHIPMENT	4/97	1/97	1/97	1/97	
COMMENTS	Internal model.	Removable data cartridge. External model.	Removable data cartridge. Internal model.	External model.	

SMALL OPTICAL DISK DRIVE SPECIFICATIONS

OPTICAL DISK DRIVE SPECIFICATIONS

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

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

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

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

Speed control: Various abbreviations are used:

CAV = constant angular velocity.

CLV = constant linear velocity.

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

Capacities: "F" is used to indicate formatted capacities. 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.

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 cross-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.

1997 DISK/TREND optical disk drive product groups included in the Removable Data Storage report

Group number	Drives included
22.	Optical disk drives less than 2 gigabytes

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

MANUFACTURER	FUJITSU	FUJITSU	FUJITSU	FUJITSU	FUJITSU
OPTICAL DRIVE	2512A MOcity	DynaMO 640 PC	DynaMO 640Si	M2512A DynaMO 230	M2513A Cat-4
DISK/TREND GROUP	22	22	22	22	22
MARKET	PCM	PCM	OEM	OEM, PCM	OEM, PCM
MEDIA: Disk diameter	86 mm	86 mm	86 mm	86 mm	86 mm
Recording technology	Magneto-Optic	Magneto-Optic	Magneto-Optic	Magneto-Optic	Magneto-Optic
DRIVE: Operating mode	Rewritable	Rewritable	Rewritable	Rewritable	Rewritable
Interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Speed control	CAV/ZCAV	ZCAV	ZCAV	CAV/ZCAV	ZCAV
CAPACITY/RECORDING DENSITY					
On-line capacity (Mbytes)	F: 128/230	F: 640/540	F: 638/534	F: 128/230	F: 640/540
Capacity per disk (Mbytes)	F: 128/230	F: 640/540	F: 638/534	F: 128/230	F: 640/540
Capacity per track (Bytes)	F: 12800/N/A	F: 34815	F: 34815	F: 12800/N/A	F: 34816
Data surfaces per spindle	1	1	1	1	1
Tracks per surface	10000/17940	18480/42042	18316	10000/17940	18480/42042
Track density (TPI)	15875/18273	23090	23000	15875/18275	23090
Maximum linear density (BPI)	24400/29296	52900	53000	24400/29300	52900
Rotational speed (RPM)	3600	3600	3600	3600	3600
PERFORMANCE					
Buffer/cache size (Kbytes)	256	2000	2000	256	2000/512
Servo type	Continuous	Continuous	Continuous	Continuous	Continuous
Average positioning time (msec)	30	35	35	30	30
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	38.3	43.3	43.3	38.3	38.3
Spin-up/Spin-down times (sec)		7/4	7/4		7/4
Data transfer rate (MBytes/sec) Internal	1.3-2.1	2.3-3.9	2.3-3.9	1.3-2.1	2.3-3.9
External	5.0 synch.	10.0 synch.	10.0 synch.	5.0 synch.	5.0/10.0 synch.
SIZE (mm: H x W x D)	25.4 x 101.6 x 146	55 x 170 x 225	25.4 x 101.6 x 160	25.4 x 101.6 x 146	25.4 x 101.6 x 146
FIRST CUSTOMER SHIPMENT	1995	4Q96	6/97	3/94	4/96
COMMENTS	Sold in Europe.	External mount. Direct overwrite.	Direct overwrite.	DynaMO is external subsystem.	Direct overwrite.

MANUFACTURER	FUJITSU	FUJITSU	FUJITSU	FUJITSU	FUJITSU
OPTICAL DRIVE	M2541B DynaMO 230 Portable	M2541BD MicroCat-3	M2541BF Pismo	M2541BS PCMCIA	M2541S MicroMO
DISK/TREND GROUP	22	22	22	22	22
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
MEDIA: Disk diameter	86 mm	86 mm	86 mm	86 mm	86 mm
Recording technology	Magneto-Optic	Magneto-Optic	Magneto-Optic	Magneto-Optic	Magneto-Optic
DRIVE: Operating mode	Rewritable	Rewritable	Rewritable	Rewritable	Rewritable
Interface	IDE	IDE	Power Book	PCMCIA	PCMCIA
Speed control	CAV/ZCAV	CAV/ZCAV	CAV/ZCAV	CAV	CAV/ZCAV
CAPACITY/RECORDING DENSITY					
On-line capacity (Mbytes) Capacity per disk (Mbytes)	F: 128/230 F: 128/230	F: 128/230 F: 128/230	F: 128/230 F: 128/230	F: 128/230 F: 128/230	F: 128/230 F: 128/230
Capacity per track (Bytes)	F: 12800/N/A	F: 12800/N/A	F: 12800/N/A	F: 12800/N/A	F: 12800/N/A
Data surfaces per spindle	1	1	1	1	1
Tracks per surface	10000/17940	10000/17940	10000/17940	10000/17940	10000/17940
Track density (TPI)	15875/18275	15875/18275	15875/18275	15875/18275	15875/18273
Maximum linear density (BPI)	24400/29300	24400/29300*	24400/29300*	24400/29300*	24400/29296*
Rotational speed (RPM)	2700	2700	2700	2700	2700
PERFORMANCE					
Buffer/cache size (Kbytes)	128	128	128	128	128(512 option)
Servo type	Continuous	Continuous	Continuous	Continuous	Continuous
Average positioning time (msec)	70	70	65	70	65
Average rotational delay (msec)	11	11.1	11.1	11.1	11
Average access time (msec)	81	81.1	76.1	81.1	76
Spin-up/Spin-down times (sec)	7/6	7/6	7/6	7/6	7/6
Data transfer rate (MBytes/sec) Internal External	.975-1.575 6.0/8.0	1.0-1.6 6.0/8.0	1.0-1.6	1.0-1.6	1.0-1.6 8.0
SIZE (mm: H x W x D)	17 x 101.6 x 140	17.2 x 101.6 x 140	17.2 x 101.6 x 140	25.3 x 113.5 x 164.8	25.3 x 113.5 x 164.8
FIRST CUSTOMER SHIPMENT	10/95	1996	1996	1996	1Q96
COMMENTS	DynaMO is external subsystem. Direct overwrite.	*2,7 RLL Code.	*2,7 RLL code.	*2,7 RLL Code.	*2,7 RLL Code. Battery pack available.

MANUFACTURER	FUJITSU	MOUNTAIN OPTECH	OLYMPUS	OLYMPUS	OLYMPUS
OPTICAL DRIVE	ZEBO	CS-250 R/W SE-250 R/W SI-250 R/W ST-250 R/W	230MO Plus* 230MO Turbo	640MO Turbo	MOS330E MOS330S MOS331E* MOS331S*
DISK/TREND GROUP	22	22	22	22	22
MARKET	PCM	OEM	OEM, PCM	PCM	OEM
MEDIA: Disk diameter	86 mm	86 mm	86 mm	86 mm	86 mm
Recording technology	Magneto-Optic	Magneto-Optic	Magneto-Optic	Magneto-Optic	Magneto-Optic
DRIVE: Operating mode	Rewritable	Rewritable	Rewritable	Rewritable	Rewritable
Interface	SCSI-2	SCSI	SCSI-2	SCSI-2	SCSI-2
Speed control	ZCAV	ZCAV	CAV	CAV/ZCAV	CAV/ZCAV
CAPACITY/RECORDING DENSITY					
On-line capacity (Mbytes) Capacity per disk (Mbytes)	F: 640/540 F: 640/540	F: 230	F: 230/128	F: 540/640	F: 230/128
Capacity per track (Bytes)	F: 34816	F: 12800	F: 12800	F: 34816	F: 12800
Data surfaces per spindle	1	1	1	1	1
Tracks per surface	18480/42042	11510/17853*	11500	18480	11500**
Track density (TPI)	23090	18273	18273	23090	18273
Maximum linear density (BPI)	52900	29540	29300	52900	29300
Rotational speed (RPM)	3600	3600	4200	3600	4200
PERFORMANCE					
Buffer/cache size (Kbytes)	2000	64	1000*	2000	256, 1000*
Servo type	Continuous	Continuous	Continuous	Continuous	Continuous
Average positioning time (msec)	35	40	28	28	27
Average rotational delay (msec)	8.3	8.3	7.1	8.3	7.1
Average access time (msec)	43.3	48.3	35.1	36.3	34.1
Spin-up/Spin-down times (sec)	7/4				
Data transfer rate (MBytes/sec) Internal External	3.9 10.0 synch.	1.475 max.	1.075-1.72/.896	1.8-3.0 5.5 synch.	1.075-1.72/.896 5.0 synch.
SIZE (mm: H x W x D)	116 x 60 x 200	44.5 x 117.5 x 206.4		35 x 123 x 218	25.4 x 101.6 x 153.5
FIRST CUSTOMER SHIPMENT	1997	1Q95	10/94	1997	2Q96
COMMENTS	External mount. Direct overwrite. Sold in Japan.	Ruggedized. *Logical tracks CS-250 is commercial version.	*Includes cache	Direct overwrite.	*1 MB optional. **37600 logical tracks.

MANUFACTURER	OLYMPUS	OLYMPUS	OLYMPUS	SHARP	SONY
OPTICAL DRIVE	MOS332S 230MO Turbo Black PowerMO 230 III	MOS341E	SYS.230	MD-PS1	MDH-10
DISK/TREND GROUP	22	22	22	22	22
MARKET	PCM	OEM	PCM	OEM	PCM
MEDIA: Disk diameter	86 mm	86 mm	86 mm	64 mm	64 mm
Recording technology	Magneto-Optic	Magneto-Optic	Magneto-Optic	Magneto-Optic	Magneto-Optic
DRIVE: Operating mode	Rewritable	Rewritable	Rewritable	Rewritable	Rd.Only,Rewrit.
Interface	SCSI-2	SCSI-2	SCSI-2,Prt.Port	Parallel Port	SCSI-2
Speed control	CAV/ZCAV	CAV	CAV/ZCAV**	CLV	CLV
CAPACITY/RECORDING DENSITY					
On-line capacity (Mbytes) Capacity per disk (Mbytes)	F: 230/128	F: 540/640	F: 128/230 F: 128/230	F: 140	F: 140 F: 140
Capacity per track (Bytes)	F: 12800	F: 34816	F:10000/12800**	F: NA	NA
Data surfaces per spindle	1	1	1	1	1
Tracks per surface	11500*	18480	11500*	10000	10000
Track density (TPI)	18273	23090	18273	15875	15875
Maximum linear density (BPI)	29300	52900	29300	39827	39827
Rotational speed (RPM)	4200	3600	4200	940-422	940-422
PERFORMANCE					
Buffer/cache size (Kbytes)	256	2000	256	128	
Servo type	Continuous	Continuous	Continuous	Continuous	Continuous
Average positioning time (msec)	27	28	27		455
Average rotational delay (msec)	7.1	8.3	7.1		45
Average access time (msec)	34.1	36.3	34.1	300	500
Spin-up/Spin-down times (sec)					
Data transfer rate (MBytes/sec) Internal External	1.075-1.72/.896 2.4	1.8-3.0 5.5 synch.	2.4	.150	.150 2.5 asynch.
SIZE (mm: H x W x D)	40 x 133 x 202	25.4 x 101.6 x 153.5	50.4 x 152.4 x 203.2	41.3 x 101.6 x 123	30 x 80 x 131
FIRST CUSTOMER SHIPMENT	2Q97	2Q96		3/97	3Q94
COMMENTS	*37600 logical tracks. Not sold in U.S.	Direct overwrite.	*37600 logical tracks. **At highest capacity. External mount.	Used with video camera.	

MANUFACTURER	SONY	SONY	SONY		
OPTICAL DRIVE	HS-1	HS-D650	RMO-S330		
DISK/TREND GROUP	22	22	22		
MARKET	PCM	OEM	PCM		
MEDIA: Disk diameter	86 mm	86 mm	86 mm		
Recording technology	Magneto-Optic	Magneto-Optic	Magneto-Optic		
DRIVE: Operating mode	Rewritable	Rewritable	Rewritable		
Interface	SCSI-2	SCSI-2	SCSI-2		
Speed control	ZCAV	ZCAV	CAV		
CAPACITY/RECORDING DENSITY					
On-line capacity (Mbytes)	F: 650	F: 650	F: 128		
Capacity per disk (Mbytes)	F: 650	F: 650	F: 128		
Capacity per track (Bytes)	N/A	N/A	F: 12800		
Data surfaces per spindle	1	1	1		
Tracks per surface	17665	17665	10000		
Track density (TPI)	21200	21200	15875		
Maximum linear density (BPI)	60500	60500	24420		
Rotational speed (RPM)	2400	2400	1800		
PERFORMANCE					
Buffer/cache size (Kbytes)	512	512	128		
Servo type	Sampled	Sampled	Continuous		
Average positioning time (msec)	33	33	120		
Average rotational delay (msec)	12.5	12.5	16.6		
Average access time (msec)	45.5	45.5	136.6		
Spin-up/Spin-down times (sec)	8/5*	8/5*			
Data transfer rate (MBytes/sec) Internal	1.0-2.0	1.0-2.0	.375		
External	10.0	5.0	4.0 synch.		
SIZE (mm: H x W x D)	177 x 60 x 250	24.5 x 101.6 x 149	52.4 x 160 x 240		
FIRST CUSTOMER SHIPMENT	2/96	11/95	7/94		
COMMENTS	External subsystem of HS-D650. *Loading/eject time included.	*Loading/eject time included.	External mount.		

HIGH CAPACITY FLEXIBLE DISK DRIVE SPECIFICATIONS

HIGH CAPACITY FLEXIBLE DISK DRIVE SPECIFICATIONS

Coverage

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

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

Capacities

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

Average access time

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

Accuracy

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

1997 DISK/TREND product groups for flexible disk drives included in the Removable Data Storage report

Group number	Drives included
13.	High capacity flexible disk drives

MANUFACTURER	IMATION	IOMEGA	IOMEGA	IOMEGA	IOMEGA
DRIVE	SuperDisk LS-120 Parallel Port External Model	Zip 100 SCSI Interface Internal Model	Notebook Zip ATAPI interface	Zip 100 Parallel Port External Model	Zip 100 SCSI Interface External Model
DISK/TREND GROUP	13	13	13	13	13
MARKET	OEM, PCM	PCM	PCM	PCM	PCM
MEDIA: Nominal disk diameter	3.5"	3.5"	3.5"	3.5"	3.5"
Recording medium	Metal Powder	Metal Powder	Metal Powder	Metal Powder	Metal Powder
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: 120/1.44	F: 25/100	F: 25/100	F: 25/100	F: 25/100
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	2	2	2
Tracks per surface	1736/80	1817	1817	1817	1817
Track density (TPI)	2490/135	2116	2116	2116	2116
Maximum linear density (BPI)	44880 BPI 33660 FCI	46000 BPI 34500 FCI	46000 BPI 34500 FCI	46000 BPI 34500 FCI	46000 BPI 34500 FCI
Recording code	1,7 RLL/MFM	1,8 RLL	1,8 RLL	1,8 RLL	1,8 RLL
Rotational speed (RPM)	720	2941	2941	2941	2941
PERFORMANCE					
Actuator type	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil
POSITIONING: Track to track(msec)	10/15	4	4	4	4
Settling time (msec)	--	--	--	--	--
Average rotational delay (msec)	41.7	10.1	10.1	10.1	10.1
Data transfer rate (KBytes/sec)	290*	4000 synch.*	1400	1400*	4000 synch.*
SIZE (mm: H x W x D)	40 x 150 x 220	25.5 x 101.5 x 165	15 x 99.5 x 135	36.9 x 134.1 x 181.6	38.6 x 134.1 x 181.6
FIRST CUSTOMER SHIPMENT	2Q97	2Q96	9/97	3/95	3/95
COMMENTS	*Parallel port. 70 msec average positioning time. Downward compatible 720 KB/1.2 MB/ 1.44 MB.	*SCSI. 29 msec average positioning time. 25 and 100 MB disk cartridges available.	29 msec average positioning time. 25 and 100 MB disk cartridges available. 12.7 mm high version sched. for 1Q98	*Parallel port. 29 msec average positioning time. 25 and 100 MB disk cartridges available.	*SCSI. 29 msec average positioning time. 25 and 100 MB disk cartridges available.

MANUFACTURER	IOMEGA	MATSUSHITA COMMUNICATION INDUSTRIAL	MATSUSHITA COMMUNICATION INDUSTRIAL	MATSUSHITA-KOTOBUKI ELECTRONICS	MATSUSHITA-KOTOBUKI ELECTRONICS
DRIVE	Zip 100 IDE Interface Internal Model	Zip 100 Parallel Port External Model	Zip 100 IDE Interface Internal Model	LS-120	LS-120 Slim
DISK/TREND GROUP	13	13	13	13	13
MARKET	PCM	PCM	PCM	OEM, PCM	OEM, PCM
MEDIA: Nominal disk diameter	3.5"	3.5"	3.5"	3.5"	3.5"
Recording medium	Metal Powder	Metal Powder	Metal Powder	Metal Powder	Metal Powder
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: 25/100	F: 25/100	F: 25/100	F: 120/1.44	F: 120/1.44
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	2	2	2
Tracks per surface	1817	1817	1817	1736/80	1736/80
Track density (TPI)	2116	2116	2116	2490/135	2490/135
Maximum linear density (BPI)	46000 BPI 34500 FCI	46000 BPI 34500 FCI	46000 BPI 34500 FCI	44880 BPI 33660 FCI	44880 BPI 33660 FCI
Recording code	1,8 RLL	1,8 RLL	1,8 RLL	1,7 RLL/MFM	1,7 RLL/MFM
Rotational speed (RPM)	2941	2941	2941	720	720
PERFORMANCE					
Actuator type	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil
POSITIONING: Track to track(msec)	4	4	4	10/15	10/15
Settling time (msec)	--	--	--	--	--
Average rotational delay (msec)	10.1	10.1	10.1	41.7	41.7
Data transfer rate (KBytes/sec)	--*	1400*	--*	4000	4000
SIZE (mm: H x W x D)	25.5 x 101.5 x 165	36.9 x 134.1 x 181.6	25.5 x 101.5 x 165	25.4 x 101.6 x 150	12.7 x 96 x 126
FIRST CUSTOMER SHIPMENT	1Q96			3Q96	3Q97
COMMENTS	*IDE. 29 msec average positioning time. 25 and 100 MB disk cartridges available.	*Parallel port. 29 msec average positioning time. 25 and 100 MB disk cartridges available.	*IDE. 29 msec average positioning time. 25 and 100 MB disk cartridges available.	70 msec average positioning time. Downward compatible 720 KB/1.2 MB/ 1.44 MB.	70 msec average positioning time. Downward compatible 720 KB/1.2 MB/ 1.44 MB.

MANUFACTURER	MITSUBISHI ELECTRIC CORPORATION	MITSUBISHI ELECTRIC CORPORATION	MITSUMI ELECTRIC	O.R. TECHNOLOGY	O.R. TECHNOLOGY
DRIVE	MF 357G LS-120	MF 357H LS-120 Slim	UHC	FD-2120A	FD-3120A
DISK/TREND GROUP	13	13	13	13	13
MARKET	OEM, PCM	OEM, PCM	OEM	OEM, PCM	OEM, PCM
MEDIA: Nominal disk diameter	3.5"	3.5"	3.5"	3.5"	3.5"
Recording medium	Metal Powder	Metal Powder	Metal Powder	Metal Powder	Metal Powder
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: 120/1.44	F: 120/1.44	F: 130/.72/1.44	F: 120/1.44	F: 120/1.44
Capacity per track (Bytes)	Varies by zone	Varies by zone	F: Varies/4608/ 9216	Varies by zone	Varies by zone
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	1736/80	1736/80	1540/80	1736/80	1736/80
Track density (TPI)	2490/135	2490/135	2700/135	2490/135	2490/135
Maximum linear density (BPI)	44880 BPI* 33660 FCI	44880 BPI* 33660 FCI	63980/17494	44880 BPI 33660 FCI	44880 BPI 33660 FCI
Recording code	1,7 RLL/MFM	1,7 RLL/MFM	1,7 MFM/RLL	1,7 RLL/MFM	1,7 RLL/MFM
Rotational speed (RPM)	720	720	3600/300	720	720
PERFORMANCE					
Actuator type	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil
POSITIONING: Track to track(msec)	10/15	10/15	--/3	6/15	6/15
Settling time (msec)	--	--	15	--	--
Average rotational delay (msec)	41.7	41.7	8.3/100	41.7	41.7
Data transfer rate (KBytes/sec)	4000	4000	3980/62.5	4000	4000
SIZE (mm: H x W x D)	25.4 x 101.6 x 150	12.7 x 96 x 126	25.4 x 101.6 x 150	12.7 x 96 x 124	25.4 x 101.6 x 150
FIRST CUSTOMER SHIPMENT	8/96	7/97	9/97	2Q97	3Q96
COMMENTS	70 msec average positioning time. Downward compatible 720 KB/1.2 MB/ 1.44 MB.	70 msec average positioning time. Downward compatible 720 KB/1.2 MB/ 1.44 MB.	Downward compatible 720 KB/1.44 MB. IDE interface.	65 msec average positioning time. Downward compatible 720 KB/1.2 MB/ 1.44 MB. Uses LS-120 disks.	65 msec average positioning time. Downward compatible 720 KB/1.2 MB/ 1.44 MB. Uses LS-120 disks.

MANUFACTURER	SWAN INSTRUMENTS				
DRIVE	UHC 3130				
DISK/TREND GROUP	13				
MARKET	OEM, PCM				
MEDIA: Nominal disk diameter	3.5"				
Recording medium	Metal Powder				
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: 130/1.44				
Capacity per track (Bytes)	F: Varies/4608/ 9216				
Data surfaces per spindle	2				
Tracks per surface	1540/80				
Track density (TPI)	2700/135				
Maximum linear density (BPI)	73200/17434				
Recording code	1,7 RLL/MFM				
Rotational speed (RPM)	3600				
PERFORMANCE					
Actuator type	Linear, Voice Coil				
POSITIONING: Track to track(msec)	3.5				
Settling time (msec)	--				
Average rotational delay (msec)	8.3				
Data transfer rate (KBytes/sec)	Up to 10000				
SIZE (mm: H x W x D)	25.4 x 101.6 x 146.1				
FIRST CUSTOMER SHIPMENT	1997				
COMMENTS	18 msec. average head positioning. Parallel port, SCSI-2 or IDE interface.				

LOW CAPACITY FLEXIBLE DISK DRIVE SPECIFICATIONS

LOW CAPACITY
FLEXIBLE DISK DRIVE SPECIFICATIONS

Coverage

This section includes low capacity flexible disk drives intended for data storage, with capacities less than five megabytes, which are now in production or announced, arranged alphabetically by manufacturer. Product specifications use the same format employed in the separate DISK/TREND Report on flexible disk drives published in previous years. Specifications of flexible disk drive models sold by computer system manufacturers, but purchased on an OEM basis from others, may be included in a few cases for clarity. In the case of captive flexible disk drives manufactured by system manufacturers, captive drives which are similar to individual OEM/Integrator models made by the same system manufacturer are usually not listed.

Capacities

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

Accuracy

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

DISK/TREND product groups

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

1997 DISK/TREND product groups for flexible disk drives included in the Removable Data Storage report

Group number	Drives included
14.	Low capacity flexible disk drives

MANUFACTURER	ALPS ELECTRIC	ALPS ELECTRIC	CITIZEN	CITIZEN	CITIZEN
DRIVE	DF 354H	DF 354N	W1DE	BXW	OSDA
DISK/TREND GROUP	14	14	14	14	14
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Nominal disk diameter	3.5"	3.5"	3.5"	3.5"	3.5"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: .7/1.4	F: .7/1.2/1.4	F: .7/1.2/1.4	F: .7/1.2/1.4	F: .7/1.4
Capacity per track (Bytes)	F: 4,608/9,216	F: 4,608/7,680/ 9,216	F: 4,608/9,216	F: 4,608/9,216	F: 4,608/9,216
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80	80/77/80	80/77/80	80/77/80	80
Track density (TPI)	135	135	135	135	135
Maximum linear density (BPI)	8717/17434	8717/14184/ 17434	8717/17434	8717/17434	8717/17434
Recording code	MFM	MFM	MFM	MFM	MFM
Rotational speed (RPM)	300	300/360/300	300/360	300/360	300
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING: Track to track(msec)	3	3	3	3	3
Settling time (msec)	15	15	15	15	15
Average rotational delay (msec)	100/83.3	100/83.3	100/83.3	100/83.3	100
Data transfer rate (KBytes/sec)	31.25/62.5	31.25/62.5	31.25/62.5	31.25/62.5	31.25/62.5
SIZE (mm: H x W x D)	25.4 x 101.6 x 145	25.4 x 101.6 x 145	11 x 96 x 116	15 x 100 x 140	25.4 x 101.6 x 149.9
FIRST CUSTOMER SHIPMENT	12/95	12/95	2Q93	1Q95	4Q87
COMMENTS	Direct drive.	Direct drive.		External mount of W1 models.	

MANUFACTURER	CITIZEN	MATSUSHITA COMMUNICATION INDUSTRIAL	MATSUSHITA COMMUNICATION INDUSTRIAL	MATSUSHITA COMMUNICATION INDUSTRIAL	MITSUBISHI ELECTRIC CORPORATION
DRIVE	OSDE	JU-226A	JU-227A	JU-257A	FCD-2M Flopico
DISK/TREND GROUP	14	14	14	14	14
MARKET	OEM	Captive,OEM,PCM	Captive,OEM,PCM	Captive,OEM,PCM	OEM
MEDIA: Nominal disk diameter	3.5"	3.5"	3.5"	3.5"	1.7"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	Metal Powder
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: .7/1.2/1.4	F: .7/1.2/1.4	F: .7/1.4	F: .7/1.4	F: 1.44
Capacity per track (Bytes)	F: 4,608/9,216	F: 4,608/7,680/ 9,216	F: 4,608/9,216	F: 4,608/9,216	F: 12,288
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80/77	80	80	80	60
Track density (TPI)	135	135	135	135	254
Maximum linear density (BPI)	8717/17434	17434	17434	8717/17434	39926
Recording code	MFM	MFM	MFM	MFM	
Rotational speed (RPM)	300	300	300	300	450
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	
POSITIONING: Track to track(msec)	3	3	3	3	
Settling time (msec)	15	15	15	15	
Average rotational delay (msec)	100	100	100	100	66.7
Data transfer rate (KBytes/sec)	31.25/62.5	62.5	62.5	31.25/62.5	125
SIZE (mm: H x W x D)	25.4 x 101.6 x 149.9	12.7 x 101.6 x 106	12.7 x 101.6 x 106	25.4 x 101.6 x 149.9	5 x 54 x 93.6
FIRST CUSTOMER SHIPMENT	4Q89	1994	1994	1987	
COMMENTS					PCMCIA Type II. Uses 2 mm x 47 mm x 49.5 mm disk cartridge. 74 msec average positioning time.

MANUFACTURER	MITSUBISHI ELECTRIC CORPORATION	MITSUBISHI ELECTRIC CORPORATION	MITSUBISHI ELECTRIC CORPORATION	MITSUMI ELECTRIC	MITSUMI ELECTRIC
DRIVE	MF 355H	MF 355F	MF 356F	D 358F2	D 359F2
DISK/TREND GROUP	14	14	14	14	14
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Nominal disk diameter	3.5"	3.5"	3.5"	3.5"	3.5"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	Barium Ferrite	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: .7/1.2/1.4	F: .7/1.2/1.4	F: .7/1.2/ 1.4/2.88	F: .7/1.2	F: .7/1.4
Capacity per track (Bytes)	F: 4,608/7,680 9,216	F: 4,608/7,680 9,216	F: 4,608/7,680/ 9,216/18,432	F: 4,608/7,680	F: 4,608/9,216
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80	80	80	80/77	80
Track density (TPI)	135	135	135	135	135
Maximum linear density (BPI)	8717/14184/ 17434	8717/14184/ 17434	8717/14184/ 17434/34868	8717/14184	8717/17434
Recording code	MFM	MFM	MFM	MFM	MFM
Rotational speed (RPM)	300/360	300/360	300/360	300/360	300
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING: Track to track(msec)	3	3	3	3	3
Settling time (msec)	15	15	15	15	15
Average rotational delay (msec)	100/83.3	100/83.3	100/83.3	100/83.3	100
Data transfer rate (KBytes/sec)	31.25/62.5	31.25/62.5	31.25/62.5/125	31.25/62.5	31.25/62.5
SIZE (mm: H x W x D)	12.7 x 96 x 126	25.4 x 101.6 x 146	25.4 x 101.6 x 146	12.7 x 96 x 130	12.7 x 96 x 130
FIRST CUSTOMER SHIPMENT	1Q94	3Q93	3Q93	3Q93	3Q93
COMMENTS	15 mm high version available with auto eject.				

MANUFACTURER	MITSUMI ELECTRIC	MITSUMI ELECTRIC	MITSUMI ELECTRIC	MITSUMI ELECTRIC	MITSUMI ELECTRIC
DRIVE	D 353G	D 353F2	D 359G	D 353F2E	D 359F2E
DISK/TREND GROUP	14	14	14	14	14
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Nominal disk diameter	3.5"	3.5"	3.5"	3.5"	3.5"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: .7/1.2/1.4	F: .7/1.2/1.4	F: .7/1.4	F: .7/1.2/1.4	F: .7/1.4
Capacity per track (Bytes)	F: 4,608/7,680 9,216	F: 4,608/7,860 9,216	F: 4,608/9,216	F: 4,608/7,860 9,216	F: 4,608/9,216
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80/77	80/77	80	80/77	80
Track density (TPI)	135	135	135	135	135
Maximum linear density (BPI)	8717/14184/ 17434	8717/14184/ 17434	8717/17434	8717/14184/ 17434	8717/17434
Recording code	MFM	MFM	MFM	MFM	MFM
Rotational speed (RPM)	300/360	300/360	300	300/360	300
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING: Track to track(msec)	3	3	3	3	3
Settling time (msec)	15	15	15	15	15
Average rotational delay (msec)	100/83.3	100/83.3	100	100/83.3	100
Data transfer rate (KBytes/sec)	31.25/62.5	31.25/62.5	31.25/62.5	31.25/62.5	31.25/62.5
SIZE (mm: H x W x D)	12.7 x 101.6 x 105.6	12.7 x 96 x 130	12.7 x 101.6 x 105.6	17.5 x 106 x 143	17.5 x 106 x 143
FIRST CUSTOMER SHIPMENT	2Q95	3Q93	2Q95	1Q95	1Q95
COMMENTS					External model.

MANUFACTURER	MITSUMI ELECTRIC	MITSUMI ELECTRIC	MITSUMI ELECTRIC	NEC	NEC
DRIVE	D 359T5 D 359T6 D 359T7	D 353T5 D 353T7	D 509V5	FD 1238H	FD 1238T
DISK/TREND GROUP	14	14	14	14	14
MARKET	OEM	OEM	OEM	Captive, OEM	Captive, OEM
MEDIA: Nominal disk diameter	3.5"	3.5"	5.25"	3.5"	3.5"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: .7/1.4	F: .7/1.2/1.4	F: .7/1.2	F: .7/1.4	F: .7/1.2/1.4
Capacity per track (Bytes)	F: 4,608/9,216	F: 4,608/7,680 9,216	F: 4,608/7,680	F: 4,608/9,216	F: 4,608/7,680 9,216
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80	80/77	80/77	80	80
Track density (TPI)	135	135	96	135	135
Maximum linear density (BPI)	8717/17434	8717/14184/ 17434	5922/9870	8717/17434	8717/14528/ 17434
Recording code	MFM	MFM	MFM	MFM	MFM
Rotational speed (RPM)	300	300/360	300/360	300	300/360
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING: Track to track(msec)	3	3	3	3	3
Settling time (msec)	15	15	15	15	15
Average rotational delay (msec)	100	100/83.3	100/83.3	100	100
Data transfer rate (KBytes/sec)	31.25/62.5	31.25/62.5	37.5/62.5	31.25/62.5	31.25/62.5
SIZE (mm: H x W x D)	25.4 x 101.6 x 150	25.4 x 101.6 x 150	41 x 146 x 193	12.7 x 96 x 126	12.7 x 96 x 126
FIRST CUSTOMER SHIPMENT	2Q94	2Q94	1Q95	1Q95	1Q95
COMMENTS					

MANUFACTURER	NEC	NEC	S.F.R.	SAMSUNG ELECTRO-MECHANICS	SAMSUNG ELECTRO-MECHANICS
DRIVE	FD 1231H	FD 1231T	DS-34AC DS-35AC Safronic	SFD-321D SFD-321DT	SFD-321B
DISK/TREND GROUP	14	14	14	14	14
MARKET	Captive, OEM	Captive, OEM	OEM	Captive, OEM	Captive, OEM
MEDIA: Nominal disk diameter	3.5"	3.5"	3.5"	3.5"	3.5"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: .7/1.4	F: .7/1.2/1.4	F: .7/1.4	F: .7/1.4	F: .7/1.2/1.4
Capacity per track (Bytes)	F: 4,608/9,216	F: 4,608/7,680 9,216	F: 4,608/9,216	F: 4,608/9,216	F: 4,608/7,680 9,216
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80	80	80	80	80
Track density (TPI)	135	135	135	135	135
Maximum linear density (BPI)	8717/17434	8717/14528/ 17434	8717/17434	8717/17434	8717/17434
Recording code	MFM	MFM	MFM	MFM	MFM
Rotational speed (RPM)	300	300/360	300	300	300/360
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING: Track to track(msec)	3	3	3	3	3
Settling time (msec)	15	15	15	15	15
Average rotational delay (msec)	100	100	100	100	100
Data transfer rate (KBytes/sec)	31.25/62.5	31.25/62.5	31.25/62.5	31.25/62.5	31.25/62.5
SIZE (mm: H x W x D)	25.4 x 101.6 x 146	25.4 x 101.6 x 146	25.4 x 101.6 x 149.9	25.4 x 101.6 x 149.9	25.4 x 101.6 x 145
FIRST CUSTOMER SHIPMENT	2Q95	2Q95	1989	2Q89	
COMMENTS					

MANUFACTURER	SAMSUNG ELECTRO-MECHANICS	SAMSUNG ELECTRO-MECHANICS	SONY	SONY	SONY
DRIVE	SFD-321S	SFD-560D SFD-560DT	MPF720	MPF920	MPF520
DISK/TREND GROUP	14	14	14	14	14
MARKET	Captive, OEM	Captive, OEM	Captive, OEM	Captive, OEM	Captive, OEM
MEDIA: Nominal disk diameter	3.5"	5.25"	3.5"	3.5"	3.5"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: .7/1.2/1.4	F: .7/1.2	F: .7/1.2/1.4	F: .7/1.2/1.4	F: .7/1.2/1.4
Capacity per track (Bytes)	F: 4,608/7,680 9,216	F: 4,608/7,680	F: 4,608/7,680/ 9,216	F: 4,608/7,680/ 9,216	F: 4,608/7,680/ 9,216
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80	80/77	80	80	80
Track density (TPI)	135	96	135	135	135
Maximum linear density (BPI)	8717/17434	5922/9646	8717/14528/ 17434	8717/14528/ 17434	8717/14528/ 17434
Recording code	MFM	MFM	MFM	MFM	MFM
Rotational speed (RPM)	300/360	300/360	300/360/300	300/360/300	300/360/300
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING: Track to track(msec)	3	3	3	3	3
Settling time (msec)	15	15	15	15	15
Average rotational delay (msec)	100	83.3	100	100	100
Data transfer rate (KBytes/sec)	31.25/62.5	31.25/62.5	31.25/62.5/62.5	31.25/62.5/62.5	31.25/62.5/62.5
SIZE (mm: H x W x D)	12.7 x 96 x 126	41.3 x 146 x 203.2	12.7 x 96 x 130	25.4 x 101.6 x 144	25.4 x 101.6 x 145
FIRST CUSTOMER SHIPMENT		4Q87	2Q95		2Q94
COMMENTS					

MANUFACTURER	TAE IL MEDIA	TAE IL MEDIA	TAE IL MEDIA	TAE IL MEDIA	TEAC
DRIVE	TFD-310	TFD-315	TFD-320	TFD-510	FD-05HF
DISK/TREND GROUP	14	14	14	14	14
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Nominal disk diameter	3.5"	3.5"	3.5"	5.25"	3.5"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: .7/1.4	F: .7/1.4	F: .7/1.4	F: .7/1.2	F: .7/1.4
Capacity per track (Bytes)	F: 4,608/9,216	F: 4,608/9,216	F: 4,608/9,216	F: 4,608/7,680	F: 4,608/9,216
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80	80	80	80	80
Track density (TPI)	135	135	135	96	135
Maximum linear density (BPI)	8717/17434	8717/17434	8717/17434	5722/9870	8717/17434
Recording code	MFM	MFM	MFM	MFM	MFM
Rotational speed (RPM)	300	300	300	360	300
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING: Track to track(msec)	3	3	3	3	3
Settling time (msec)	15	15	15	15	15
Average rotational delay (msec)	100	100	100	83.3	100
Data transfer rate (KBytes/sec)	31.25/62.5	31.25/62.5	31.25/62.5	37.5//62.5	31.25/62.5
SIZE (mm: H x W x D)	25.4 x 102 x 130	25.4 x 102 x 126	25.4 x 102 x 143.5	41.3 x 146 x 193	12.7 x 101.6 x 129.5
FIRST CUSTOMER SHIPMENT	8/95	4/97	8/97	7/95	10/91
COMMENTS					Direct drive motor. 101.6 mm or 96 mm width available.

MANUFACTURER	TEAC	TEAC	TEAC	TEAC	TEAC
DRIVE	FD-05HG	FD-04HG	FD-05PHG	FD-235GF	FD-235GS
DISK/TREND GROUP	14	14	14	14	14
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Nominal disk diameter	3.5"	3.5"	3.5"	3.5"	3.5"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: .7/1.2/1.4	F: .7/1.2/1.4	F: .7/1.2/1.4	F: .7/1.2	F: .7/1.2
Capacity per track (Bytes)	F: 4,608/9,216	F: 4,608/9,216	F: 4,608/9,216	F: 4,608/7,680	F: 4,608/7,680
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80	80	80	80	80
Track density (TPI)	135	135	135	135	135
Maximum linear density (BPI)	8717/17434	8717/17434	8717/17434	8717/14528	8717/14528
Recording code	MFM	MFM	MFM	MFM	MFM
Rotational speed (RPM)	300/360	300/360	300/360	300/360	300/360
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING: Track to track(msec)	3	3	3	3	3
Settling time (msec)	15	15	15	15	15
Average rotational delay (msec)	100/83.3	100/83.3	100/83.3	100/83.3	100/83.3
Data transfer rate (KBytes/sec)	31.25/62.5	31.25/62.5	31.25/62.5	31.25/62.5	31.25/62.5
SIZE (mm: H x W x D)	12.7 x 101.6 x 129.5	12.7 x 101.6 x 106	15.5 x 106.2 x 146	25.4 x 101.6 x 145	41.9 x 104.1 x 161.8
FIRST CUSTOMER SHIPMENT		2Q95	4/92	2Q88	2Q88
COMMENTS	Direct drive motor. 101.6 mm or 96 mm width available.	Direct drive motor.	External drive unit.		SCSI interface.

MANUFACTURER	TEAC	TEAC	TEAC	TEAC	TEAC
DRIVE	FD-235HF	FD-235HG	FD-05HGS	FD-235HS	FD-155GF
DISK/TREND GROUP	14	14	14	14	14
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Nominal disk diameter	3.5"	3.5"	3.5"	3.5"	5.25"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: .7/1.4	F: .7/1.2/1.4	F: .7/1.2/1.4	F: .7/1.4	F: .7/1.2
Capacity per track (Bytes)	F: 4,608/9,216	F: 4,608/9,216	F: 4,608/9,216	F: 4,608/9,216	F: 4,608/7,680
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80	80	80	80	80/77
Track density (TPI)	135	135	135	135	96
Maximum linear density (BPI)	8717/17434	8717/17434	8717/17434	8717/17434	5922/9646
Recording code	MFM	MFM	MFM	MFM	MFM
Rotational speed (RPM)	300	300/360	300/360	300	300/360
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING: Track to track(msec)	3	3	3	3	3
Settling time (msec)	15	15	15	15	15
Average rotational delay (msec)	100	100	100/83.3	100	100/83.3
Data transfer rate (KBytes/sec)	31.25/62.5	31.25/62.5	31.25/62.5	31.25/62.5	31.25/62.5
SIZE (mm: H x W x D)	25.4 x 101.6 x 145	25.4 x 101.6 x 145	25.4 x 101.6 x 144.5	41.9 x 104.1 x 161.8	25.4 x 146 x 191
FIRST CUSTOMER SHIPMENT	2Q88		2Q93	1990	8/91
COMMENTS			SCSI interface.	SCSI interface.	

MANUFACTURER	TEAC	Y-E DATA	Y-E DATA	Y-E DATA	Y-E DATA
DRIVE	FD-55GFR	YD-702J	YD-686C	YD-701B YD-702B YD-702D	YD-701B-6336H
DISK/TREND GROUP	14	14	14	14	14
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Nominal disk diameter	5.25"	3.5"	3.5"	3.5"	3.5"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: .7/1.2	F: .7/1.2/1.4	F: .7/1.2	F: .7/1.2/1.4	F: .7/1.2/1.4
Capacity per track (Bytes)	F: 4,608/7,680	F: 4,608/7,680 9,216	F: 4,608/7,680	F: 4,608/7,680 9,216	F: 4,608/7,680 9,216
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80/77	80/77/80	80/77	80/77/80	80/77/80
Track density (TPI)	96	135	135	135	135
Maximum linear density (BPI)	5922/9646	8717/14184/ 17434	8717/14184	8717/14184/ 17434	8717/14184/ 17434
Recording code	MFM	MFM	MFM	MFM	MFM
Rotational speed (RPM)	300/360	300/360/300	300/360	300/360	600/720/600
PERFORMANCE					
Actuator type	Band, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING: Track to track(msec)	3	3	3	3	3
Settling time (msec)	15	15	15	15	15
Average rotational delay (msec)	100/83.3	100/83.3/100	100/83.3	100	50/41.6/50
Data transfer rate (KBytes/sec)	31.25/62.5	31.25/62.5/62.5	31.25/62.5	31.25/62.5/62.5	62.5/125/125
SIZE (mm: H x W x D)	41.3 x 146 x 203.2	12.7 x 96 x 129.5	25.4 x 101.6 x 149.9	25.4 x 101.6 x 149.9	25.4 x 101.6 x 149.9
FIRST CUSTOMER SHIPMENT	1987	2Q94	1Q87	1Q87	2Q95
COMMENTS	Dual speed.				Doublespeed drive sold for duplicators

MANUFACTURER	Y-E DATA	Y-E DATA	Y-E DATA	Y-E DATA	Y-E DATA
DRIVE	YD-701B-6331S	YD-701B-6431H	YD-701B-6431S	YD-380B-1710B	YD-380B-1714B
DISK/TREND GROUP	14	14	14	14	14
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Nominal disk diameter	3.5"	3.5"	3.5"	5.25"	5.25"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: .7/1.2/1.4	F: .7/1.2/1.4	F: .7/1.2/1.4	F: 1.2	F: .7/1.2
Capacity per track (Bytes)	F: 4,608/7,680 9,216	F: 4,608/7,680 9,216	F: 4,608/7,680 9,216	F: 7,680	F: 4,608/7,680
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80/77/80	80/77/80	80/77/80	77	80/77
Track density (TPI)	135	135	135	96	96
Maximum linear density (BPI)	8717/14184/ 17434	8717/14184/ 17434	8717/14184/ 17434	9646	5922/9646
Recording code	MFM	MFM	MFM	MFM	MFM
Rotational speed (RPM)	600/720/600	1200/1440/1200	1200/1440/1200	360	300/360
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor
POSITIONING: Track to track(msec)	3	3	3	3	3
Settling time (msec)	15	15	15	15	15
Average rotational delay (msec)	50/41.6/50	25/20.8/25	25/20.8/25	83.3	100/83.3
Data transfer rate (KBytes/sec)	62.5/125/125	125/250/250	125/250/250	62.5	31.25/62.5
SIZE (mm: H x W x D)	25.4 x 101.6 x 149.9	25.4 x 101.6 x 149.9	25.4 x 101.6 x 149.9	41.3 x 146 x 203.2	41.3 x 146 x 203.2
FIRST CUSTOMER SHIPMENT	2Q95	3Q95	3Q95	4/86	4/86
COMMENTS	Doublespeed R/W drive sold for duplicators	Quadspeed drive sold for duplicators	Quadspeed R/W drive sold for duplicators		

MANUFACTURER	Y-E DATA	Y-E DATA	Y-E DATA	Y-E DATA	
DRIVE	YD-380B-1734H	YD-380B-1734S	YD-801 YD-802	YD-180	
DISK/TREND GROUP	14	14	14	14	
MARKET	OEM	OEM	OEM	OEM	
MEDIA: Nominal disk diameter	5.25"	5.25"	5.25"	8"	
Recording medium	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	Oxide Coated	
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: .7/1.2	F: .7/1.2	F: 1.2/2.4	F: .6/1.2	
Capacity per track (Bytes)	F: 4,608/7,680	F: 4,608/7,680	F: 20,832	F: 4,096/8,192	
Data surfaces per spindle	2	2	2	2	
Tracks per surface	80	80/77	80	77	
Track density (TPI)	96	96	96	48	
Maximum linear density (BPI)	5922/9870	5922/9870	19740	3408/6816	
Recording code	MFM	MFM	MFM	MFM	
Rotational speed (RPM)	600/720	600/720	180/360	360	
PERFORMANCE					
Actuator type	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	
POSITIONING: Track to track(msec)	3	3	3	3	
Settling time (msec)	15	15	15	15	
Average rotational delay (msec)	50/41.6	50/41.6	166.7	83.3	
Data transfer rate (KBytes/sec)	75/125	75/125	62.5	31.25/62.5	
SIZE (mm: H x W x D)	41.3 x 146 x 203.2	41.3 x 146 x 203.2	41.3 x 146 x 203.2	57.2 x 217.2 x 320	
FIRST CUSTOMER SHIPMENT	6/90	6/91	1Q87	9/81	
COMMENTS	Double speed drive sold for duplicators.	Double speed R/W drive sold for duplicators	Compatible with 1.0 and 1.6 MB formats.		

MANUFACTURER PROFILES

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. "1996 total net sales" covers the fiscal year ending in 1996 for each firm unless noted otherwise, or for the parent company if the storage product manufacturer is a subsidiary. All fiscal years end on December 31, 1996, 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 rates for 1996 are used, as cited by the U.S. Federal Reserve Bulletin.

Country	Currency	Currency units/U.S. dollar
Germany	Deutschmark	1.50
Italy	Lira	1,543.0
Japan	Yen	108.8
Netherlands	Guilder	1.69
South Korea	Won	805.0
Taiwan	Dollar	27.5
United Kingdom	Pound	0.64

Use caution in making comparisons of sales revenue and income figures on a year to year basis, as they may be significantly impacted by exchange rate changes.

U.S. Manufacturers

ACTIONTEC, INC.
750 North Mary Avenue
Sunnyvale, CA 94086

Founded in 1993 as Premax, the firm specializes in PC Card storage and peripheral boards. The firm's manufacturing is done in Taiwan. Intel chips are used in a line of flash memory cards and flash disk cards that range from 256 kilobytes to 64 megabytes in capacity. The company changed its name in 1995 to eliminate confusion with other organizations and as a step to establish a stronger brand image.

ADVANCED MICRO DEVICES
1 AMD Place
Sunnyvale, CA 94088

1996 total net sales: $1,953,019,000 Net income: ($68,950,000)

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

AMD's flash product line includes flash chips and PC Card flash memory cards operating on 5 volts. Card capacities from 1 to 32 megabytes are available. AMD relies upon outside contractors to assemble its flash memory cards, as the firm's primary emphasis is upon chips. AMD introduced lines of 5 volt and 3 volt Miniature Cards in 1996.

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

AMP INCORPORATED
Harrisburg, PA 17105

1996 total net sales: $5,468,028,000 Net income: $286,984,000

AMP manufacturers electronic hardware and electrical and electronic connectors. The firm produced a line of flash memory cards ranging from 128 kilobytes to 16 megabytes, selecting Atmel, AMD and Intel chips for its flash memory cards. In 1993, the firm acquired a minority interest in card producer New Media. AMP produced some flash cards not fully compliant with the computer oriented PC Card interface specification, but suitable for use with industrial equipment. In 1997, AMP sold its flash memory card operations to M-Systems.

AURA ASSOCIATES
2605 South Winchester Boulevard
Campbell, CA 95008

Aura Associates, founded by disk drive industry veterans in mid-1986, initially planned to develop a 2.5" drive using multiple actuators and offering very fast access time and transfer rate. An early model of the drive was demonstrated at the 1988 Fall Comdex, but was never produced. More recently, Aura designed 1.8" drives which were produced by NEC, but for which Aura also retained manufacturing and sales rights. The firm began shipments of PC Card Type III rigid disk drives in 1993, but suspended sales due to market weakness. More recently, the company undertook a development program for an electronic camera using PC Card Type III drives, but ceased operations in mid-1997.

AVATAR SYSTEMS CORPORATION
1455 McCarthy Boulevard
Milpitas, CA 95035

Avatar was founded in 1991 by John Bizjak, a veteran of several pioneering disk drive programs, to develop high capacity disk cartridge drives. The company started production of an 85 megabyte 2.5" disk cartridge drive in mid-1993, using glass disks, and intended for portable and desktop applications. After management changes in 1994, emphasis was placed on 170 megabyte drive models, primarily for OEM markets. After more management changes in 1996, emphasis is now being placed on 250 megabyte drive models targeted at distribution markets. Drive development is centered in Milpitas, using a manufacturing facility established in Thailand in 1995.

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

1996 total net sales: $704,669,000 Net income: $10,281,000

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.

CELESTICA INC. (Subsidiary of Onex)
844 Don Mills Road
North York, Ontario M3C 1V7
Canada

Celestica got into the flash card business as a contract manufacturer of flash memory cards for IBM Microelectronics. The firm was planning to introduce its own brand of card after its acquisition by Onex, a contract assembler for the auto industry, but plans were subsequently put on hold and no flash cards have yet been announced.

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

1996 total net sales: $33,412,000 Net income: ($4,282,000)
(FY ending 6/30/96)

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

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

1997 total net sales: $917,154,000 Net income ($46,156,000)
(FY ending 3/29/97)

Cirrus Logic is a producer of specialized controller and interface chips and related products. The company entered the PC Card market in 1995 with a line of flash disk cards based on Samsung 16 megabit NAND logic chips. The company sells complete cards or portions thereof to OEM customers. Production began in mid-1995, but was terminated in late 1996 when Cirrus sold its flash memory card operations to a group of managers, who subsequently formed Lexar Microsystems.

INTEGRAL PERIPHERALS
5775 Flatiron Parkway
Boulder, CO 80301

Integral Peripherals was founded in September, 1990, by engineering and management personnel who previously pioneered in early 2.5" drives at Prairie-

Tek. 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 a 42 megabyte model, in production since early 1992, and a succession of higher capacity models which followed. The existing 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 mobile computer applications.

The company has pioneered in utilizing untextured disks in higher capacity models, a technique made possible by using the ramp loading head method to avoid parking heads on the disk surface. Integral began its high volume manufacturing in Singapore in mid-1992, moved into a new plant in 1995 and has added 1.8" drives with up to 340 megabytes, with a 510 megabyte model announced, all in PC Card Type III format. In 1995, Integral added 2.5" drives as the beginning of a new product family, the result of a design contract with Samsung Electronics to provide designs for 2.5" drives, with both companies entitled to manufacture the drives involved. After finding a cool market reception for latecomers to the 2.5" disk drive business, Integral switched to 3" drives in 1997, while maintaining its existing 1.8" PC Card drive family.

INTEL CORPORATION
2200 Mission College Boulevard
Santa Clara, CA 95052

1996 total net sales: $20,847,000,000 Net income: $5,157,000,000

Aside from being the leading manufacturer of microprocessors, Intel manufactures flash chips, flash memory cards and flash disk cards ranging from 1 megabyte to 40 megabytes. Production of the flash memory cards began in 1993, while the flash disk cards began shipments in mid-1994. The company tends to emphasize flash memory over flash disk, and expanded its flash memory offerings during 1995 and 1996, but discontinued its flash disk products. Intel is also the leading promoter of the Miniature Card small form factor flash memory card. Intel's initial flash production program was delayed due to problems at several Japanese firms used for chip production, but demand and capacity are now balanced. 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

1996 total net sales: $75,947,000,000 Net income: $5,429,000,000

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

IBM Microelectronics Division originally supplied IBM's PC Card flash disk cards, but has transferred the responsibility to IBM Japan. 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.

IOMEGA CORPORATION
1821 West Iomega Way
Roy, UT 84067

1996 total net sales: $1,212,769,000 Net income: $57,328,000

Iomega, founded in 1980, was successful in establishing production for its unique 8" flexible disk drive, which maintained control of head/disk contact with the Bernoulli effect. The product was originally intended as an OEM drive, but Iomega had much better luck with subsystems for the personal computer add-on market. The original 8" drives for the IBM PC market provided most of the company's revenue until displaced by the 5.25" models in production from 1987 to 1996. But time passes on, and the Bernoulli drive product line is now out of production, as Iomega moves on to new products with much larger markets.

Attempting to broaden its product coverage, Iomega licensed the Insite Peripherals "floptical" drive and media, and selected Chinon as a manufacturing partner for the drive. Iomega's 20 megabyte "floptical" drive was introduced in 1992, but was discontinued in 1994 after only limited sales success. That venture convinced Iomega's management that a comparable drive with higher capacity and the right price could be a success. The result was the 100 megabyte "Zip" 3.5" floppy drive, which began shipments in early 1995, and has found a much broader market, due to its unique combination of 100 megabyte disk capacity and low list price. Iomega has announced that more than seven million Zip drives have been shipped.

The one gigabyte "Jaz" drive, which first shipped in late 1995, marked Iomega's entry into the rigid cartridge disk drive market. The Jaz was produced for

Iomega under contract by Sequel until the Autumn of 1996, then Iomega moved manufacturing to its own factory in Penang, which was purchased in 1996 from Quantum, when that company discontinued internal manufacturing of high-end rigid disk drives. The Penang factory now produces Jaz and Zip drives and media.

KINGSTON TECHNOLOGY CORPORATION
17600 Newhope Street
Fountain Valley, CA 92708

Kingston, founded in 1987, manufactures mostly memory upgrades for personal computers, servers, workstations and printers, but also supplies flash disk cards, some of its own manufacture and others made for the firm by third parties.

LEXAR MICROSYSTEMS, INC.
47421 Bayside Parkway
Fremont, CA 94538

Lexar, a manufacturer of flash disk components and cards, was created in 1996 when a group of managers bought out the flash memory operations of Cirrus Logic. The current product line includes PC Card and Compact Flash form factor flash disk cards. Lexar is also a major supplier of controller chips to other manufacturers of flash disk cards.

MAGICRAM, INC.
1850 Beverly Boulevard
Los Angeles, CA 90057

MagicRAM, founded in 1990, develops and manufactures PC Card products and DRAM memory upgrades for notebook computers. Some of the firm's flash memory cards are internally manufactured, others are provided by third parties. Since 1994, MagicRAM has been evolving from being only an OEM manufacturer to a firm with both manufacturing and distribution capability.

MICRON TECHNOLOGY, INC.
8000 South Federal Way
Boise, ID 83707

1996 total net sales: $3,653,800,000 (FY ending 8/29/96)   Net income: $593,500,000

Micron Technology, a major manufacturer of DRAM, SRAM and flash memory components, has indicated its intent to ship disk memory cards from 10 megabyte to 100 megabyte capacity in the second half of 1997 using Micron's own devices. The nonvolatile memory products will be produced by Micron Quantum Devices, a Micron Technology subsidiary. Some of the Micron cards will be in small form factor formats.

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

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

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

NEW MEDIA MEMORY CORPORATION
23561 Ridge Route Drive, Suite N
Laguna Hills, CA 92653

New Media produces flash memory cards ranging from 256 kilobytes to 8 megabytes in capacity. The firm was originally known as New Media Corporation, but separated from that organization in 1997. AMP purchased a minority interest in the company, but AMP and New Media produced separate PC Card flash memory product lines.

RAYMOND ENGINEERING
217 Smith Street
Middletown, CT 06457

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

SANDISK CORPORATION
140 Caspian Court
Sunnyvale, CA 94089

1996 total net sales: $97,599,000 Net income: $14,485,000

Founded in 1988 as SunDisk, SanDisk is today the largest producer of flash disk ATA interfaced PC Card memories. In mid-1995, the company changed its name from SunDisk to SanDisk to avoid confusion with other organizations. Products range from 1.8 megabyte to 175 megabytes in capacity. Matsushita Electronics, NEC and LG Group produce the chips for SanDisk, which are then mounted on boards by Anam, a Korean contract manufacturer. Final card assembly is done in Thailand by still another contractor. In 1993, Seagate acquired a 25% interest in SanDisk, and for a while distributed the SanDisk cards on a nonexclusive basis, an activity which ceased in 1995. Other announced SanDisk customers include Motorola, Seiko Epson and Verbatim. SanDisk has entered into a number of alliances with other firms for development of suitable chips, including NEC, with which it is working on 256 megabit chips for production in 1997. Also in 1997, SanDisk invested $45 million in a joint venture semiconductor manufacturing facility with United Microelectronics Corporation, in Taiwan. SanDisk's first direct foundry investment, the facility is expected to start production by the end of 1998, with SanDisk guaranteed 12.5% of the production.

SanDisk is the primary sponsor of Compact Flash (CF), a small form factor card with an ATA interface. CF, which has acquired its own trade association, was the first of the small form factor formats to enter the market, and its acceptance by manufacturers of digital cameras and other digital consumer equipment places SanDisk in a potentially advantageous position as these consumer markets develop.

SEAGATE TECHNOLOGY
920 Disc Drive
Scotts Valley, CA 95066

1997 total net sales: $8,940,020,000 Net income: $658,040,000
(FY ending 6/30/97)

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. Conner Peripherals was acquired in early 1996. Seagate currently manufactures 2.5", 3.5" and 5.25" rigid drives, all above 420 megabytes in capacity. A 43 megabyte 1.8" PC Card Type III rigid disk drive was announced in 1993, but was subsequently dropped. The firm also produces many of its own components, including heads, media and semiconductors.

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

SIMPLE TECHNOLOGY INCORPORATED
3001 Daimler Street
Santa Ana, CA 92705

STI is a manufacturer of PC Cards and memory upgrades. The flash memory product line includes both linear flash and flash disk cards, the latter introduced in 1996.

SMART MODULAR TECHNOLOGIES
4305 Cushing Parkway
Fremont, CA 94538

1996 total net sales: $401,800,000 Net income: $25,100,000
(FY ending 10/31/96)

Formed in 1988, rapidly growing SMT is a specialist in add-on and add-in memory card products, especially in SIMM and DIMM format. Modems and other card products are also manufactured. The company began selling PC Card flash memory cards in 1992, with designs based upon Intel and AMD chips, and later expanded production to include Compact Flash and Miniature Cards. In addition to factories in California, the firm also manufactures in Scotland and Puerto Rico. The firm produces products on a contract basis for computer and other system manufacturers, and also distributes them through its Apex Division.

SWAN INSTRUMENTS
3000 Olcott Street
Santa Clara, CA 95054

Swan Instruments, founded in 1984, is a producer of rigid disk drive head testing instruments and fixtures. It is also among the ranks of the few firms developing high capacity flexible disk drives, and in 1994 announced a high capacity floppy disk drive in a 3.5" form factor, with the combination of fixed and removable metal powder flexible disks. Swan had licensed technology for high capacity floppy drives previously developed by Antek Peripherals, and which was subsequently also licensed to Mitsumi Electric. After a prolonged legal contest, a truce was signed, with an agreement that both Mitsumi and Swan have the rights to manufacture the drives, but that initially Mitsumi will concentrate on the drives and Swan on the disks. The currently announced 130 megabyte 3.5" drive will be backward compatible with 1.44 megabyte standard 3.5" diskettes, with initial production promised for 1997.

SYQUEST TECHNOLOGY
47071 Bayside Parkway
Fremont, CA 94538

1996 disk sales: $75,100,000
1996 total net sales: $200,400,000 Net income: ($136,700,000)
(FY ending 9/30/96)

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

In the 1990's, SyQuest increased the capacity of its 5.25" cartridge disk drive series to 88 megabytes, then to 200 megabytes. A 3.5" disk cartridge drive program resulted in first shipments of 105 and 270 megabyte models in 1993. SyQuest also manufactures the disk cartridges for the drives, and cartridges account for about half of the firm's revenue. A unique 1.8" drive was announced in 1995, utilizing a disk cartridge designed to be removable from a PC Card Type III disk drive, but the project was stopped in early 1996.

The EZ135, a 135 megabyte drive marketed as a counter to the high capacity floppy lomega "Zip" drive, began shipping in mid-1995, but the product was a major financial drain and production was stopped in mid-1996. SyQuest has suffered financial difficulties since mid-1995, as the result of costs which were higher than expected for the EZ135, combined with significant penetration of traditional SyQuest markets by both the lomega Zip drive and the Jaz 1 gigabyte rigid disk cartridge drive. As the result of the company's continuing financial losses, a major management reorganization was undertaken, 60% of the company's employees were laid off, and the company's activities were refocused on new products. The 230 megabyte EZFlyer 3.5" drive replaced the EZ135, and the new 1.5 gigabyte SyJet went into production in early 1997, with the mission to reclaim the high-end disk cartridge market from the lomega Jaz.

VISIONTEK
1175 Lakeside Drive
Gurnee, IL 60031

Privately held VisionTek was founded in 1988, functioning originally as a memory broker. The firm rapidly developed manufacturing capabilities and now makes a variety of memory cards and PC Card products that are sold through distribution. While flash memory shipments were all resale as of publication time, production of PC Card format flash memory cards with ATA interfaces was planned for the fourth quarter of 1996, with follow-on production of Compact Flash memories anticipated for 1997. However, the company has deferred production plans for the time being and is not manufacturing memory cards.

Asian Manufacturers

(All fiscal years end in March, 1997, unless otherwise noted. All companies are in Japan unless otherwise noted.)

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

1997 total net sales: $4,195,054,000 Net income: $44,539,000

Alps Electric is a diversified manufacturer of electronic components and subassemblies for television, audio, instruments and computer applications. Printers, keyboards, mice and disk drives together account for approximately 26% of Alps' revenues. The firm's initial surge in floppy drive shipments came in 1981, with a rapid buildup of shipments to Apple Computer.

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

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

Carry Computer provides a variety of PC Card based products, including memories, modems, network interface cards and card "drives". The memory cards range from 2 to 20 megabytes in capacity and include flash memory, flash disk and Compact Flash types.

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

1996 total net sales: $306,624,000 Net income: ($39,627,000)

Chinon is best known for its cameras and lenses, but much of its sales come from equipment for information systems. Eastman Kodak held approximately 12.3% ownership for many years, but is now increasing its investment and assuming control. 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 also appeared under Chinon's own label for use with IBM and Apple personal computers. A 128 megabyte optical 3.5" drive was announced in 1992 and began shipping in early 1993, but is now out of production.

The firm introduced its flexible disk drive product line in 1984, eventually consisting of half high 5.25" drives and 3.5" microfloppies. In mid-1992, Chinon established Chinon Asia Private Ltd., a Singapore based company, to manufacture flexible disk drives. Chinon and Iomega had an agreement for Chinon to manufacture the "floptical" disk drive that Iomega licensed from Insite Peripherals. Due to the limited size of the 20 megabyte floptical drive market, Iomega discontinued the product and the Chinon production program was terminated. After several years in decline, the Chinon floppy drive program was discontinued in 1996.

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

1997 total net sales: $3,612,089,000 Net income: $89,759,000

Citizen is steadily expanding its diversification into additional products, from its basic position of strength as Japan's second largest watch manufacturer. Watches are 55% of sales. In addition to printers, displays, and small computers, Citizen introduced 3.5" microfloppies in 1984, offering the first one inch high floppy drive, and began an aggressive sales program in the U.S. and Europe, aimed at the OEM market.

In 1989, Citizen again led the industry in drive packaging, this time with the first introduction of 19 millimeter high 3.5" floppy disk drives, followed in 1990 with drives only 15 millimeters high. A 20.6 megabyte (formatted) floppy drive using metal powder media was announced in late 1989, and since dropped due to weak market reaction. In late 1992 Citizen announced the thinnest 3.5" floppy drive to date, only 11 millimeters in height, and production began in 1993.

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

1997 total net sales: $11,510,544,000 Net income: $784,602,000

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

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

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

1997 total net sales: $41,399,835,000 Net income: $424,223,000

Fujitsu is Japan's largest producer of computer systems and also manufactures a wide variety of other electronic equipment. Computer products represent about 66% of Fujitsu's 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. Through its aggressive pricing, Fujitsu is the leading supplier of 230 megabyte 3.5" optical drives. The firm is one of the pioneers in developing the market for the 640 megabyte 3.5" optical disk drive.

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

1997 total net sales: $78,351,000,000 Net income: $812,006,000

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

The company has been active in the flash chip market for several years, and has developed its own flash cell AND architecture, announced in 1992, which combines features of NAND and NOR architectures. In early 1994, Hitachi and Mitsubishi Electric announced they would jointly develop and market 16 megabit and 64 megabit flash memory products. Each firm will second source the other's chips. A small quantity of low capacity PCMCIA flash memory cards were made by Hitachi in 1994, but the firm's primary effort is expected to be in the chip area with 16 megabit or larger chips. Hitachi and Mitsubishi coannounced 16 megabit chips in late 1995, following with 64 megabit chips in late 1996.

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

Hyundai is manufacturing 4 megabit and 16 megabit flash memory chips for sale to other companies and for use in its own line of flash memory cards (introduced in 1996), which extend from 1 to 20 megabytes. The firm also had a majority ownership in a U.S. subsidiary, LaserByte, which produced 3.5" optical drives until it ceased operations in 1995.

KINGMAX TECHNOLOGY INC.
295, Section 2, Kuang Fu Road
Hsin-Chu City, Taiwan

Kingmax is a manufacturer of integrated circuit cards, including flash memory cards, as well as computer memory modules, SRAM, Fax/Modem and Ethernet cards. The firm's original flash products were linear flash, but flash disk cards were added in 1996 and small form factor cards in 1997.

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

1997 total net sales: $7,486,330,000 Net income: $263,716,000

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

MCI introduced a .7 megabyte 2" floppy drive that was adopted by Zenith in 1989 for use in a notebook computer but was otherwise shunned by the computer industry. The company made several attempts to pioneer various internally developed high capacity floppy drive configurations, most with only modest improvement over standard 5.25" and 3.5" floppy drive capacities. In 1996, MCI took a license from Iomega, and will produce the Zip 100 megabyte drive.

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

1997 total net sales: $70,563,633,000 Net income: $1,267,264,000

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

Matsushita is a flash foundry for SanDisk, and is expanding its capabilities to design and produce flash chips and derivative products. 16 megabit chips have been used since 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.

PC Card 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 16 megabytes. The company announced in mid-1997 that it would also manufacture Compact Flash cards with capacities from 4 to 32 megabytes.

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

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

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

1997 total net sales: $5,713,559,000 Net income: $193,519,000

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

MKE is manufacturing the second generation 120 megabyte floptical drive known as the LS-120, with sales through Matsushita companies and O.R. Technology. Production started in the second half of 1996.

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

1997 total net sales: $34,245,192,000 Net income: $78,351,000

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). 3.3 volt chips went into production in late 1995. The firm currently offers flash memory cards based upon Intel chips with capacities ranging from 256 kilobytes to 20 megabytes. Flash disk cards are available in capacities to 75 megabytes.

A family of half high 5.25" floppy drives was introduced in 1982, and Mitsubishi started shipping 3.5" microfloppy drives in 1983. Mitsubishi became a major supplier of flexible disk drives to IBM, following the IBM introduction of PS/2 in 1987, and in 1991 the firm introduced a 2.88 megabyte 3.5" drive which remained in production until 1997, with IBM as the major customer. In 1996, Mitsubishi obtained a license to manufacture LS-120 high capacity floppy drives, and started production before the end of that year. After several years of flexible disk drive production at Mitsubishi's Koriyama Works, Melco Manufacturing (Thailand), a joint venture for the manufacture of floppy drives was established with Kang Yong Electric Manufacturing Co. The joint venture is largely owned by Mitsubishi.

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

1997 total net sales: $1,320,261,000 Net income: $67,614,000

Mitsumi is a leading manufacturer of electronic subassemblies and components, including magnetic heads. Floppy disk drives represent about 13% of sales. The firm established a joint venture facility with Commodore, named Newtronics, to produce 5.25" and 3.5" floppy drives, and acquired complete ownership of Newtronics in 1986. During the last few years, Mitsumi has established a pattern of high growth in floppy drive sales, the result of low cost manufacturing operations and the company's aggressive pricing policy. Mitsumi has established a manufacturing facility in Malaysia for floppy disk drives and began manufacturing at Cebu Mitsumi in the Philippines in early 1992.

One inch high 3.5" drives went into production in 1987, followed by 3/4 inch high drives in 1989 and 12.7 millimeter high 1.44 megabyte drives in 1991. The company announced a 128 megabyte 3.5" floppy drive based on an Antek Peripherals design in November, 1995. However, production was delayed pending resolution of a patent licensing dispute with Swan Instruments, which has now been settled. It was agreed that both companies will have the rights to manufacture the drives, but it is expected that initially Mitsumi will produce the drives, with Swan arranging for diskette manufacturing. The currently announced 130 megabyte 3.5" drive will be backward compatible with 1.44 megabyte standard 3.5" diskettes, with initial production promised for 1997.

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

1997 total net sales: $45,505,000,000   Net income: $1,114,000,000

NEC has defined its product area as communications and computers, with computer products accounting for about 46% of 1995 revenues. The firm has the largest share of the Japanese PC market. NEC makes a variety of data storage products, including floppy, rigid, CD-ROM and 3.5" optical disk drives.

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

Starting in 1978 the company manufactured two sided 8" floppy disk drives, and was one of the earliest firms to offer half high 8" floppy drives, with shipments starting in late 1981, and not phased out until 1996. 3.5" microfloppy drives and half high 5.25" drives were introduced in 1984. The majority of NEC's floppy drive shipments have been for captive applications.

NEC was an early participant in the high capacity floppy drive market with the 1988 introduction of a 3.5" 9.4 megabyte drive for sale with its microcomputer systems. A 10 megabyte version with downward compatibility to .7 and 1.44 megabyte drives was introduced in 1990. NEC was very active on the JEIDA committee working to standardize high capacity 3.5" floppy disk drives, and announced a 21.4 megabyte drive. NEC high capacity floppy drive production for its own designs was limited, and all have been dropped. In 1997, NEC announced that it has taken an Iomega license to manufacture the Zip 100 megabyte drives. Also in 1997, the NEC division responsible for notebook computers announced that it will use the new 12.7 millimeter high LS-120 drives in some of its notebook computer models.

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

1997 total net sales: $2,854,174,000 Net income: $21,346,000

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

Olympus began marketing under its own brand name in 1992 when it introduced a 3.5" 128 megabyte drive. This was followed by a 230 megabyte version in early 1994. At that time the firm also announced 5.25" full height and half height MO drives. A high performance 3.5" MO drive was introduced in 1995, followed by a 640 megabyte drive in 1996. A direct overwrite version was added in 1997.

O.R. TECHNOLOGY, INC.
Subsidiary of O.R. Computer System Pte. Ltd.
42 West Campbell Avenue
Campbell, CA 95008

O.R. Technology, Inc., was formed in November, 1995, as a combination of Insite Peripherals and Optics Research. 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 at the beginning of the 1990's. Trademarked as the "floptical", the drive used 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, 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 attempted to achieve mainstream status through licensing of established drive and media manufacturers, with Iomega as the first announced licensee. 3M and Hitachi Maxell were granted licenses as media producers, and made equity investments in Insite.

Despite establishment of reliable drive and media manufacturing sources, the Insite drive's price was 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 were unwilling to add floptical drives as standard products. The market was confined to storage subsystems builders active in the add-on market and to OEM sales for specialized applications. In order to develop a higher capacity drive with a potentially larger market, several of the companies participating in the floptical program established Optics Research in Boulder, Colorado, to undertake development of a 120 megabyte backward compatible version of the floptical drive. Before completion of the project, Iomega dropped out of the program, in order to develop its own high capacity floppy drive, without backward compatibility, which was introduced in 1995 as the "Zip" 100 megabyte drive. The Optics Research program resulted in the 1995 introduction of the LS-120, with drives to be manufactured by Matsushita-Kotobuki Electronics and media to be supplied by 3M (now Imation).

In the meantime, 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, Insite was sold to O.R. Computer, a subsidiary of Ocean Radio Group, based in Singapore. 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 was continued and sales of the 20 megabyte floptical continued until 1996. With the start of MKE's production of the 120 megabyte LS-120 in the second half of 1996, O.R. Technology has sold the drive through distribution and system integrator channels, in addition to direct sales by Matsushita to system manufacturers, such as Compaq Computer. In October, 1996, O.R. announced the completion of a contract manufacturing arrangement with Kaifa Group, which is expected to result in the start of production of LS-120 drives in China in the second half of 1997.

SAMSUNG ELECTRO-MECHANICS CO., LTD.
314, Maetan 3 Dong, Paldai-Ku, Suwon
Kyungki-Do, Korea

1995 total net sales: $1,669,193,000 (FY ending 12/95) — Net income: $43,727,000

Part of the Samsung electronics business group, Samsung Electro-Mechanics is a diversified electronics component manufacturer with almost 10,000 employees. In 1995, the firm began a major expansion into automotive parts, and in the same year the Samsung Electronics floppy disk drive business was transferred to Samsung Electro-Mechanics. Samsung Electronics got started in floppy drive production in 1983 when Shugart Associates granted a license to manufacture and market the Shugart floppy drives in South Korea. Samsung Electro-Mechanics produces most components used in its floppy drives internally, with a concentration on 3.5" low capacity floppy drives in both one inch high and half inch high models.

SAMSUNG ELECTRONICS CO., LTD.
250 Taepyengno 2-ga, Chung-Gu
Seoul, Korea

1996 total net sales: $19,719,930,000 (FY ending 12/96)   Net income: $203,919,000**

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 company's revenues are derived from information systems and related products. The company also produces rigid and optical disk drives. An active product development center for disk drives has been established in the United States. Samsung Electronics is using Toshiba's NAND memory architecture in a family of flash chips. The firm has licensed Toshiba's SSFDC small form factor card, but otherwise prefers to manufacture chips rather than 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 has also manufactured a portable computer, displays, and floppy, optical and rigid disk drives. Seiko Epson announced a 128 megabyte 3.5" optical disk drive in 1992. However, the firm has elected to remarket certain 3.5" and 5.25" optical drive models rather than produce them internally.

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

The first Epson floppy drive was a captive 5.25" one third high unit first shipped in 1982 and used with the Epson portable computer. In 1983, Epson added an OEM floppy drive product line of 5.25" and 3.5" models, including 3.5" drives with very low power requirements, and in recent years concentrated on standard 3.5" floppy drive models. In 1996, the company started manufacturing the Iomega Zip drive, selling the drives under the Epson label, as well as producing them under contract for Iomega. However, Seiko Epson decided in mid-1996 that the profit opportunities in the flexible disk drive business were insufficient, and closed out production of both low capacity and high capacity floppy drives.

S.F.R.
7-5-17 Nakazato
Tendo-shi, Yamagata 994

S.F.R., founded in October, 1988, originally was called Digital Systems, Inc., and later adopted the name of its major distributor, Japan Peripherals Network (JPN). In 1991, the firm adopted Safronic Corporation as its name, with JPN remaining a separate organization distributing peripherals, including floppy disk drives made by Safronic, and transitioned to the S.F.R. name in 1995. The company has used contract manufacturing sources for half high 5.25" drives and 1.44 megabyte 3.5" drives, and in the second half of 1993 started production in China through a contract manufacturing arrangement managed by a Hong Kong firm. Sales are mostly through distribution.

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

1997 total net sales: $16,460,563,000 Net income: $446,277,000

Founded in 1935, Sharp originally made mechanical pencils. Sharp is now a supplier of electrical and electronic equipment for both consumer electronics and office automation. About 49% of the company's sales are derived from computer or computer related products, including desktop and transportable personal computers. Sharp is a Sony licensee for the 2.5" MiniDisc system and is expected to incorporate the MiniDisc in future equipment for the consumer market. In the flash memory area, Sharp has been one of Intel's foundry operations for flash memory chips. Sharp also markets chips under its own name.

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

1997 total net sales: $52,060,434,000 Net income: $1,282,037,000

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 two thirds of revenues. Sony is also a leading manufacturer of magneto-optic disk drives and high performance CD-ROM drives. The company is vertically integrated and supplies its own media, and is currently the largest producer of magneto-optic media.

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

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

In 1981 Sony introduced the first drive using a 3.5" flexible diskette, which became the industry's floppy drive standard after several years of struggling with other formats for market dominance. After several generations of floppy drives, Sony's product line evolved into low-cost models in the standard 25.4 and 12.7 millimeter package heights, and the company remains one of the industry production leaders. Sony pioneered the submicrofloppy field with a very high bandwidth .7 megabyte 2" floppy disk drive based upon a Mavica video camera storage device, but the data version of the 2" drive did not find a following in the computer industry.

TAE IL MEDIA CO., LTD.
456-1 Moknae-Dong, Ansan-Shi
Kyonggi, Korea

1995 total net sales: $328,075,000 (FY ending 12/95)   Net income: $5,590,000

Tae Il was established in 1983 and has grown into a diversified manufacturer of components for disk drives and other computer industry products, as well as a manufacturer of personal computers, monitors and printers. In 1996, the company initiated production of floppy drives and CD-ROM drives. In addition to manufacturing facilities in South Korea, Tae Il is establishing production for many of its products at a large-scale manufacturing plant in Harbin, China.

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

1997 total net sales: $1,300,368,000   Net income: $34,767,000

TEAC is best known for its leadership position in the flexible disk drive industry, but the firm also has been active in recent years in developing its CD-ROM product line. Shipments of 5.25" floppy drives for the OEM market started in 1978, and in 1985 TEAC announced its line of 3.5" drives, including a 1.44 megabyte model and subsequently added one inch high models.

Rapid growth made TEAC the leader in worldwide noncaptive floppy drive revenues during the early 1990's, and the company did not lose the industry's shipment leadership until 1996. The firm joined Toshiba in 1987 in announcing 2.88 megabyte 3.5" floppy drives using barium ferrite media, but without significant results. 19 millimeter high 3.5" drives were introduced in 1989, and in 1991 TEAC introduced the industry's first 12.7 millimeter high 3.5" floppy disk drive, moving to the front in the race to downsize microfloppy drives. TEAC has made manufacturing and licensing arrangements with a number of firms in Japan, Korea, and other countries. Much of TEAC's current production has been moved to Malaysia. The company has also established a drive component manufacturing operation in Singapore.

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

1997 total net sales: $50,101,000,000 Net income: $1,153,705,000

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 62% of sales revenues are related to data communications or computer products. Toshiba is a leading producer of 2.5" rigid disk drives, and also manufactures CD-ROM drives. The firm also proposed, but did not market, a 1.3 gigabyte 3.5" phase change optical drive.

Toshiba's flash memory program dates back to the mid-1980s, although the firm was unable to capitalize financially on its early participation. In later years the company developed a high performance NAND flash architecture, and is currently supplying chips to several customers, including IBM Microelectronics and National Semiconductor. Toshiba has entered into flash memory development agreements with other firms as well, including licensee Samsung Electronics, with which it is developing 64 megabit chips. Toshiba's flash memory and flash disk cards were announced in late 1994. The cards currently use 16 megabit chips. Toshiba is one of the founding members of SSFDC (Solid State Floppy Disk Card association) and a primary sponsor of that format. Toshiba subsequently renamed the SSFDC format as "SmartMedia".

Toshiba was an early manufacturer of 8", 5.25" and 3.5" floppy drives. High capacity barium ferrite media was developed by Toshiba for 2.88 megabyte 3.5" floppies, with production of drives and media starting in 1988, and several other firms licensed the drive and media. In the 1990's, Toshiba deemphasized floppy drive manufacturing, and relied on contract manufacturing arrangements for its floppy drive product line, and eventually discontinued the program.

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

Founded in 1988, Transcend is a manufacturer of controllers, printer memory, memory boards and copy protection devices. Flash memory PC Cards range from 2 megabytes to 20 megabytes in capacity. The firm has also begun to supply flash disk cards for use with digital cameras.

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

1996 total net sales: $158,222,000 Net income: ($7,093,000)

Y-E Data is a spin-off of Yaskawa Electric, a diversified manufacturer of heavy electric, factory automation and data processing equipment. Data processing products are the responsibility of Y-E Data, which first manufactured 8" one sided floppy drives in 1974 under an Orbis license. In addition to its drive manufacturing activities, Y-E Data supplies drive kits to manufacturers in India, mainland China and other Asian countries.

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

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

European/Middle Eastern Manufacturers

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

Calluna Technology was founded to design and manufacture 1.8" drives in Glenrothes. The founders were all veterans of Rodime, the pioneer manufacturer of 3.5" drives, 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 disk drives in the PCMCIA Type III PC Card format in mid-1993. The PC Card drive product line has since been expanded, and currently includes drives with capacities up to 520 megabytes. Production of the 520 megabyte drive was initiated in 1997, utilizing a contract manufacturing arrangement with Xyratex, the firm which resulted from a management buy out of IBM's facilities at Havant, U.K.

MEMORY CARD TECHNOLOGY
Saralyst Alle 53
DK-8270 Aarhus/Hojbjerg
Denmark

MCT is a manufacturer of memory upgrade products for computers and computer peripherals, with marketing operations in Europe and the United States. The product line includes PC Card flash memories.

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

1996 total net sales: $11,750,000 Net income: ($987,000)

Founded in 1989, M-Systems offers flash memory cards and supporting flash file system software, allowing the flash memory cards to emulate disk drives. Flash memory cards from 1 to 64 megabytes are available, including an extended operating temperature series. The company, along with SCM Microsystems, was a cosponsor of the FTL (Flash Translation Layer) standard used with flash memory cards. In 1996, the firm introduced FLite, flash file system software for use with consumer electronics and embedded applications. FLite brings a DOS-like file capability to processor based equipment that does not use DOS, allowing card interchange with PC based readers.

In mid-1997, M-Systems made several acquisitions, including Pretec and its Taiwan parent, C-One, followed by the flash memory card business of AMP. C-

One continues to operate as a wholly owned subsidiary, providing M-Systems with a stronger manufacturing and marketing posture in Asia.

NOMAI
188, rue de la Liberte -- B.P. 141
50301 AVRANCHES cedex
France

Nomai entered the data storage market in 1992 as a manufacturer and marketer of rigid disk drive cartridges compatible with SyQuest 5.25" drives. After a flurry of legal actions by SyQuest were settled, Nomai was successful in setting up extensive distribution for the disk cartridge product line, including the temporary enlistment of Iomega as a reseller.

In 1995, the company announced the development of high capacity 3.5" rigid disk cartridge drives, with initial shipments starting at the end of 1995. The basic 540 megabyte drive design was done in Scotland by Myrica (U.K.) Limited, a design firm staffed with Rodime graduates, with technology assistance from universities in the U.K. and France. The drive is being manufactured at Havant in the U.K. by Xyratex, the IBM spin-off, and is sold by both Nomai and Xyratex. In the Spring of 1997, Nomai added a 750 megabyte disk cartridge drive to its product line, also manufactured by Xyratex.

SCM MICROSYSTEMS GMBH
Pettenkoferstrasse 7
D-85276 Pfaffenhofen
Germany

SCM has been active in flash memory storage products since 1990, developing a flash card host module enabling computers to accept flash cards. The firm, with M-systems, also proposed a flash filing system, much of which was incorporated into the PC Card standards. In November, 1994, SCM announced a line of flash memory cards, but the firm emphasizes its flash card reader product line rather than the cards themselves.

SGS-THOMSON MICROELECTRONICS
20041 Agrate Brianza
Italy

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

DTDISK-1

DISK/TREND ON DISK

1997 DISK/TREND REPORT

DISK/TREND ON DISK

Introduction

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

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

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

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

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

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

Note: Please read the license on the following page.

DISK/TREND ON DISK

Information License

DISK/TREND supplies diskettes containing selected information from the 1997 DISK/TREND Report as a separately purchased option to subscribers to the corresponding 1997 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, Lotus and Lotus 1-2-3 are trademarks of International Business Machines Corporation.
MS-DOS is a trademark of Microsoft Corporation.
AutoImport is a trademark of White Crane Systems, Inc.

Getting started

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

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

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

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

STATISTICAL TABLES

Loading and Installation

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

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

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

   TYPE A:READ.ME>PRN

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

   COPY A:?T*.*

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

   COPY A:*.PRN (if using the Lotus 1-2-3 data parsing commands)
   COPY A:MASK?2.MSK (if you are using AutoImport version 2.xx)
   COPY A:MASK?3.MSK (if you are using AutoImport version 3.xx)

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

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

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

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

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

   /FR<filename>

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

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

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

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

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

If you don't use AutoImport

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

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

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

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

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

Using AutoImport

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

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

MASK TABLE

Mask File Name	Rigid Report	Removable Report	Optical Report	Array Report
MASKA	<-------- Table 1--------->		Tables 1,2	Table 1
	<-------------- Product Group Revenue ------------------>			
	<-------------- Product Group Shipment ----------------->			
MASKB	<-------- Table 2 -------->		Tables 3,4	Table 2
MASKC	Tables 3,4,6,9, 10,11	Tables 3 to 6, 11,12,24,25	Tables 5 to 12	Tables 3 to 7
MASKD	<-- All Product Group Application Tables ---->			N/A
MASKE	N/A	Drive height, Drive capacity	Write-Once/ Erasable Analysis	N/A
MASKH	Tables 7,8	Table 29	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	1997 Rigid Report	1997 Removable Report	1997 Optical Report	1996 Array Report
1	MASKA	MASKA	MASKA	MASKA
2	MASKB	MASKB	MASKA	MASKB
3	MASKC	MASKC	MASKB	MASKC
4	MASKC	MASKC	MASKB	MASKC
5	MASKC	MASKC	MASKC	MASKC
6	MASKC	MASKC	MASKC	MASKC
7	MASKH	--	MASKC	MASKC
8	MASKH	--	MASKC	--
9	MASKC	MASKA	MASKC	--
10	MASKC	MASKA	MASKC	MASKA
11	MASKC	MASKC	MASKC	MASKA
12	--	MASKC	MASKC	--
13	--	--	--	--
14	MASKA	MASKI	--	--
15	MASKA	--	--	--
16	--	MASKI	--	MASKA
17	--	--	MASKA	MASKA
18	MASKD	MASKI	MASKA	--
19	MASKI	--	--	--
20	--	MASKI	--	--
21	MASKA	--	MASKD	MASKD
22	MASKA	MASKA	--	--
23	--	MASKA	MASKA	MASKA
24	--	MASKC	MASKA	MASKA
25	MASKD	MASKC	--	--
26	MASKI	MASKA	--	--
27	--	MASKA	MASKD	--
28	MASKA	MASKA	--	--
29	MASKA	MASKH	MASKA	MASKA
30	--	MASKD	MASKA	MASKA
31	--	--	--	--
32	MASKD	MASKA	--	--
33	MASKI	MASKA	MASKD	--
34	--	--	--	--
35	MASKA	--	MASKA	
36	MASKA	MASKI	MASKA	
37	--	MASKD	--	
38	--	--	--	
39	MASKD	MASKA	MASKE	
40	MASKI	MASKA	MASKD	
41	--	--	--	
42	MASKA	--	MASKA	
43	MASKA	MASKD	MASKA	
44	--	--	--	
45	--	MASKA	--	
46	MASKD	MASKA	MASKA	
47	MASKI	--	MASKA	

Cross-reference (continued)

Table Number	1997 Rigid Report	1997 Removable Report	1997 Optical Report	1996 Array Report
48	--	--	--	
49	MASKA	MASKD	--	
50	MASKA	--	MASKE	
51	--	MASKA	MASKA	
52	--	MASKA	MASKA	
53	MASKD	--	--	
54	MASKI	--	--	
55	--	MASKE	MASKE	
56	MASKA	MASKE	MASKA	
57	MASKA	MASKD	MASKA	
58	--	--	--	
59	--		--	
60	MASKD		MASKE	
61	MASKI		MASKA	
62	--		MASKA	
63	MASKA		--	
64	MASKA		--	
65	--		MASKE	
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:MASK?2.MSK (If using AutoImport version 2.xx)
   COPY A:MASK?3.MSK (If using AutoImport version 3.xx)

   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. Press 'ENTER' (or double click on the selected name). Now position the cursor on the "RETRIEVE MASK" button and select it to load the mask.

4. Select Input file name option on the File Selection Menu.

   Enter the name of the file, <u>including the extension</u>, which will be of the form yy? where yy is the year of the report and ? is the report type as above.

   Examples: RT4.97R OT14.97O AT19.97A VT3.97V

5. Select the Output file option on the File Selection menu. (Should always be done after mask retrieval.)

   Enter the name of the file. The file name form recommended is ?Tnn, where ? is the type of report (A, R, V, or O), T is just that, and nn is the DISK/TREND Report table number matching the file being translated. You should not enter the file name extension as the system adds it automatically for you.

   Examples: RT4 OT14 AT20 VT23

6. The default spreadsheet type to which translation is made is Lotus 1-2-3 version 2.x. If you wish to translate to a different spreadsheet format you may choose it by selecting Format from the File Selection menu and then selecting your preference from the menu of choices displayed.

7. You are ready to translate. Recheck all the file names displayed to be CERTAIN they are correct. Select "CONVERT" button using the mouse (or arrow keys and ENTER). If you are asked "Do you want to load input file *.* named in mask", answer "NO". You will see the file being translated scroll by as the translation proceeds. If it does not scroll during translation, you may have a damaged mask file. See the next section for details on mask file creation.

8. If you want to do more translations, repeat from step 3.

9. When you are done translating, leave AutoImport by typing /Q, or use the mouse to select "Quit" on the menu bar to return to the AutoImport main menu, to leave AutoImport and return to DOS. It will save you some keystrokes if you copy your new spreadsheet files to your spreadsheet directory. If you are using a two floppy system, just remove the AutoImport disk from drive A and substitute your spreadsheet disk.

Mask Generation

1. Start AutoImport as above. When the opening screen appears, select "File" using the mouse or type /F.

2. Name the input file you will use as the template to create the mask. The file name will be of the form ?Tnn.yy?, where ? is the type of report (R, O, V or A), nn is the table number and yy is the report year.

   Example: OT10.97O, VT3.97V

   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 top left 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: VT3. You don't need to enter the file extender.

7. To make more masks, repeat from step 2. To quit the mask function, type /QY (quit).

Other AutoImport Functions

AutoImport can do much more than the functions described above, which are those concerned with a basic understanding of how to create spreadsheets from DISK/TREND ON DISK files. See the separate AutoImport manual provided for details of these other functions.

SPECIFICATION TABLES

Loading

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

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

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

    TYPE A:READ.ME>PRN

2. Do this step if you have a hard disk. Log into the hard disk directory in which your spreadsheet normally stores worksheet files. Using the DOS "COPY" command, copy all the specification table files to the hard disk.

    COPY A:?S*.*

3. Now you are ready to start Lotus 1-2-3 or other spreadsheet. If you are using a two floppy system, place the DISK/TREND disk in drive B and the Lotus spreadsheet system disk in drive A. If you are using a rigid disk system, place the spreadsheet system disk in floppy drive A. If your spreadsheet is not Lotus 1-2-3, you will have to translate the data from Lotus 1-2-3 to your format. Almost all spreadsheet packages of recent vintage are able to do this translation. After translation, if needed, start your spreadsheet as usual. After obtaining the blank spreadsheet image on the screen, use the spreadsheet File Retrieve command to select a file. The equivalent Lotus 1-2-3 command is: /FR<filename>

    The file names are in the format XSYZZ.WK1 or XSYZZ.WKS, depending upon which version of Lotus 1-2-3 you are using. X,Y, and Z are:

    X= O (Optical disk drive data)
    R (Rigid disk drive data)
    C (Cartridge rigid disk drive data)
    S (Semiconductor flash card data)
    F (High capacity and low capacity flexible disk drive data)

    In the case of the Removable Data Storage Report, there will be separate specification tables for Optical, Rigid, Cartridge rigid disk, High and Low capacity flexible disk drive and Semiconductor flash card data.

Y= Table number. Usually, there is only one table for each type of data, but if the specification file is so large as to need multiple disks to hold it, there may be several.

ZZ=Year of report.

Example: OS197 Optical disk drive specification table.
RS197 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: **650-961-6209**

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.