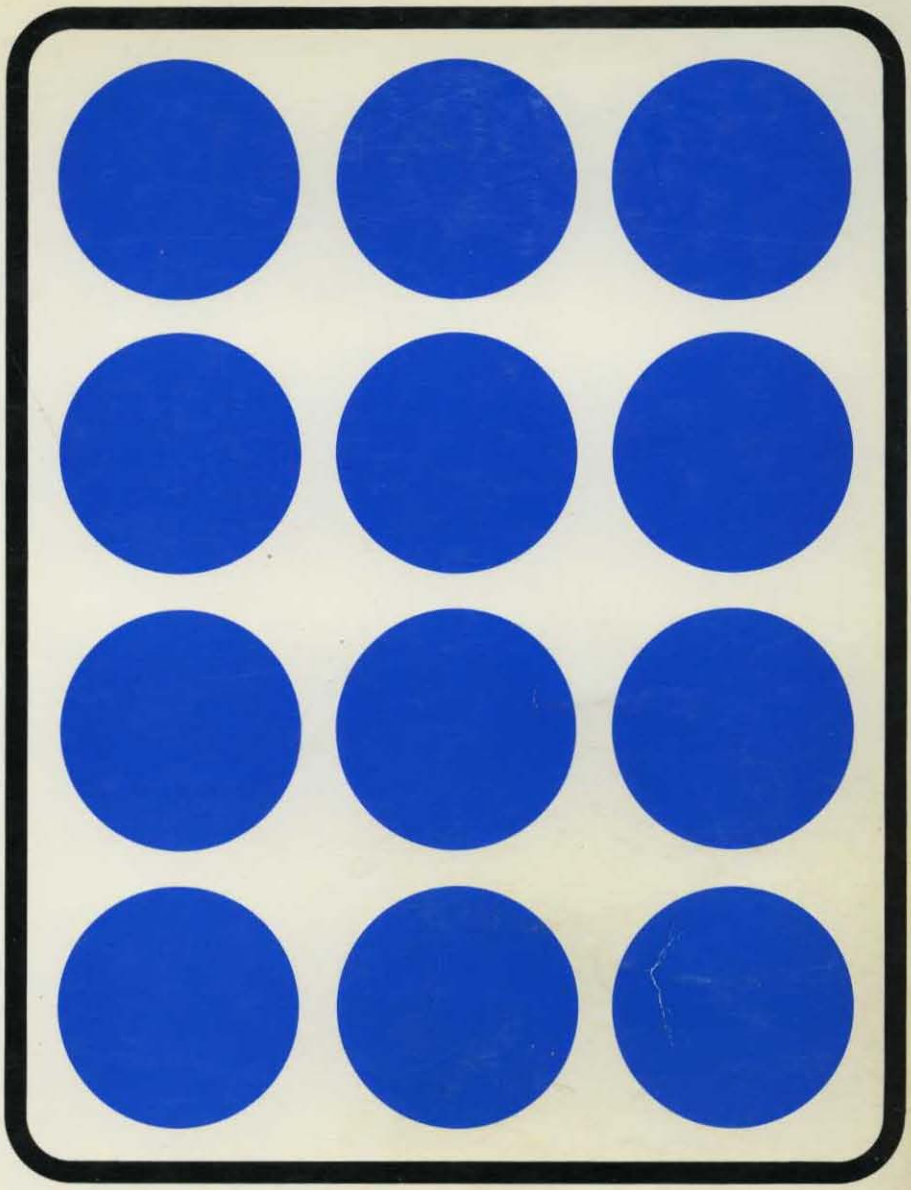
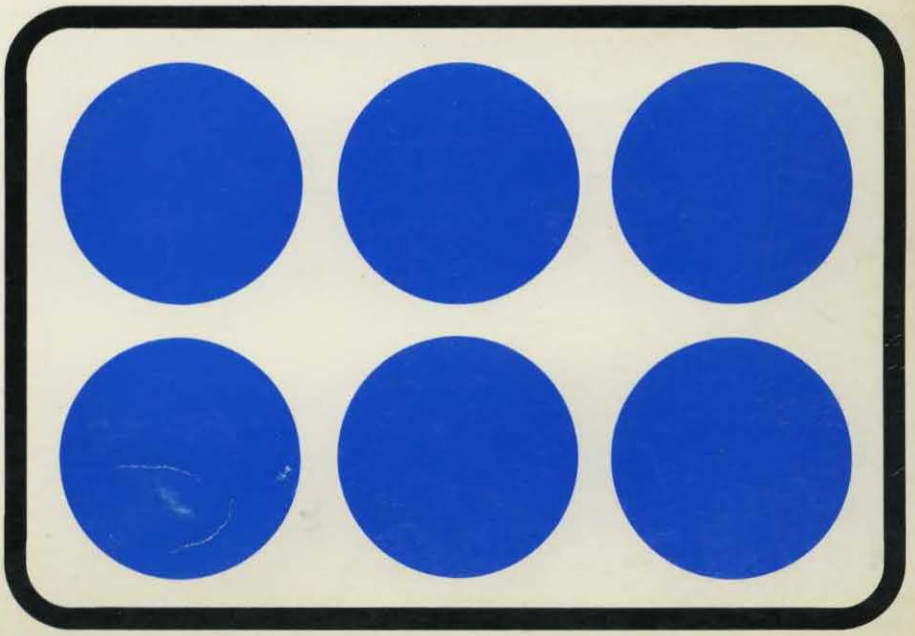


1986 DISK/TREND® REPORT



RIGID DISK DRIVES

1986 DISK/TREND® REPORT

RIGID DISK DRIVES

October, 1986

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FOREWORD

We lost another ten companies during the last year. The disk drive industry is a very tough place to exist unless your product line is kept up to date, and you are a low cost producer, and you attain a major market share, and your management thinks clearly and works long days.

The same rules apply to most businesses in free markets, of course. It's just that the short product life cycles in the disk drive industry make everything so frantic. We suspect that most survivors have a sense of satisfaction, and a few make a lot of money.

The DISK/TREND Report is now ten years old, and has grown to three volumes, including the first report of optical disk drives, which was published in July. This report on rigid disk drives will be followed, as usual, with a separate report of flexible disk drives to be released in November.

We are always willing to help you at any time by providing additional information on the industry which we may have available. And, as always, we welcome and appreciate your suggestions for improvements in the DISK/TREND report.

James N. Porter

Robert H. Katzive

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INTRODUCTION

Here are some changes in the DISK/TREND Report that will be helpful

As always, we try to keep the DISK/TREND Report's format as consistent as possible from year to year, so that regular readers will find it simpler to use. Nevertheless, we also try to improve clarity of the information presented, and to add new material as appropriate. Here are this year's additions:

* Application summaries have been added for each product group, showing worldwide unit shipments broken down into seven categories, with estimates for 1985 and projections for 1989. As a baseline, manufacturers throughout the world have helped us pinpoint the applications in which their drives are used, and we have combined this information with the DISK/TREND database to prepare the first comprehensive estimate of rigid disk drive applications.

* As a convenience to readers, year-to-year growth rates, expressed as percentage change notations, have been added to the disk diameter breakdown tables in each product group, as well as to several of the tables in the summary section.

* This year's report on rigid disk drives doesn't contain detailed information on optical disk drives, as the 1985 edition did. Optical disk drives are now covered in a separate report, published for the first time in July of this year.

Same time next year, but...

We do not revise the main groups into which data for this report is organized very frequently, recognizing that many DISK/TREND users employ the same groups in their internal plans, but we have concluded that next year will be one of those occasions. Several changes will be made in the 1987 DISK/TREND Report on rigid disk drives:

* Both of the existing disk cartridge drive groups will be combined into a single group, due to the low shipment level for low-end disk cartridge drives.

* Both of the existing disk pack drive groups will be combined, also because of declining shipments.

* Fixed disk drives with more than 500 megabytes capacity will be split into two groups, since the total revenues in this product range are now so great. One group will cover 500-1000 megabyte drives and another group will cover drives over 1000 megabytes.

SUMMARY: RIGID MAGNETIC DISK DRIVES

Industry size

1985's revenue growth rate was well below the traditional level for the rigid disk drive industry, and 1986 is going to be even lower. 30.2% revenue growth in 1984 was followed by 15.1% in 1985, and 1986's estimated revenue of $15,050,500,000 represents an increase of only 9.7%. However, DISK/TREND forecasts for the 1987-89 period indicate a recovery to an average annual growth of 19.6%.

Overall growth for OEM drives was held down in 1985 by declining shipments of older 14" models, but OEM revenues are increasing by 30.9% in 1986, outpacing all other distribution channels. Manufacturers of high end 5.25" drives are seeing the largest gains, but all OEM fixed disk drive groups are growing rapidly.

IBM's disk drive revenues were 46.3% of the industry's total for 1985, and are expected to hover in the mid-40% range through 1989, reaching $12,350,800,000 in that year. IBM's 1986 revenues are growing at a rate of only 8.9%, well below normal, due to a soft market for the company's 3380 drive family.

Other captive disk drive manufacturing programs are undergoing the same change from 14" drives to smaller drives that is already well advanced in the OEM drive segment of the market. As a result, captive revenues were down for many producers in 1985 and 1986, with a recovery for most firms expected in 1987-89, during which growth rates should average 21.5%.

TABLE 1

CONSOLIDATED WORLDWIDE REVENUES

ALL EXISTING MOVING HEAD DISK DRIVE GROUPS

REVENUE SUMMARY

	DISK DRIVE REVENUES, BY SHIPMENT DESTINATION ($M)									
	1985		Forecast							
	Revenues		1986		1987		1988		1989	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM Captive	3,655.5	6,351.1	4,155.6	6,914.9	4,973.6	8,314.3	6,796.3	11,321.0	7,482.0	12,350.8
Other U.S. Captive	1,153.3	1,937.2	869.9	1,461.6	1,434.7	2,261.3	1,728.5	2,711.2	1,739.3	2,793.1
TOTAL U.S. CAPTIVE	4,808.8	8,288.3	5,025.5	8,376.5	6,408.3	10,575.6	8,524.8	14,032.2	9,221.3	15,143.9
PCM	129.0	190.3	136.2	187.6	347.4	475.7	461.5	657.4	729.6	1,075.4
OEM	1,480.1	1,911.7	1,964.4	2,566.6	2,204.7	2,899.6	2,241.6	2,980.4	2,249.4	3,060.0
TOTAL U.S. NON-CAPTIVE	1,609.1	2,102.0	2,100.6	2,754.2	2,552.1	3,375.3	2,703.1	3,637.8	2,979.0	4,135.4
TOTAL U.S. REVENUES	6,417.9	10,390.3	7,126.1	11,130.7	8,960.4	13,950.9	11,227.9	17,670.0	12,200.3	19,279.3
Non-U.S. Manufacturers										
Captive	75.9	1,682.2	65.9	1,940.0	77.5	2,390.9	89.5	2,785.1	105.0	3,179.5
PCM	170.4	499.4	178.4	543.9	276.0	664.6	342.2	759.8	496.8	1,105.2
OEM	454.2	1,144.9	565.0	1,435.9	715.8	1,707.5	877.5	1,932.1	1,031.0	2,084.0
TOTAL NON-U.S. REVENUES	700.5	3,326.5	809.3	3,919.8	1,069.3	4,763.0	1,309.2	5,477.0	1,632.8	6,368.7
Worldwide Recap										
TOTAL WORLDWIDE REVENUES	7,118.4	13,716.8	7,935.4	15,050.5	10,029.7	18,713.9	12,537.1	23,147.0	13,833.1	25,648.0

Marketing channels

The list of disk drive manufacturers is shrinking slightly again this year, with the worldwide total now at 70 companies, down two from last year. Asian manufacturers are still being added to the list: New this year are Fuji Electric, Toyo Soda and YE Data. 21 Asian firms, mostly Japanese, are now on the list. 11 European organizations are now listed, growing one this year with the addition of SAGEM.

Nine U.S. manufacturers were deleted from last year's list. Most of these companies had market shares too small to justify continuing in the industry. The change of fortunes was especially notable in the case of Computer Memories, which was left with a negligible share of the 5.25" fixed disk drive market after IBM ceased to be a customer at the end of 1985. Three new firms have been added -- Brand Technologies, Conner Peripherals and Memory Systems -- to bring the U.S. total to 38 companies.

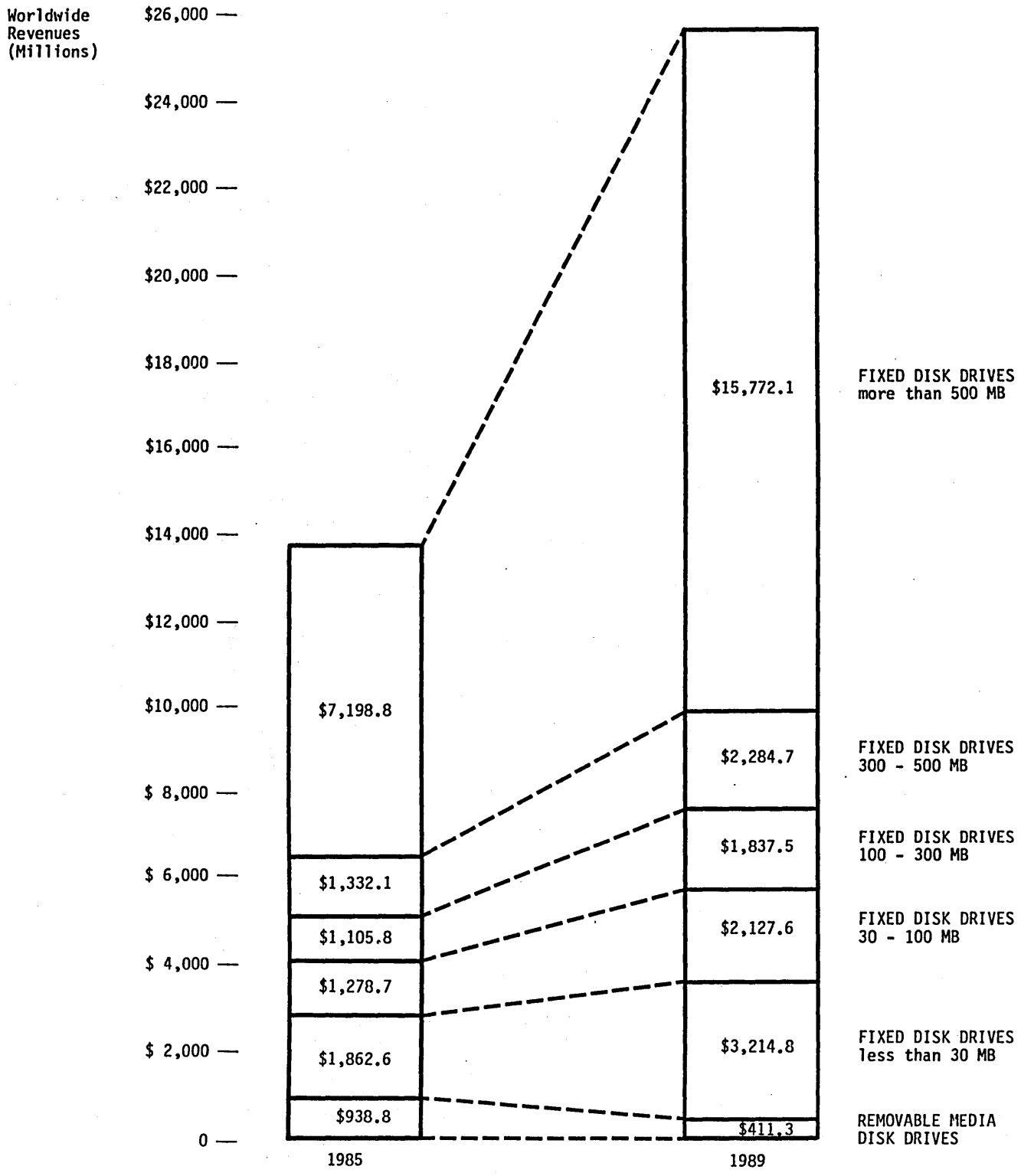
Users of the DISK/TREND Report should note that revenues are reported at the level of each drive's first public sale. The price used for each drive is the estimated value at the first time it is sold to a non-affiliated buyer, at captive end user, PCM or OEM levels. Prices are based on disk drives alone, without controllers or other accessories, and leased drives are valued at the price they would command if actually sold.

An understanding of the relative price levels of captive, PCM and OEM drives is important in interpreting DISK/TREND revenue statistics, to avoid an exaggerated impression of the share of the industry's total unit shipments held by captive drives. An approximation of the OEM value of typical captive drives can be obtained by dividing captive revenues for most types of drives by a factor of 4 to 5.

Figure 1

CHANGING PRODUCT MIX

CONSOLIDATED WORLDWIDE RIGID DISK DRIVE REVENUES



Product mix

Worldwide shipments of fixed disk drives with capacities less than 30 megabytes were 67.8% of the industry's 1985 total. Now composed mostly of 5.25" and 3.5" models, the group's 1985 worldwide shipments of 3,287,100 drives are forecasted to swell to 9,457,000 units in 1989, with 3.5" drives comprising more than 90% of that year's total. However, it should be noted that although drives in this group constitute about two thirds of the industry's unit shipments, they made up only 13.6% of 1985's worldwide revenue, with 12.5% forecasted for 1989.

The other four DISK/TREND product groups for fixed disk drives are also continuing a healthy pattern of overall growth in revenues and shipments. The few instances of negative revenue growth shown for fixed disk drives in Table 3 are caused by shipment declines for older 8" and 14" drives, which were typically sold at higher average unit prices than the smaller diameter drives which have replaced them.

The continuing slide in average unit prices also causes the revenue growth rates for all of the fixed disk drive groups to fall below unit shipment growth rates through 1989, when expressed as percentages. Nevertheless, the revenue total for all fixed disk drives is forecasted at $25,236,700,000 for 1989.

Removable disk drives, already only a shadow of their previous importance to the industry, are expected to drop to $411,300,000 in revenues for 1989, 1.6% of the industry total. The only group of removable disk drives expected to maintain a pattern of growth is disk cartridge drives over 12 megabytes, mostly small diameter models.

TABLE 2

CONSOLIDATED WORLDWIDE REVENUES
RIGID MAGNETIC DISK DRIVES

MARKET CLASS REVIEW
REVENUE SUMMARY

WORLDWIDE REVENUES BY MANUFACTURER TYPE	1985 Revenues $M	1985 Revenues %	1986 Forecast $M	1986 Forecast %	1987 Forecast $M	1987 Forecast %	1988 Forecast $M	1988 Forecast %	1989 Forecast $M	1989 Forecast %
U.S. Manufacturers										
IBM Captive	6,351.1	46.3%	6,914.9	45.9%	8,314.3	44.4%	11,321.0	48.9%	12,350.8	48.1%
	+36.4%		+8.9%		+20.2%		+36.2%		+9.1%	
Other U.S. Captive	1,937.2	14.1%	1,461.6	9.7%	2,261.3	12.0%	2,711.2	11.7%	2,793.1	10.8%
	-15.8%		-24.6%		+54.7%		+19.9%		+3.0%	
PCM	190.3	1.3%	187.6	1.2%	475.7	2.5%	657.4	2.8%	1,075.4	4.1%
	-11.3%		-1.4%		+153.6%		+38.2%		+63.6%	
OEM	1,911.7	13.9%	2,566.6	17.0%	2,899.6	15.4%	2,980.4	12.8%	3,060.0	11.9%
	-2.1%		+34.3%		+13.0%		+2.8%		+2.7%	
Total U.S. Manufacturers	10,390.3	75.6%	11,130.7	73.8%	13,950.9	74.3%	17,670.0	76.2%	19,279.3	74.9%
	+13.9%		+7.1%		+25.3%		+26.7%		+9.1%	
Non-U.S. Manufacturers										
Captive	1,682.2	12.2%	1,940.0	12.8%	2,390.9	12.7%	2,785.1	12.0%	3,179.5	12.3%
	-.2%		+15.3%		+23.2%		+16.5%		+14.2%	
PCM	499.4	3.6%	543.9	3.6%	664.6	3.5%	759.8	3.2%	1,105.2	4.3%
	+11.5%		+8.9%		+22.2%		+14.3%		+45.5%	
OEM	1,144.9	8.6%	1,435.9	9.8%	1,707.5	9.5%	1,932.1	8.6%	2,084.0	8.5%
	+73.8%		+25.4%		+18.9%		+13.2%		+7.9%	
Total Non-U.S. Manufacturers	3,326.5	24.4%	3,919.8	26.2%	4,763.0	25.7%	5,477.0	23.8%	6,368.7	25.1%
	+19.1%		+17.8%		+21.5%		+15.0%		+16.3%	
Worldwide Recap										
Captive	9,970.5	72.7%	10,316.5	68.5%	12,966.5	69.3%	16,817.3	72.7%	18,323.4	71.4%
	+15.4%		+3.5%		+25.7%		+29.7%		+9.0%	
PCM	689.7	5.0%	731.5	4.9%	1,140.3	6.1%	1,417.2	6.1%	2,180.6	8.5%
	+4.1%		+6.1%		+55.9%		+24.3%		+53.9%	
OEM	3,056.6	22.3%	4,002.5	26.6%	4,607.1	24.6%	4,912.5	21.2%	5,144.0	20.1%
	+17.0%		+30.9%		+15.1%		+6.6%		+4.7%	
Total All Manufacturers	13,716.8	100.0%	15,050.5	100.0%	18,713.9	100.0%	23,147.0	100.0%	25,648.0	100.0%
	+15.1%		+9.7%		+24.3%		+23.7%		+10.8%	

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

TABLE 3

CONSOLIDATED WORLDWIDE REVENUES
RIGID DISK DRIVES
PRODUCT CATEGORY REVIEW

REVENUE SUMMARY

WORLDWIDE REVENUES ALL MANUFACTURERS	1985 Revenues $M	1985 Revenues %	Forecast 1986 $M	1986 %	1987 $M	1987 %	1988 $M	1988 %	1989 $M	1989 %
DISK CARTRIDGE DRIVES less than 12 Megabytes	102.7 -50.1%	.7%	70.7 -31.2%	.5%	56.8 -19.7%	.3%	35.7 -37.1%	.2%	18.9 -47.1%	.1%
DISK CARTRIDGE DRIVES more than 12 Megabytes	167.1 -38.2%	1.2%	153.5 -8.1%	1.0%	136.6 -11.0%	.7%	137.9 +1.0%	.6%	130.2 -5.6%	.5%
DISK PACK DRIVES less than 100 Megabytes	220.3 -32.0%	1.6%	168.5 -23.5%	1.1%	153.7 -8.8%	.8%	125.1 -18.6%	.5%	127.1 +1.6%	.5%
DISK PACK DRIVES more than 100 Megabytes	448.7 -24.6%	3.3%	382.6 -14.7%	2.5%	307.0 -19.8%	1.6%	218.7 -28.8%	.9%	135.1 -38.2%	.5%
FIXED DISK DRIVES less than 30 Megabytes	1,862.6 +12.2%	13.6%	2,074.6 +11.4%	13.8%	2,265.4 +9.2%	12.1%	2,738.5 +20.9%	11.8%	3,214.8 +17.4%	12.5%
FIXED DISK DRIVES 30 - 100 Megabytes	1,278.7 -1.9%	9.3%	1,909.0 +49.3%	12.7%	2,098.0 +9.9%	11.2%	2,157.0 +2.8%	9.3%	2,127.6 -1.4%	8.3%
FIXED DISK DRIVES 100 - 300 Megabytes	1,105.8 +11.6%	8.1%	1,118.5 +1.1%	7.4%	1,447.4 +29.4%	7.7%	1,691.0 +16.8%	7.3%	1,837.5 +8.7%	7.2%
FIXED DISK DRIVES 300 - 500 Megabytes	1,332.1 +8.8%	9.7%	1,292.7 -3.0%	8.6%	1,794.8 +38.8%	9.6%	2,111.9 +17.7%	9.1%	2,284.7 +8.2%	8.9%
FIXED DISK DRIVES more than 500 Megabytes	7,198.8 +34.8% +36.1	52.5%	7,880.4 +9.5%	52.4%	10,454.2 +32.7%	55.9%	13,931.2 +33.3%	60.3%	15,772.1 +13.2%	61.5%
Total Worldwide Revenue	13,716.8 +15.1% +15.6	100.0%	15,050.5 +9.7%	100.0%	18,713.9 +24.3%	100.0%	23,147.0 +23.7%	100.0%	25,648.0 +10.8%	100.0%
% U.S. Mfg.	75.7%		73.9%		74.5%		76.3%		75.1%	

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

TABLE 4

CONSOLIDATED WORLDWIDE SHIPMENTS
RIGID DISK DRIVES
PRODUCT CATEGORY REVIEW

UNIT SHIPMENT SUMMARY

UNIT SHIPMENTS IN THOUSANDS	1985 Shipments Units	1985 Shipments %	1986 Forecast Units	1986 Forecast %	1987 Forecast Units	1987 Forecast %	1988 Forecast Units	1988 Forecast %	1989 Forecast Units	1989 Forecast %
DISK CARTRIDGE DRIVES less than 12 Megabytes	55.9 -37.3%	1.2%	37.5 -32.9%	.5%	28.0 -25.3%	.3%	15.4 -45.0%	.1%	5.8 -62.3%	--
DISK CARTRIDGE DRIVES more than 12 Megabytes	73.4 +34.4%	1.5%	104.1 +41.8%	1.4%	119.6 +14.9%	1.2%	133.7 +11.8%	1.1%	142.2 +6.4%	1.0%
DISK PACK DRIVES less than 100 Megabytes	36.9 -16.7%	.8%	32.6 -11.7%	.4%	32.5 -.3%	.3%	29.6 -8.9%	.3%	31.3 +5.7%	.2%
DISK PACK DRIVES more than 100 Megabytes	34.9 -31.7%	.7%	31.7 -9.2%	.4%	28.9 -8.8%	.3%	21.4 -26.0%	.2%	13.8 -35.5%	.1%
FIXED DISK DRIVES less than 30 Megabytes	3,287.1 +29.9%	67.8%	4,709.4 +43.3%	63.5%	6,175.2 +31.1%	64.5%	7,816.0 +26.6%	66.2%	9,457.0 +21.0%	67.6%
FIXED DISK DRIVES 30 - 100 Megabytes	823.4 +65.3%	17.0%	1,793.5 +117.8%	24.2%	2,149.7 +19.9%	22.5%	2,445.0 +13.7%	20.7%	2,708.0 +10.8%	19.3%
FIXED DISK DRIVES 100 - 300 Megabytes	192.8 +55.1%	4.0%	269.8 +39.9%	3.6%	461.9 +71.2%	4.8%	623.9 +35.1%	5.3%	778.0 +24.7%	5.6%
FIXED DISK DRIVES 300 - 500 Megabytes	120.4 +29.9%	2.5%	175.2 +45.5%	2.4%	231.4 +32.1%	2.4%	313.1 +35.3%	2.6%	385.8 +23.2%	2.8%
FIXED DISK DRIVES more than 500 Megabytes	230.2 +38.6%	4.5%	261.6 +13.6%	3.5%	344.8 +31.8%	3.6%	424.4 +23.1%	3.5%	487.5 +14.9%	3.4%
Total Worldwide Shipments	4,855.0 +33.0%	100.0%	7,415.4 +52.7%	100.0%	9,572.0 +29.1%	100.0%	11,822.5 +23.5%	100.0%	14,009.4 +18.5%	100.0%
% U.S. Mfg.	66.8%		70.4%		68.2%		67.3%		66.6%	

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

OEM market

Product trends in the OEM segment of the disk drive industry usually foretell significant changes in captive drives a year or two in advance. The intense competition among manufacturers of OEM drives stimulates early development and introduction of new drive configurations -- frequently earlier than the managements of captive producers would prefer.

OEM drive manufacturers led the way in pioneering smaller diameter disk drives, and that thrust is continuing. Starting with the first shipment of the Seagate 5.25" 6 megabyte drive in 1980, OEM drive manufacturers have been pushing 5.25" drives into higher and higher capacity ranges, now capped by Maxtor's announced 765 megabyte drive promised for 1987 delivery. The full size 5.25" form factor, in turn, is losing ground to half high 5.25" drives. Over half of 5.25" fixed drives less than 30 megabytes are now half high models, as are a quarter of the 30-100 megabyte drives.

The 5.25" form factor is also being displaced by 3.5" drives in the group of fixed drives less than 30 megabytes. 3.5" drives already comprise almost a third of the 1986 shipments in this group, and next year are forecasted to edge over half of the total, with some help from IBM, which is expected to widely adopt 3.5" drives for its office personal computer family. The OEM drive pioneers are now moving up to the next capacity range, with several 3.5" drives now being introduced in the 30-100 megabyte product group.

Due to changes in product mix and declining average unit prices, 1985 worldwide OEM disk drive revenues rose only 17.0%, while unit shipments for all types of drives increased 30.2%. The 1986 worldwide OEM unit

shipment forecast for 1986 is up 54.7%, influenced heavily by excellent increases in volume for the fixed disk drive groups with capacities below 100 megabytes. However, the overall growth in worldwide unit shipments expected for 1987-89 is an average of 19.7% per year, with revenues growing an average of 8.8% per year.

Despite increased competition from Asian and European disk drive manufacturers, U.S. producers of OEM drives have been holding onto market share somewhat better than expected in 1986. The reasons are probably found in the vigorous rate of new product introductions by U.S. manufacturers, primarily in small diameter disk drives, and in the dramatic movement in the dollar/yen exchange rate. While the 64.1% of worldwide OEM revenues held by U.S. drive manufacturers in 1986 is down sharply from 1984's 74.7%, the outlook for 1989 is a healthy 59.4% -- a very respectable showing considering the level of competition involved.

TABLE 5

OEM WORLDWIDE REVENUES
RIGID DISK DRIVES
PRODUCT CATEGORY REVIEW

REVENUE SUMMARY

WORLDWIDE REVENUES ALL MANUFACTURERS	1985 Revenues $M	1985 Revenues %	1986 $M	1986 %	1987 $M	1987 %	Forecast 1988 $M	Forecast 1988 %	Forecast 1989 $M	Forecast 1989 %
DISK CARTRIDGE DRIVES less than 12 Megabytes	57.5	1.9%	44.5	1.1%	35.3	.8%	24.5	.5%	12.5	.2%
	~~+47.4%~~		-22.6%		-20.7%		-30.6%		-49.0%	
	-32.2									
DISK CARTRIDGE DRIVES more than 12 Megabytes	74.9	2.4%	66.2	1.7%	77.7	1.7%	87.6	1.8%	91.7	1.8%
	~~+41.1%~~		-11.6%		+17.4%		+12.7%		+4.7%	
	-33.0									
DISK PACK DRIVES less than 100 Megabytes	116.8	3.9%	109.6	2.7%	113.3	2.4%	109.8	2.2%	114.3	2.2%
	~~+20.8%~~		-6.2%		+3.4%		-3.1%		+4.1%	
	-23.0									
DISK PACK DRIVES more than 100 Megabytes	176.1	5.7%	161.8	4.0%	164.5	3.6%	124.9	2.6%	85.7	1.7%
	~~+34.7%~~		-8.1%		+1.7%		-24.1%		-31.4%	
	-36.9									
FIXED DISK DRIVES less than 30 Megabytes	984.3	32.3%	1,075.0	27.0%	1,259.3	27.4%	1,431.5	29.2%	1,650.4	32.2%
	~~+197.3%~~		+9.2%		+17.1%		+13.7%		+15.3%	
	+12.7									
FIXED DISK DRIVES 30 - 100 Megabytes	726.8	23.8%	1,189.8	29.7%	1,230.8	26.7%	1,199.7	24.4%	1,142.7	22.2%
	~~+64.7%~~		+63.7%		+3.4%		-2.5%		-4.8%	
	+50.6									
FIXED DISK DRIVES 100 - 300 Megabytes	355.4	11.6%	434.5	10.9%	601.1	13.1%	685.9	14.0%	740.4	14.4%
	~~+33.3%~~		+22.3%		+38.3%		+14.1%		+7.9%	
	+58.0									
FIXED DISK DRIVES 300 - 500 Megabytes	295.4	9.7%	432.0	10.8%	536.6	11.6%	600.4	12.2%	653.4	12.7%
	~~+54.7%~~		+46.2%		+24.2%		+11.9%		+8.8%	
	+60.6									
FIXED DISK DRIVES more than 500 Megabytes	269.4	8.7%	489.1	12.1%	588.5	12.7%	648.2	13.1%	652.9	12.6%
	~~+59.1%~~		+81.6%		+20.3%		+10.1%		+0.7%	
	101.2									
Total Worldwide Revenues	3,056.6	100.0%	4,002.5	100.0%	4,607.1	100.0%	4,912.5	100.0%	5,144.0	100.0%
	✓+17.0%		+30.9%		+15.1%		+6.6%		+4.7%	
% U.S. Mfg.	62.5%		64.1%		62.9%		60.6%		59.4%	

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

TABLE 6

OEM WORLDWIDE SHIPMENTS
RIGID DISK DRIVES
PRODUCT CATEGORY REVIEW

UNIT SHIPMENT SUMMARY

UNIT SHIPMENTS IN THOUSANDS	1985 Shipments Units	1985 Shipments %	1986 Units	1986 %	1987 Units	1987 %	Forecast 1988 Units	Forecast 1988 %	Forecast 1989 Units	Forecast 1989 %
DISK CARTRIDGE DRIVES less than 12 Megabytes	46.4	1.2%	32.4	.5%	24.3	.3%	14.0	.2%	5.0	--
	+207.3%		-30.2%		-25.0%		-42.4%		-64.3%	
	-25.0									
DISK CARTRIDGE DRIVES more than 12 Megabytes	62.0	1.6%	91.3	1.6%	109.5	1.5%	124.1	1.4%	133.4	1.4%
	+228.0%		+47.3%		+19.9%		+13.3%		+7.5%	
	+72.7									
DISK PACK DRIVES less than 100 Megabytes	26.6	.7%	26.1	.4%	28.1	.4%	28.6	.3%	30.5	.3%
	-4.7%		-1.9%		+7.7%		+1.8%		+6.6%	
	-18.9									
DISK PACK DRIVES more than 100 Megabytes	19.2	.5%	19.0	.4%	19.4	.2%	14.7	.2%	10.0	.1%
	-38.7%		-1.0%		+2.1%		-24.2%		-32.0%	
	-39.6									
FIXED DISK DRIVES less than 30 Megabytes	2,732.9	71.6%	3,847.7	65.1%	4,965.3	66.9%	6,018.0	68.3%	7,079.0	70.0%
	+477.3%		+40.8%		+29.0%		+21.2%		+17.6%	
	+20.5									
FIXED DISK DRIVES 30 - 100 Megabytes	723.6	19.0%	1,544.2	26.1%	1,721.6	23.2%	1,871.5	21.3%	1,979.0	19.5%
	+30.1%		+113.4%		+11.5%		+8.7%		+5.7%	
	+85.1									
FIXED DISK DRIVES 100 - 300 Megabytes	136.3	3.6%	209.7	3.6%	358.6	4.8%	470.0	5.3%	559.0	5.5%
	-76.8%		+53.9%		+71.0%		+31.1%		+18.9%	
	+87.7									
FIXED DISK DRIVES 300 - 500 Megabytes	52.7	1.3%	94.5	1.6%	147.3	2.0%	196.6	2.2%	240.0	2.4%
	-91.3%		+79.3%		+55.9%		+33.5%		+22.1%	
	+67.3									
FIXED DISK DRIVES more than 500 Megabytes	21.8	.5%	48.7	.7%	62.5	.7%	75.0	.8%	90.5	.8%
	-96.4%		+123.4%		+28.3%		+20.0%		+20.7%	
	+15.8									
Total Worldwide Shipments	3,821.5	100.0%	5,913.6	100.0%	7,436.6	100.0%	8,812.5	100.0%	10,126.4	100.0%
	+30.2%		+54.7%		+25.8%		+18.5%		+14.9%	
% U.S. Mfg.	66.7%		69.4%		65.8%		63.2%		61.2%	

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

TABLE 7

1985 ESTIMATED MARKET SHARES
WORLDWIDE REVENUES OF ALL RIGID MAGNETIC DISK DRIVES
(Value of non-U.S. currencies estimated at average 1985 rates)

	CAPTIVE		PCM		OEM		TOTAL INDUSTRY	
	$M	%	$M	%	$M	%	$M	%
U.S. MANUFACTURERS								
Burroughs	184.4	1.8	--	--	--	--	184.4	1.3
Century Data Systems	6.0	0.1	--	--	63.3	2.1	69.3	.5
Computer Memories	--	--	--	--	150.5	4.9	150.5	1.1
Control Data	759.1	7.6	47.1	6.8	513.0	16.8	1,319.2	9.6
Data General	136.0	1.4	--	--	--	--	136.0	1.0
Digital Equipment	536.4	5.4	--	--	--	--	536.4	3.9
Hewlett-Packard	258.3	2.6	--	--	.8	--	259.1	1.9
Ibis	--	--	--	--	31.2	1.0	31.2	.2
IBM	6,351.1	63.7	--	--	65.2	2.1	6,416.3	46.8
Maxtor	--	--	--	--	74.9	2.5	74.9	.5
Memorex	--	--	62.7	9.1	--	--	62.7	.5
Micropolis	--	--	--	--	93.2	3.0	93.2	.7
Microscience International	--	--	--	--	33.7	1.1	33.7	.2
Miniscribe	--	--	--	--	113.4	3.7	113.4	.8
Priam	--	--	--	--	104.2	3.4	104.2	.8
Quantum	--	--	--	--	125.9	4.1	125.9	.9
Seagate Technology	--	--	--	--	285.5	9.3	285.5	2.1
Shugart	24.9	.2	--	--	11.4	.4	36.3	.3
Storage Technology	--	--	80.5	11.7	4.7	.2	85.2	.6
SyQuest	--	--	--	--	36.3	1.2	36.3	.3
Tandon	--	--	--	--	70.5	2.3	70.5	.5
Other U.S.	32.1	.3	--	--	134.0	4.4	166.1	1.2
U.S. Total	8,288.3	83.1	190.3	27.6	1,911.7	62.5	10,390.3	75.7
NON-U.S. MANUFACTURERS								
Bull	39.8	.4	--	--	10.6	.3	50.4	.4
Fujitsu	484.2	4.9	228.3	33.1	386.9	12.7	1,099.4	8.0
Hitachi	274.1	2.7	227.9	33.0	140.3	4.6	642.3	4.7
ISOT	31.2	.3	--	--	133.3	4.4	164.5	1.2
Mitsubishi	29.3	.3	--	--	9.7	.3	39.0	.3
NEC	537.6	5.4	--	--	151.4	5.0	689.0	5.0
Nippon Peripherals	--	--	43.2	6.3	24.6	.8	67.8	.5
Olivetti	188.4	1.9	--	--	3.0	.1	191.4	1.4
Rodime	--	--	--	--	107.5	3.5	107.5	.8
Tokico	21.6	.2	--	--	17.4	.6	39.0	.3
Toshiba	44.8	0.5	--	--	56.0	1.8	100.8	.7
Other Non-U.S.	31.2	.3	--	--	104.2	3.4	135.4	1.0
Non-U.S. Total	1,682.2	16.9	499.4	72.4	1,144.9	37.5	3,326.5	24.3
WORLDWIDE TOTAL	9,970.5	100.0	689.7	100.0	3,056.6	100.0	13,716.8	100.0

NOTE: Drives sold in the PCM market by other than the original manufacturer are valued at PCM price levels above, to avoid distortion of total PCM market values.

Codes: 3 = 3"-3.9" C = Captive
5 = 5.25" P = PCM
8 = 8"-9" O = OEM
10 = 10.5"
14 = 14"

TABLE 8

CURRENT PRODUCT LINES
MANUFACTURERS OF MOVING HEAD MAGNETIC DISK DRIVES

DISK/TREND PRODUCT GROUP:		1	2	3	4	5	6	7	8	9
U.S. Manufacturers	Type	Disk Cartridge Drives <12 MB	Disk Cartridge Drives >12 MB	Disk Pack Drives <100 MB	Disk Pack Drives >100 MB	Fixed Disk Drives <30 MB	Fixed Disk Drives 30-100 MB	Fixed Disk Drives 100-300 MB	Fixed Disk Drives 300-500 MB	Fixed Disk Drives >500 MB
Alpha Data	O									14
Amcodyne	O		8							
Atasi	O						5	5		
Brand Technologies	O						5	5		
Burroughs	C				14			8,14		14
Century Data Systems	O				14			14	8,14	8,14
Cogito	O					5				
Conner Peripherals	O						3			
Control Data	O,C		8	8,14	14	5	5	5,8,14	8	8,14
Cybernex Adv. Storage Tech.	O						5	5		
Data General	C				14	8,14	14		14	14
Digital Equipment	C	14	8		14			14	14	
Hewlett-Packard	C,O		8		14	3,14	14	14	14	
Ibis	O									14
IBM	C,O					3,5,8	5,8	8,14	8,14	14
Josephine County Technology	O					5				
LaPine Technology	O					3				
Maxtor	O						5	5	5	
Memorex	C,P									14
Memory Systems	O						5			
Micropolis	O						5	5	5	
Microscience International	O					3,5	5			
Micro Storage	O		5							
Miltope	O		3,5				5	5		
Miniscribe	O					3,5	5	5		
Northern Telecom	O						8	8	8	8
Peripheral Technology	O					3	3			
Plus Development	O					3				
Priam	O						5,8,14	5,8,14	5,8	
Quantum	O					5,8	5,8	5		
Seagate Technology	O					5	5	5		
Storage Technology	O,P									14
SyQuest Technology	O	3	3			3	3			
Tandon	O					3,5	5			
Tecstor	O								14	
Tulin	O					5	5			
Western Dynex	O	5								
Xebec	O					5				
Asian Manufacturers										
Alps Electric	O					3,5				
Epson	C,O					3,5				
Fuji Electric	O					3				
Fujitsu	C,O,P		14			3,5,8	3,5,8	8,14	8,10,14	10,14
Hitachi	C,O,P					3,5,8	5,8	5,8	8	8,14
Matsushita Com. Ind.	O					3,5				
Mitsubishi	C,O					3,5	5	5,8	8	
NEC	C,O				14	3,5	5,8	5,8	8	8,14
Nippon Electric Industry	O					5				
Nippon Peripherals	O,P					3,5	3,5			14
Nippon Systemhouse	O	3				3	3			
Oki Electric	C,O					5	5			
Ricoh	C,O		5							
Otari	O					5				
TEAC	O					5	5			
Tokico	O					5	5			
Tokyo Electric	O					5				
Toshiba	C,O						5,8	5,8	8	8
Toyo Soda	O							5		
Victor Company of Japan	O					3				
YE Data	O						3			
European Manufacturers										
BASF	O					5	5			
Bull	C,O		5,10				5	10		
ISOT	C,O	14		14	14					
Kovo	C,O	14			14					
Newbury	O	5					3,5	5	5	
Nixdorf	C			14						
Olivetti	C,O					3,5	5			
Pertec	O							8	8	8
Rodime	O					3,5	5	5		
Sagem	O					5	5			
Siemens	O							5	5	

TECHNICAL REVIEW

Competing technologies

The large size and the high growth rate of the market for magnetic disk drives has inspired many attempts to apply other technologies in an attempt to capture a significant share of market. Of these competitive technologies, only a few remain as likely contenders.

Two perennial candidates for serious consideration as data storage technologies continue to show promise: Magnetic bubbles and optical disks. Bubbles are now used in many harsh environment applications and are being designed into selected data processing systems, such as portable computers. Some types of optical disks have now achieved the status of actual commercial products, with a few manufacturers making limited shipments. Both technologies will be discussed in more detail later in this section. A separate DISK/TREND report on optical disk drives published earlier this year covers the current market situation.

Sponsors of other would-be alternates to magnetic rigid disk recording, such as semiconductor memory, continue to find the competition tougher than expected. Magnetic disk technology is frequently described as a "moving target." As the target moves, it becomes continually more cost effective. The history of magnetic disk recording is one of continually improving recording densities, and this advancement translates directly into lower cost for data storage. Higher density means fewer heads and disks for a given capacity, thus reduced physical size, smaller motors, less heat, lower power, etc. And as densities have been improved, development in head positioning techniques has provided faster data access.

Great competitive strength is now derived from the size of the world-wide magnetic disk drive industry, which includes scores of well established manufacturers and an amazing diversity of products. System manufacturers, employing thousands of engineers making their data storage selection decisions, are comfortable and familiar with the magnetic disk drive industry, know the system integration requirements for disk drives, and have well established opinions on the credibility of specific manufacturers, based on extensive actual experience. These factors provide a high level of momentum for magnetic disk drives which will not be undercut by any potential alternative products soon, or without very good reason.

Among the technological newcomers, it is reasonable to expect those with outstanding strengths for specific applications to be successful in gradually developing selected niche markets. Today's leading candidates for commercial success are discussed in the following sections.

* Read-only optical disks: The read-only optical disk category is dominated by the CD-ROM. Storage capacities of 550 to 600 megabytes are typical of these products. CD-ROM technology borrows heavily from the designs of the 4.72" CD audio players now in volume production. CD-ROM acceptance benefits from industry agreement on the CD standards developed jointly by Sony and Philips. In addition to the 4.72" CD-ROM, which is limited in performance, high performance 12" read-only drives are being shipped by Reference Technology.

  It will be possible to use read-only media with write-once drives. 3M and other companies have proposed such media in a 5.25" format, but the low costs of the CD-ROM relative to read-write drives make it unlikely that read/write drives will significantly inhibit the growth of the CD-ROM market.

  Most read-only optical drives will be used with small systems to provide personal access to large amounts of information. The success of read-only optical disks, in general, depends upon the existence and timely development of a data base publishing industry willing to make use of the CD-ROM format to support its clients. As of mid-1986, there were relatively few titles available on CD-ROM, and of these, none seemed likely to be a major success.

Another significant factor is the need to have a common standard for recording format that allows disks to be interchanged between systems. While none yet exists, an ad hoc group of companies has proposed such a standard and submitted it to the appropriate standards committees.

* Non-reversible optical disks: The first optical disk recording systems to enter the market are "non-reversible" or "write-once" systems. After many years of costly development programs undertaken by several European and Japanese manufacturers, such devices are beginning to be introduced as shippable products.

  Because they have track densities approaching 16,000 tracks per inch, write-once drives are capable of higher areal densities than magnetic recording techniques now in use. Some planned systems provide several gigabytes on a single removable disk. Other products are being used in mass storage systems which access large numbers of optical disks under system control.

  Although not yet demonstrated, advocates of the various types of optical disk media technologies believe that their disks will provide archival lives which equal or exceed those of magnetic media, with 10 years being a commonly encountered specification for archival life of the media. Lifetime is limited by the gradual appearance of defects on the recording layer due to the corrosive effects of water and oxygen on the metal films used in the recording layers of the media. The termination point of media lifetime occurs when the error correction capability of the drive is no longer capable of coping with the gradually increasing media defect density. Some recently introduced media based on dye-polymer designs have no metallic films and may offer improved stability.

  In broad terms, two kinds of systems will be offered: Document storage and data storage systems. Systems intended to store images of documents were early entries to the market in Japan, offered by Toshiba, Matsushita Electric, and others. The early emphasis on optical document storage systems in the Japanese market is explained by the extremely complicated character of the written Japanese language. Since most business communication and records are in handwritten characters, the Japanese emphasis first on copying machines, then facsimile transmission, and now optical document storage systems is understandable. At this time, it does not appear that optical document storage systems will be able to compete on a price per image basis with microfilm for bulk storage of images. However, the fast and convenient access to stored images provided by optical disk systems will probably create a major place for them in the emerging office automation market for large-scale specialized applications.

Data storage systems have been later to develop, partly because of more stringent demands upon the media and the difficulty of developing a drive with performance suitable for data processing applications. Optical data storage systems and disk drives from a variety of firms, including Optical Storage International, Optotech, Optimem, ISI, Alcatel Thomson Gigadisc, Hitachi, Toshiba, NEC and Sony are now being shipped in modest numbers. These firms have identified a number of target applications involving databases which are infrequently or never updated, and for which a write-once system would not be at a disadvantage -- such as stock market history, legal files, seismic data, banking transaction logs and law enforcement records. Replacement of magnetic tape for general archival storage is also high on the target list. While Storage Technology Corporation was unsuccessful in bringing its high performance 7640 product to market, it did succeed in setting expectations for the functionality of a high-end, DP-oriented optical storage product. The STC project has been cancelled and is now up for sale.

The write-once systems now available or entering the market use comparable, but differing technologies, with capacities per disk in the range of one hundred megabytes to three gigabytes. The smaller capacity products are being marketed initially as OEM drives for use in small systems; larger capacity drives are being used in captive systems and by a few OEM purchasers.

Obviously, the market for this generation of optical disk systems will be limited to the niches which can tolerate nonreversibility. These niches do exist and the low cost per byte of optical storage will start to open selected markets to optical disk systems. In some applications, the ability of write-once storage systems to maintain an audit trail or indicate whether or not stored data has been modified is a significant benefit.

Large automated libraries that provide random access to tens or hundreds of disks make the use of large scale optical storage potentially very attractive for banks, insurance companies and other organizations with massive records that must be easily accessed. But the markets will be specialized, with system manufacturers slow to act. Little displacement of magnetic disk drives will result in the foreseeable future. Some displacement of tape in archival applications is probable.

* Erasable optical disks: The possibility for real inroads into the market for magnetic disk drives exists with reversible optical disk systems, when either of the principal proposed technologies reaches the status of a reliable production product. Magneto-optical recording has seen development activity for more than twenty years, and "phase change" optical recording has attracted considerable attention during the past few years.

Low-end erasable optical drives offer the promise of higher capacities and access times equivalent to those offered by many of today's small magnetic rigid drives. Such drives should be more reliable than magnetic disk drives due to the decreased chance of head crashes obtained through more head/disk separation. High end erasable drives await the availability of larger diameter erasable media, which is difficult to fabricate within the current state of the art.

Especially impacted will be magnetic tape. The ability to add an optical disk for backup using the same controller used for other system disks offers the system OEM an attractive opportunity to reduce system complexity and cost while simultaneously improving performance.

Most current magneto-optical development programs involve using a low power laser to change the magnetic state of the active layer on a disk. The laser raises the temperature of the active layer into the range of the Curie point while a magnetic field is present, causing individual magnetic domains on the disk to align with the direction of the external field. Changes in magnetic orientation are detected during reading, as the affected spot on the disk causes a small rotation in the polarized light reflected from the surface or transmitted through the disk. However, magneto-optical disks have not yet shown the ability to overwrite in place: A complete sector must be erased before the sector can be rewritten.

Phase change optical recording involves a different type of amorphous coating, in which individual spots on the disk are changed by polarized light from a crystalline state, during which light is reflected, to a noncrystalline state, during which light is absorbed. Fujitsu has revealed a comparable process in which different crystalline states are used to vary reflectivity.

A third technology, potentially the least expensive to manufacture, is erasable dye/polymer. As of yet, only limited success has been obtained with this technique because developers have not been able to demonstrate an adequately large number of write/erase cycles. Individual firms are also working on other proposed reversible optical recording technologies, but none of these are known to have overcome all of the problems, which have included: Slow completion of the reversal cycle, limitations on the number of reversals before degradation, poor shelf life, and low recording density.

Magneto-optical storage is close to being in a manufacturable status, although some additional work needs to be done to insure that the media is adequately resistant to corrosion caused by exposure to air, water and atmospheric pollutants. Most of the technical problems have been overcome by some of the U.S., Japanese or European companies working in the area, and a few of

these firms have committed to the heavy investment required to establish volume production capability. Technology announcements of products in 3.5" and 5.25" formats have been made by Verbatim, 3M, and several Japanese firms, and several firms are preparing to manufacture magneto-optical drives and media in volume by 1988. Phase change media production could follow in a few years if acceptable stability and producibility are feasible.

* Magnetic bubbles: If regarded as a specialized data storage product, magnetic bubbles still look like a product with a future, despite a serious loss of credibility after the 1981 departure of National Semiconductor, Texas Instruments and Rockwell International from the field. The rate at which the market for magnetic bubbles developed was clearly not acceptable for the drop-outs, which had plans for much more immediate returns on their investments.

  Bubbles' markets were obviously not the mainstream data storage applications dominated by magnetic disk and tape drives. As expected by disk and tape manufacturers, but not by many bubble manufacturers, the older products were well established, mostly multiple sourced, and getting better all the time. But there are many practical limitations for disk and tape, and applications where they are unsuitable or marginal because of environmental limitations or minimum practical size thresholds.

  Bubbles started to find suitable applications, once they were actually in production and support chips became available. The highest manufacturing levels are still maintained by Hitachi, with most production used by Nippon Telephone and Telegraph for a variety of telecommunication applications. AT&T, with manufacturing by Western Electric, is believed to be much further behind in developing internal bubble applications, despite the fact that the basic technology was invented at Bell Labs.

  The successful bubble program of Intel Magnetics has been instrumental in developing a wide variety of applications. Intel led the market with 1 Mbit chips, the introduction of support circuits and a guaranteed future price reduction policy. The company has attracted a variety of customers in specialized and harsh environment applications -- at least sufficient to establish quantity production and start down the learning curve.

  The non-volatility of magnetic bubbles and their suitability for capacities too small to be cost effective for magnetic disk drives has proven to be attractive to system manufacturers for applications such as industrial control systems, robots, point of sale terminals, portable computers, medical instrumentation, avionic systems and militarized systems.

The future market available to magnetic bubbles will be directly proportional to their price level as compared to magnetic disk for equivalent capacities. During the rest of the 1980's, it still seems probable that bubbles' prices will not approach disks' prices -- and bubbles' main markets will be smaller and more specialized.

In the 1990's, content addressable, high density bubble memories based upon Vertical Bloch Line (VBL) domains and bubble logic might be able to challenge disk memory in some applications. R&D efforts at Carnegie-Mellon University have shown promise, but much remains to be done to make VBL a practical technology.

* High capacity flexible disk drives: It is within the capabilities of today's technology to fabricate a floppy disk drive offering over 30 megabytes of storage capacity by using media capable of 40,000 FCI recording density and 2,7 RLL coding. Although such a product is not expected soon, when available, it could compete in the very low end of potential magnetic and optical disk drive markets.

The 12 megabyte 5.25" floppy disk drive announced by Eastman Kodak will develop markets with specialized systems and in the personal computer add-on market. Future products may double capacities to 24 megabytes. Iomega has already announced a 5.25", 20 megabyte Bernoulli disk drive. But capacities in this range are only the beginning of the potential expansion of floppy drive capabilities. Two other more significant rival technologies are waiting in the wings to boost floppy capacity.

Perpendicular recording for flexible disks has received considerable attention in recent years, and has the potential to increase capacity for a 5.25" drive to 5-10 megabytes without significant increases in track density. Toshiba is preparing to ship a 4 megabyte, 3.5" drive based on barium ferrite as the recording material. By using a sputtered thin film on a Mylar substrate, perpendicular recording disks could achieve linear densities of at least 50,000 BPI. The increased track densities of today, exceeding 300 TPI, could increase capacities by a factor of three or more.

It is likely that the largest limitation to the development of markets for floppy drives using sputtered media will be media availability. Success would require that media be produced by the millions of units, which would be difficult with today's batch sputtering processes, and durability remains a problem for thin film media used with head in-contact floppy disk drives. In addition to Toshiba, Sony and Matsushita Electric have revealed programs to develop 3.5" drives and media using perpendicular recording.

Another technology with yet unrealized promise for improving floppy capacities involves use of very small magnetic particles, not much longer than they are wide. Use of such particles in coatings with conventional binder systems could result in "isotropic" magnetic recording, in which many more flux changes per inch could be obtained than with conventional recording. The big advantage for this technique may be producibility of the media, with little to change in existing floppies but the magnetic particles. Presumably, existing coating lines operated by the several major floppy media suppliers could be used. The principal difficulty with isotropic media to date has been oversensitivity to thermal change, with the potential under some circumstances to lose recorded data. As a result, activity in the area of isotropic media is low at present.

* Stretched surface recording: SSR, as this technique is commonly known, was devised by the 3M Corporation over the last several years. It employs a disk composed of magnetically coated plastic film stretched across concentric cylindrical rings. The chief characteristic of this technology is that it allows a head to fly on an air cushion backed by a deformable surface that bulges slightly in the region under the head. This provides close head-media separation needed for high capacity but also makes the product head crash proof. Disk drives using this design technique could be produced in either fixed or removable format and can offer the same capacity as a small Winchester drive. The media, however, will have a cost only 1/3 to 1/4 that of the rigid disk media in current or projected use. Several firms are currently working with 3M on various versions of products using SSR. If adequately supported and promoted by 3M, SSR has the potential to be a major commercial technology by 1990.

Disk drive enhancements

Most of the major technology innovations now in use in the disk drive industry have come from IBM. IBM developed all the basic disk recording technology, and independent firms merely adapted heads, disks and other components to the specific drive configurations desired. However, due to IBM's lack of activity in development of small disk drives for several years, many variations in the technology have been introduced by others.

* Recording heads: Ferrite Winchester heads patterned after IBM's 3340/3350 designs still dominate in fixed media disk drives, except for PCM drives using ferrite heads designed to compete against IBM's 3370, 3375, 3380, and other new drives with ferrite heads having sliders with 3370 contours. The conventional ferrite heads are available from multiple sources, are routinely produced with good manufacturing yields, and are competitively priced. They will continue to be used for the majority of other captive and OEM drives until thin film heads are widely available and are price competitive with Winchester heads. 1984 saw the beginning of thin film head shipments for small diameter OEM disk drives, and production is expected to gradually increase as more vendors start to master the process and gain control of process yields.

  The U.S. manufacturers of PCM 3380 equivalent drives are using thin film heads, however, despite limited current availability. Drive manufacturers have established internal development and manufacturing programs for thin film heads, and are continuing to maintain close liaison with outside head manufacturers until availability becomes more routine.

* Recording disks: As IBM progressed through succeeding generations of disk drives, the disk media employed underwent only a refinement of the basic process of applying an oxide coating, to achieve a continually thinner application of a uniform coating, plus improvements in surface lubricants. The disks used in a majority of Winchester drives today are derived from IBM's process improvements.

  For several years, there has been a stampede by numerous established and new firms to install production capability for thin film disks. Most have aimed at the market for 5.25" and smaller disk drives, and the managements involved recognize the need to establish credibility by offering facilities capable of producing large quantities of disks, with adequate process controls, at prices competitive with oxide disks of comparable quality.

Some of this activity has been generated because of the higher density potential of thin film disks (few 5.25"drives with less than 100 megabyte capacity need more density than oxide disks offer).

Things got started in 1981, with adoption of plated media by Irwin International, IMI, New World, Evotek, SyQuest, and Texas Instruments, all for 5.25" or smaller disk drives, and Ibis, for 14" drives. Ampex was the major supplier for the bulk of the plated disks used through 1984. Several other companies also installed production capacity for plated disk production, but few remain in the business today. Many would-be manufacturers of plated disks lacked adequate process control and were unable to sustain high production yields or to meet delivery commitments on a consistent basis. The industry now requires that plated disks be supplied with a sputtered carbon overcoat layer to provide lubrication and mechanical protection at the head-disk interface.

A second wave of companies using sputtering methods to deposit thin magnetic films is shipping disks in significant quantities. These firms are finding that the sputtering process is easier to control than the plating process, usually resulting in substantially higher yields. Sputtering is also less subject to water contamination. Sputtering lines are less flexible than a plating line, however, which is a factor in the inability of producers of 8" disk drives to obtain assured sources of sputtered 8" media. Sputtered disk producers are concentrating on 5.25" or 3.5" media because the bulk of the near term demand is in those sizes.

Many firms use both plating and sputtering technologies in multiple layer disks, sputtering the magnetic recording layer on top of a layer of plated nickel that isolates the substrate from the magnetic layer. Like the plated disk, disks with sputtered magnetic layers usually have carbon overcoats for protection.

Despite the increasing acceptance of thin film media, oxide media retains a dominant position in the low end of the rigid disk drive market due to somewhat improved performance and considerably reduced prices.

* Head positioning methods: The industry is not moving forward rapidly with TPI improvements. Several of the highest performance small drives operate at about 1000 TPI, but such precision is too costly for most drives. The industry still has plenty of room for innovation in this area -- the majority of disk drives still operate below 500 TPI. IBM introduced a double density version of the 3380 in the first half of 1985 that uses higher track density. This drive uses an estimated 1,400 TPI, and will be influential in moving the rest of the industry to higher track densities.

* Perpendicular recording: Today's disk drives all use longitudinal recording, making use of long, thin magnetic particles oriented parallel to the surface of the recording medium. As many as 100,000 BPI could theoretically be resolved by recording heads if magnetization were oriented in a plane perpendicular to the recording surface.

  A very large amount of development activity in perpendicular recording has been underway in Japan, with application objectives in video and audio recording, as well as for data storage. In the United States, IBM and other manufacturers have development programs, but it appears that the earliest products may come from small firms. Lanx has supplied sputtered small diameter disks to manufacturers of existing high performance small drives, with the objective of making significant increases in capacity possible for existing drive mechanisms at modest cost increases. Censtor has announced a development program for a matched set of disks and heads.

  As of yet, no major system manufacturer appears close to shipping a drive or system using perpendicular recording in any form other than a demonstration model. The resources required to provide appropriate system channels and drive controllers are more than most firms have chosen to expend. The high bit densities implicit in perpendicular recording result in very high data transfer rates that currently available controllers for small disk drives can't handle. Most system suppliers will wait for someone else to pay the development costs.

DEFINITIONS

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

MARKET CLASSIFICATION

Market class is used here, arbitrarily, to differentiate captive, PCM and OEM disk drive marketing activities.

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

* Drives sold by DEC, Hewlett-Packard or Burroughs are considered captive, if internally manufactured or made by a subsidiary.

* In the case of a joint venture disk drive manufacturer such as Magnetic Peripherals, Inc., a joint venture of Control Data, Sperry, and Honeywell, MPI drives sold by Honeywell are included in captive, and MPI drives sold by CDC are included in captive, PCM or OEM groups, as appropriate. Sperry became a co-owner of MPI in 1983, and starting in 1983 Sperry shipments have been combined with those of Control Data, MPI's managing partner.

Non-captive: Any public sale or lease by any disk drive manufacturer, except sales or leases of internally manufactured drives by computer manufacturers or system OEMs primarily for use with their own systems. Both OEM and PCM shipments are included in the non-captive category.
Examples:

* Shipments by Hitachi are non-captive, except for drives sold with systems by the parent company or other subsidiaries.

* CDC disk drive sales to NCR are non-captive, in that NCR does not share in ownership of MPI, and are included in OEM totals.

PCM: Disk drives sold or leased by "plug compatible manufacturers" directly to end users; shipments of internally manufactured drives by computer manufacturers or system OEMs are not included unless supplied in plug compatible configurations for installation with systems supplied by other manufacturers. This category is not limited to plug compatible

drives installed on IBM systems. It includes any drives which are suitably equipped to be connected without additional hardware to systems of all types, including minicomputers and small business systems.
Examples:

* Disk drives sold by Memorex to end users of IBM systems.

* On an arbitrary basis, drives manufactured by Fujitsu, Hitachi, or Nippon Peripherals and resold in the PCM market by other companies are included in PCM totals, in order to avoid distortion of total industry PCM activity.

OEM: Disk drives sold through any non-captive distribution channel except PCM. (See also the definition of "Distribution channel"). Drives are normally sold to OEMs to be included in complete systems or subsystems; such drives are included in OEM totals whether or not the OEM actually manufactures the remainder of the system or subsystem, or merely assembles components and adds software. Sales by a disk drive manufacturer to a second drive manufacturer for resale are included only in shipment totals for the originating drive manufacturer, except when drives are produced on a contract manufacturing basis with a design supplied by the disk drive manufacturer which finally sells the drive to a third party. Distributors and dealers are arbitrarily defined to be included in OEM totals.

GEOGRAPHIC CLASSIFICATION

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

U.S. vs. Worldwide SHIPMENTS: Shipments are classified U.S. or worldwide depending on the shipment destination of a drive's first public sale.
Examples:

* An OEM shipment by a U.S. drive manufacturer to a European system manufacturer is included in worldwide totals.

* An OEM shipment by a Japanese drive manufacturer to a U.S. system manufacturer is included in U.S. totals.

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.
Examples:

* IBM, Seagate and Hewlett-Packard are considered U.S. manufacturers, even though each firm manufactures some of its disk drives in non-U.S. locations.

* Pertec and Northern Telecom are considered non-U.S. manufacturers, since they are subsidiaries of non-U.S. firms.

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 unit totals are counted in spindles, even though some drive configurations include more than one spindle. In order to avoid distortion of shipment information for certain large fixed disk drives used with mainframe systems, certain models have been arbitrarily counted on the basis that two spindles are equivalent to one IBM 3380 spindle (noted in the statistical tables as needed).

Revenue: Based on sales of disk drives alone, as normally sold by individual manufacturers. Controllers sold as separate units are not included, nor are spare parts or service. When individual disk drive 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 or OEM levels. Prices used for leased drives are on an "if sold" basis, at captive or PCM levels, as appropriate. All prices are in 1986 constant dollars.

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

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

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

DISTRIBUTION CHANNEL CLASSIFICATION

Shipments of non-captive drives (OEM and PCM market classes) are analyzed by each of the following distribution channels:

Mainframe computer manufacturers: Any manufacturer which derives the largest share of its revenues from selling mainframes, even though other types of products may also be sold. Examples: IBM, NCR, Honeywell, Control Data.

Mini/micro computer manufacturers: Any manufacturer which derives the largest part of its revenues from the manufacture of minicomputers, plus semiconductor manufacturers which produce computer systems as part of their product lines. Examples of this class include: Digital Equipment, Data General, Intel, Motorola, Hewlett-Packard, Prime Computer.

System OEMs/systems houses: (1) OEMs which manufacture a system requiring disk drives, such as Foxboro, Wang or Compaq. (2) System houses, of any size, which combine finished components and software to offer users complete systems.

Independent peripherals suppliers: Specialized manufacturers which add controllers, interfaces and other equipment or software, and offer plug compatible subsystems to end users, system OEMs and systems houses. Examples are Tallgrass, Xylogics and Emulex.

Distributors, dealers, end users: This category includes: (1) Sales of plug compatible (PCM) disk drives with any other necessary hardware by disk drive manufacturers directly to end users, whether or not title to the equipment is to be held by end users themselves or by lessor. (2) Distribution through wholesalers, such as Hamilton Avnet, Arrow, or dealers of any type.

APPLICATIONS

Disk drive applications are associated with a specific class of system, regardless of the manufacturer or method of distribution. The categories used in this report are given below.

Mainframe/supermini: Disk drives attached to the processor or to a terminal associated with a general purpose mainframe or supermini-computer.

Minicomputers and multiple-user microcomputers: Disk drives associated with small general purpose processors typically serving multiple users. This category also includes network file servers. Examples include: IBM System/36, AT&T 3B2, DEC PDP-11.

Microcomputers: Includes disk drives attached to a general purpose microcomputer typically used by a single user in a professional or business environment. Examples: Compaq Plus, IBM PC/XT, IBM PC/AT, Apple Macintosh.

Office systems and workstations: Disk drives attached to office systems designed for dedicated use in specific applications, such as word processing, electronic mail, or document storage. Specialized hardware is normally used. Examples: Wang OIS series, NBI and CPT office systems.

Non-office systems and workstations: Includes disk drives used with systems in non-office dedicated applications, such as order processing or shipping, point of sale, medical, factory production control, law enforcement, CAD/CAM/CAE, military, etc.

Consumer and hobby computers: Used in equipment sold primarily to consumers for non-business applications.

Other applications: Any application not included above.

DISK CARTRIDGE DRIVES, LESS THAN 12 MB

1986 DISK/TREND REPORT

DISK CARTRIDGE DRIVES, LESS THAN 12 MEGABYTES

Coverage

Examples of disk drives in this group include:

14" disk diameter

Digital Equipment	RL02
ISOT	CM 5400, CM 5410
Kovo (Zbrojovka Brno)	KDP 724

10.5" disk diameter

Bull	D120

5.25" disk diameter

Newbury Data	NDR 505
Western Dynex	WD-505

3.9" disk diameter

SyQuest Technology	SQ-306RD
Nippon Systemhouse	SQ-306RD

This product group includes all removable-only or fixed/removable disk drives with a total capacity per spindle of less than 12 megabytes. Each fixed/removable combination drive is counted as one spindle.

The number of disk drives offered in this group continues to shrink, as older models are discontinued. None of the companies which led in shipments of 14" disk cartridge drives during the heyday of this group -- Control Data, Diablo or Western Dynex -- are currently represented with products. This is the last year in which these products will be covered in a separate DISK/TREND group. Next year they will be combined with disk cartridge drives with capacities more than 12 MB in a single product group for disk cartridge drives.

Market status

DISK/TREND estimate of total market size:

Worldwide sales ($M)	1985	1986	1987	1988	1989
U.S. manufacturers	45.3	19.5	13.2	2.0	--
All manufacturers	102.7	70.7	56.8	35.7	18.9

The low-end disk cartridge drives in this group were once the volume leaders for the industry. They were among the first OEM disk drives introduced in the late 1960's and were the first captive drives produced by Digital Equipment, Data General, Hewlett-Packard and many other system manufacturers, both in the U.S. and other countries.

But the end is now is sight. Small fixed disk drives, offering lower cost and better reliability, have now displaced low-end disk cartridge drives in most of their traditional applications. Most requirements which still require removability, for security reasons or to exchange databases, also now require more capacity, resulting in movement to disk cartridge drives with more than 12 MB capacity.

SyQuest, the U.S. manufacturer of 3.9" disk cartridge drives, remained the leader in worldwide OEM shipments during 1985, with 27,000 units, 58.2% of the total. The largest application for these drives is in security sensitive markets for personal computers, in which there is a need to remove all stored data for safekeeping. ISOT shipped 13,000 14" drives, 29.1% of the 1985 worldwide non-captive total, primarily for Eastern Bloc minicomputer applications.

Marketing trends

Shipments of U.S. 14" drives in this group are expected to end next year. OEM and captive shipments of 14" drives within the Eastern Bloc

countries are expected to continue for several more years, as production of small fixed disk drives gradually increases.

The outlook for 8" and 10.5" drives in this group also is poor, for both captive and OEM drives. Only a few manufacturers produce such drives, and their marketing efforts have been frustrated by lack of industry standards -- plus prices which are high when compared to 5.25" drives, using either fixed or removable disks.

The projections for 3.9" and 5.25" disk cartridge drive shipments in this group show continued decline, in view of the fact that drive manufacturers are now emphasising drives with over 12 megabytes, which are covered in another product group.

Technical trends

Technology used in existing small disk cartridge drives is adapted from older designs. Heads use variations from 3330 and 3350 designs, in some cases combined with smaller sliders. Disks used in current drives include conventional Winchester oxide coated, plus newer thin film disks. It is not expected that drive manufacturers will develop new low-end disk cartridge drives -- most requirements for removable disk storage in this capacity range will be satisfied with high-end floppy drives.

Forecasting assumptions

1. 14" and 8" disk cartridge drives will continue to decline, due to competitive pressure from higher capacity disk cartridge drives and small diameter disk drives, both fixed and disk cartridge types.

2. OEM price levels will increase after 1986, with increased shipments of 14" drives primarily within the Eastern Bloc countries.

TABLE 9

DISK CARTRIDGE DRIVES, LESS THAN 12 MEGABYTES

REVENUE SUMMARY

	DISK DRIVE REVENUES, BY SHIPMENT DESTINATION ($M)									
	1985 Revenues		Forecast 1986		1987		1988		1989	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM Captive	--	--	--	--	--	--	--	--	--	--
Other U.S. Captive	17.6	29.4	7.6	12.6	5.0	8.4	--	--	--	--
TOTAL U.S. CAPTIVE	17.6	29.4	7.6	12.6	5.0	8.4	--	--	--	--
PCM	--	--	--	--	--	--	--	--	--	--
OEM	13.3	15.9	4.9	6.9	3.4	4.8	1.4	2.0	--	--
TOTAL U.S. NON-CAPTIVE	13.3	15.9	4.9	6.9	3.4	4.8	1.4	2.0	--	--
TOTAL U.S. REVENUES	30.9	45.3	12.5	19.5	8.4	13.2	1.4	2.0	--	--
Non-U.S. Manufacturers										
Captive	--	15.8	--	13.6	--	13.1	--	11.2	--	6.4
PCM	--	--	--	--	--	--	--	--	--	--
OEM	.7	41.6	--	37.6	--	30.5	--	22.5	--	12.5
TOTAL NON-U.S. REVENUES	.7	57.4	--	51.2	--	43.6	--	33.7	--	18.9
Worldwide Recap										
TOTAL WORLDWIDE REVENUES	31.6	102.7	12.5	70.7	8.4	56.8	1.4	35.7	--	18.9
OEM Average Price ($000)	.5	1.2	.4	1.3	.4	1.4	.4	1.7	--	2.5

TABLE 10

DISK CARTRIDGE DRIVES, LESS THAN 12 MEGABYTES

UNIT SHIPMENT SUMMARY

	DISK DRIVE UNIT SHIPMENTS, BY SHIPMENT DESTINATION (000)									
	1985 Shipments		Forecast 1986		1987		1988		1989	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM Captive	--	--	--	--	--	--	--	--	--	--
Other U.S. Captive	4.2	7.0	1.8	3.0	1.2	2.0	--	--	--	--
TOTAL U.S. CAPTIVE	4.2	7.0	1.8	3.0	1.2	2.0	--	--	--	--
PCM	--	--	--	--	--	--	--	--	--	--
OEM	24.3	29.4	12.1	17.1	8.4	12.0	3.5	5.0	--	--
TOTAL U.S. NON-CAPTIVE	24.3	29.4	12.1	17.1	8.4	12.0	3.5	5.0	--	--
TOTAL U.S. SHIPMENTS	28.5	36.4	13.9	20.1	9.6	14.0	3.5	5.0	--	--
Non-U.S. Manufacturers										
Captive	--	2.5	--	2.1	--	1.7	--	1.4	--	.8
PCM	--	--	--	--	--	--	--	--	--	--
OEM	.2	17.0	--	15.3	--	12.3	--	9.0	--	5.0
TOTAL NON-U.S. SHIPMENTS	.2	19.5	--	17.4	--	14.0	--	10.4	--	5.8
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	28.7	55.9	13.9	37.5	9.6	28.0	3.5	15.4	--	5.8
Cumulative Shipments										
IBM	53.3	79.0	53.3	79.0	53.3	79.0	53.3	79.0	53.3	79.0
Non-IBM	606.4	1,105.6	620.3	1,143.1	629.9	1,171.1	633.4	1,186.5	633.4	1,192.3
WORLDWIDE TOTAL	659.7	1,184.6	673.6	1,222.1	683.2	1,250.1	686.7	1,265.5	686.7	1,271.3

TABLE 11

DISK CARTRIDGE DRIVES, LESS THAN 12 MEGABYTES

WORLDWIDE REVENUES ($M)

BREAKDOWN BY DISK DIAMETER

	1985 Revenues				Forecast 1986				1987			1988		1989
	14"	8"	5.25"	<5.25"	14"	8"	5.25"	<5.25"	14"	5.25"	<5.25"	14"	<5.25"	14"
U.S. MANUFACTURERS														
Captive	29.4	--	--	--	12.6	--	--	--	8.4	--	--	--	--	--
OEM	1.1	2.8	.1	11.9	--	--	.1	6.8	--	--	4.8	--	2.0	--
TOTAL U.S. REVENUES	30.5	2.8	.1	11.9	12.6	--	.1	6.8	8.4	--	4.8	--	2.0	--
NON-U.S. MANUFACTURERS														
Captive	12.0	2.3	--	1.5	11.2	.9	--	1.5	12.8	--	.3	11.2	--	6.4
OEM	39.5	.2	1.9	--	36.5	--	1.1	--	30.0	.5	--	22.5	--	12.5
TOTAL NON-U.S. REVENUES	51.5	2.5	1.9	1.5	47.7	.9	1.1	1.5	42.8	.5	.3	33.7	--	18.9
WORLDWIDE RECAP														
Captive	41.4	2.3	--	1.5	23.8	.9	--	1.5	21.2	--	.3	11.2	--	6.4
	-64.9%	-32.4%	--	--	-42.5%	-60.9%	--	--	-10.9%	--	-80.0%	-47.2%	--	-42.9%
OEM	40.6	3.0	2.0	11.9	36.5	--	1.2	6.8	30.0	.5	4.8	22.5	2.0	12.5
	-25.4%	-75.4%	-9.1%	-25.6%	-10.1%	--	-40.0%	-42.9%	-17.8%	-58.3%	-29.4%	-25.0%	-58.3%	-44.4%
Total Revenues	82.0	5.3	2.0	13.4	60.3	.9	1.2	8.3	51.2	.5	5.1	33.7	2.0	18.9
	-52.4%	-66.0%	-9.1%	-16.2%	-26.5%	-83.0%	-40.0%	-38.1%	-15.1%	-58.3%	-38.6%	-34.2%	-60.8%	-43.9%
ANNUAL SHARE, BY DIAMETER	79.9%	5.2%	1.9%	13.0%	85.4%	1.3%	1.7%	11.6%	90.2%	.9%	8.9%	94.5%	5.5%	100.0%

NOTE: 8 inch totals include 10.5 inch drives

TABLE 12

DISK CARTRIDGE DRIVES, LESS THAN 12 MEGABYTES

WORLDWIDE SHIPMENTS (000)

BREAKDOWN BY DISK DIAMETER

	1985 Shipments				Forecast									
					1986				1987			1988		1989
	14"	8"	5.25"	<5.25"	14"	8"	5.25"	<5.25"	14"	5.25"	<5.25"	14"	<5.25"	14"
U.S. MANUFACTURERS														
Captive	7.0	--	--	--	3.0	--	--	--	2.0	--	--	--	--	--
OEM	.3	2.0	.1	27.0	--	--	.1	17.0	--	--	12.0	--	5.0	--
TOTAL U.S. SHIPMENTS	7.3	2.0	.1	27.0	3.0	--	.1	17.0	2.0	--	12.0	--	5.0	--
NON-U.S. MANUFACTURERS														
Captive	1.5	.5	--	.5	1.4	.2	--	.5	1.6	--	.1	1.4	--	.8
OEM	15.7	.1	1.2	--	14.6	--	.7	--	12.0	.3	--	9.0	--	5.0
TOTAL NON-U.S. SHIPMENTS	17.2	.6	1.2	.5	16.0	.2	.7	.5	13.6	.3	.1	10.4	--	5.8
WORLDWIDE RECAP														
Captive	8.5	.5	--	.5	4.4	.2	--	.5	3.6	--	.1	1.4	--	.8
	-68.0%	-28.6%	--	--	-48.2%	-60.0%	--	--	-18.2%	--	-80.0%	-61.1%	--	-42.9%
OEM	16.0	2.1	1.3	27.0	14.6	--	.8	17.0	12.0	.3	12.0	9.0	5.0	5.0
	-17.5%	-75.3%	-31.6%	-15.9%	-8.7%	--	-38.5%	-37.0%	-17.8%	-62.5%	-29.4%	-25.0%	-58.3%	-44.4%
Total Shipments	24.5	2.6	1.3	27.5	19.0	.2	.8	17.5	15.6	.3	12.1	10.4	5.0	5.8
	-46.7%	-71.7%	-31.6%	-14.3%	-22.4%	-92.3%	-38.5%	-36.4%	-17.9%	-62.5%	-30.9%	-33.3%	-58.7%	-44.2%
ANNUAL SHARE, BY DIAMETER	43.9%	4.7%	2.3%	49.1%	50.8%	.5%	2.1%	46.6%	55.8%	1.1%	43.1%	67.6%	32.4%	100.0%

NOTE: 8 inch totals include 10.5 inch drives

TABLE 13

DISK CARTRIDGE DRIVES, LESS THAN 12 MEGABYTES

APPLICATIONS SUMMARY
Percentage of Worldwide Shipments

APPLICATION	1985 Estimate Units (000)	1985 Estimate %	1989 Projection Units (000)	1989 Projection %
MAINFRAME/SUPERMINI General purpose	--	--	--	--
MINICOMPUTERS AND MULTI-USER MICROS Business and professional, including networks	26.0	46.5	.8	14.3
MICROCOMPUTERS Business and professional, single user	1.7	3.0	--	--
OFFICE SYSTEMS AND WORKSTATIONS Dedicated application	5.1	9.2	.1	.6
NON-OFFICE SYSTEMS AND WORKSTATIONS Technical, distribution, medical, other specialized	23.1	41.3	4.9	85.1
CONSUMER AND HOBBY COMPUTERS	--	--	--	--
OTHER APPLICATIONS	--	--	--	--
Total	55.9	100.0	5.8	100.0

TABLE 14

DISK CARTRIDGE DRIVES, LESS THAN 12 MEGABYTES

DISTRIBUTION CHANNEL SUMMARY
U.S. Non-Captive Disk Drives

Distribution channel	1985 U.S. Net Shipments Units (000)	%	FORECAST 1986 %	1987 %	1988 %	1989 %
Mainframe computer manufacturers	8.1	33.0	36.9	40.7	41.9	
Mini/micro computer manufacturers	10.0	40.7	45.1	49.8	53.4	
System OEMs/systems houses	2.3	9.5	6.9	4.3	1.7	--
Independent peripherals suppliers	1.0	4.2	2.0	--	--	--
Distributors, dealers, end users	3.1	12.6	9.1	5.2	3.0	--
TOTAL	24.5					

TABLE 15

DISK CARTRIDGE DRIVES, LESS THAN 12 MEGABYTES

MARKET SHARE SUMMARY
Worldwide Shipments of Non-Captive Disk Drives

Drive Manufacturers	1985 Net Shipments: To United States Destinations, Units (000) 14"	8"	5.25"	<5.25"	Total	%	Worldwide, Units (000) 14"	8"	5.25"	<5.25"	Total	%
SYQUEST	--	--	--	22.0	22.0	89.8	--	--	--	27.0	27.0	58.2
ISOT	--	--	--	--	--	--	13.5	--	--	--	13.5	29.1
Other U.S.	.4	2.0	.1	--	2.5	10.2	.5	2.0	.1	--	2.6	5.6
Other Non-U.S.	--	--	--	--	--	--	2.0	.1	1.2	--	3.3	7.1
TOTAL	.4	2.0	.1	22.0	24.5	100.0	16.0	2.1	1.3	27.0	46.4	100.0

NOTE: 8 inch totals include 10.5 inch drives

DISK CARTRIDGE DRIVES, MORE THAN 12 MB

1986 DISK/TREND REPORT

DISK CARTRIDGE DRIVES, MORE THAN 12 MEGABYTES

Coverage

Examples of disk drives in this group include:

14" disk diameter

Control Data	9448-32, 9448-64, 9448-96
Fujitsu	F6417

10.5" disk diameter

Bull	D140, D145

8" disk diameter

Amcodyne	Arapahoe 7110, Tomahawk 7130
Control Data	9457
Digital Equipment	RC25

5.25" disk diameter

Bull	D526
DMA Systems	360
MFM	360
Micro Storage	MS 212
Miltope	RDS-1500, RDS-8600
Ricoh	RH5130

3.9" disk diameter

SyQuest Technology	SQ312RD, SQ319

This is a diverse group of drives, all of which use a removable disk cartridge which is usually, but not always, combined with one or more fixed disks in a single drive. Several unique configurations are also included, such as Fujitsu's F6417 (67 megabytes removable) and Miltope's drives incorporating heads and media in a removable cartridge. Consistent with the rest of the industry, the trend in this group has been to smaller diameter drives -- and the remaining 14" drives are expected to be phased out soon.

Market status

DISK/TREND estimate of total market size:

Worldwide sales ($M)	1985	1986	1987	1988	1989
U.S. manufacturers	143.4	121.7	99.5	99.3	89.4
All manufacturers	167.1	153.5	136.6	137.9	130.2

Total shipments of disk cartridge drives with more than 12 megabytes capacity have followed an up and down pattern during the 1980's, with each year of growth followed by a new decline. However, this pattern now appears to be improving during 1985 and 1986, with two consistent growth years. Total worldwide shipments for 1985 were 73,400 drives, up 34.4%, and 1986 is expected to reach 104,100, an increase of 41.8%.

This product group is undergoing fundamental changes in product mix. Until the last few years the leading product in the group was the 14" Control Data 9448 "Phoenix", which peaked in 1982 with 28,500 drives in that year. The competition from smaller, lower cost fixed disk drives has been effective, however, and 14" drives in this group are no longer significant.

Unfortunately, the growth expectations of several years ago for 8" and 5.25" drives have been largely unfulfilled to date. Disk cartridge drives are more difficult to design and manufacture than fixed disk drives of the same capacity and disk diameter, due to increased mechanical complexity and greater risk of contamination.

The extent of these problems was not clearly recognized by most would-be producers of 8" and 5.25" drives, resulting in long delays for availability of announced products, shipment of many unreliable disk drives, and several failed programs. With this history, it is entirely understandable that many system manufacturers who previously used 14" disk

cartridge drives in small office and engineering systems, and would have liked to continue with removable disk drives in smaller sizes, tired of waiting and switched to fixed disk drives.

Most of the current growth in this group is from SyQuest's 3.9" drive and from the several producers of 5.25" drives which survived a shaky start-up period. SyQuest led in 1985 shipments of non-captive drives with 40,000 units, 64.5% of the worldwide total. Control Data held 11.9% of worldwide shipments, consisting of 7,400 14" and 8" drives.

Marketing trends

DISK/TREND forecasts for this group have been reduced this year, repeating a pattern from the past. Given the background of technical difficulties, shaky financial status of some manufacturers, lack of media interchange standards and excellent competition from fixed disk drives, it is easy to understand why a majority of the computer industry's system manufacturers are no longer using disk cartridge drives.

Despite the negative influences, disk cartridge drives provide removability, which is highly desirable for some applications. The most important of these consists of a variety of requirements frequently called the "security" market -- the various government offices and defense contractors which are required to remove all data from computer systems when not in use, so that it may be kept under lock and key. Other current markets for disk cartridge drives consist of specialized systems employing exchangable data bases and some personal computer users with specialized requirements.

It is expected that the unit shipment leadership currently held by 3.9" drives will be assumed by 5.25" drives in 1987, with 5.25" drives

reaching 108,900 units in 1989, 76.7% of the worldwide total. The markets still available to high end disk cartridge drives want the higher capacities that 5.25" drives will be able to provide and will generally find the 5.25" form factor to be satisfactory.

8" disk cartridge drives are forecasted at unit shipments of 15,300 for 1989, all from U.S. manufacturers. Captive shipments are expected to decline, but OEM shipments will enjoy modest growth, driven by the security market.

Technical trends

The basic recording technologies now in use for products in this group will continue to predominate for years. Most of the 14" drives used variations to the older 3330 technology.

The 8" and smaller drives introduced to date incorporate elements of the older technologies, but utilize head designs similar to Winchester heads, sometimes with "mini" sliders. All of the existing 8" drives use oxide coated disks, while the various 5.25" and 3.9" models use oxide or thin film disks. All use embedded servo techniques in order to maximize the disk surface area available for recording.

The major difference in high density recording between disk cartridge drives and fixed disk drives is higher probability of particulate contamination in removable disk drives. At existing linear recording densities, removability appears to be completely practical. But at densities well above 10,000 BPI, already in use with high capacity fixed disk drives, heads must fly at lower altitudes, increasing the need for lower contamination levels. It may be possible to increase density in removable disk drives, but the degree of engineering difficulty will be high. Changes in

heads, filtration systems and seals may be necessary, and thin film disks are likely to be used because their surfaces seem to be more durable than oxide coated disks.

Forecasting assumptions

1. 8" disk cartridge drives will find adequate markets in security applications to sustain growth.

2. Production for 5.25" disk cartridge drives, including models with higher capacities, will be available in large production quantities from multiple sources starting in 1986 and 1987, with good acceptance.

TABLE 16

DISK CARTRIDGE DRIVES, MORE THAN 12 MEGABYTES

REVENUE SUMMARY

	DISK DRIVE REVENUES, BY SHIPMENT DESTINATION ($M)									
	1985 Revenues		Forecast 1986		1987		1988		1989	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM Captive	--	--	--	--	--	--	--	--	--	--
Other U.S. Captive	34.6	80.4	16.1	70.8	14.8	42.7	21.6	36.0	14.0	23.4
TOTAL U.S. CAPTIVE	34.6	80.4	16.1	70.8	14.8	42.7	21.6	36.0	14.0	23.4
PCM	--	--	--	--	--	--	--	--	--	--
OEM	40.2	63.0	43.9	50.9	47.7	56.8	52.4	63.3	53.8	66.0
TOTAL U.S. NON-CAPTIVE	40.2	63.0	43.9	50.9	47.7	56.8	52.4	63.3	53.8	66.0
TOTAL U.S. REVENUES	74.8	143.4	60.0	121.7	62.5	99.5	74.0	99.3	67.8	89.4
Non-U.S. Manufacturers										
Captive	--	11.8	--	16.5	--	16.2	--	14.3	--	15.1
PCM	--	--	--	--	--	--	--	--	--	--
OEM	1.4	11.9	7.8	15.3	11.8	20.9	13.5	24.3	14.3	25.7
TOTAL NON-U.S. REVENUES	1.4	23.7	7.8	31.8	11.8	37.1	13.5	38.6	14.3	40.8
Worldwide Recap										
TOTAL WORLDWIDE REVENUES	76.2	167.1	67.8	153.5	74.3	136.6	87.5	137.9	82.1	130.2
OEM Average Price ($000)	.8	1.2	.6	.7	.6	.7	.6	.7	.6	.6

TABLE 17

DISK CARTRIDGE DRIVES, MORE THAN 12 MEGABYTES

UNIT SHIPMENT SUMMARY

	DISK DRIVE UNIT SHIPMENTS, BY SHIPMENT DESTINATION (000)									
	1985		Forecast							
	Shipments		1986		1987		1988		1989	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM Captive	--	--	--	--	--	--	--	--	--	--
Other U.S. Captive	3.8	9.2	2.0	8.4	1.8	5.2	2.7	4.5	1.8	3.0
TOTAL U.S. CAPTIVE	3.8	9.2	2.0	8.4	1.8	5.2	2.7	4.5	1.8	3.0
PCM	--	--	--	--	--	--	--	--	--	--
OEM	50.8	57.6	69.7	73.9	69.8	78.2	73.9	84.6	74.9	87.4
TOTAL U.S. NON-CAPTIVE	50.8	57.6	69.7	73.9	69.8	78.2	73.9	84.6	74.9	87.4
TOTAL U.S. SHIPMENTS	54.6	66.8	71.7	82.3	71.6	83.4	76.6	89.1	76.7	90.4
Non-U.S. Manufacturers										
Captive	--	2.2	--	4.4	--	4.9	--	5.1	--	5.8
PCM	--	--	--	--	--	--	--	--	--	--
OEM	1.0	4.4	12.0	17.4	21.4	31.3	27.0	39.5	31.7	46.0
TOTAL NON-U.S. SHIPMENTS	1.0	6.6	12.0	21.8	21.4	36.2	27.0	44.6	31.7	51.8
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	55.6	73.4	83.7	104.1	93.0	119.6	103.6	133.7	108.4	142.2
Cumulative Shipments										
IBM	--	--	--	--	--	--	--	--	--	--
Non-IBM	246.8	412.9	330.5	517.0	423.5	636.6	527.1	770.3	635.5	912.5
WORLDWIDE TOTAL	246.8	412.9	330.5	517.0	423.5	636.6	527.1	770.3	635.5	912.5

TABLE 18

DISK CARTRIDGE DRIVES, MORE THAN 12 MEGABYTES

WORLDWIDE REVENUES ($M)

BREAKDOWN BY DISK DIAMETER

	1985 Revenues				Forecast													
					1986				1987				1988			1989		
	14"	8"	5.25"	<5.25"	14"	8"	5.25"	<5.25"	14"	8"	5.25"	<5.25"	8"	5.25"	<5.25"	8"	5.25"	<5.25"
U.S. MANUFACTURERS																		
Captive	13.0	67.4	--	--	6.0	64.8	--	--	--	42.7	--	--	36.0	--	--	23.4	--	--
OEM	20.4	16.5	6.1	20.0	1.4	18.3	10.4	20.8	--	24.1	16.3	16.4	29.1	22.6	11.6	33.2	25.6	7.2
TOTAL U.S. REVENUES	33.4	83.9	6.1	20.0	7.4	83.1	10.4	20.8	--	66.8	16.3	16.4	65.1	22.6	11.6	56.6	25.6	7.2
NON-U.S. MANUFACTURERS																		
Captive	1.6	10.2	--	--	.9	6.6	9.0	--	.3	3.0	12.9	--	--	14.3	--	--	15.1	--
OEM	8.4	1.7	1.8	--	.4	1.1	13.8	--	--	--	20.9	--	--	24.3	--	--	25.7	--
TOTAL NON-U.S. REVENUES	10.0	11.9	1.8	--	1.3	7.7	22.8	--	.3	3.0	33.8	--	--	38.6	--	--	40.8	--
WORLDWIDE RECAP																		
Captive	14.6	77.6	--	--	6.9	71.4	9.0	--	.3	45.7	12.9	--	36.0	14.3	--	23.4	15.1	--
	-39.7%	-42.3%	--	--	-52.7%	-8.0%	--	--	-95.7%	-36.0%	+43.3%	--	-21.2%	+10.9%	--	-35.0%	+5.6%	--
OEM	28.8	18.2	7.9	20.0	1.8	19.4	24.2	20.8	--	24.1	37.2	16.4	29.1	46.9	11.6	33.2	51.3	7.2
	-49.3%	-58.8%	-14.1%	--	-93.7%	+6.6%	+206.3%	+4.0%	--	+24.2%	+53.7%	-21.2%	+20.7%	+26.1%	-29.3%	+14.1%	+9.4%	-37.9%
Total Revenues	43.4	95.8	7.9	20.0	8.7	90.8	33.2	20.8	.3	69.8	50.1	16.4	65.1	61.2	11.6	56.6	66.4	7.2
	-46.4%	-46.4%	-14.1%	--	-80.0%	-5.2%	+320.3%	+4.0%	-96.6%	-23.1%	+50.9%	-21.2%	-6.7%	+22.2%	-29.3%	-13.1%	+8.5%	-37.9%
ANNUAL SHARE, BY DIAMETER	26.1%	57.3%	4.7%	11.9%	5.7%	59.3%	21.6%	13.4%	.2%	51.2%	36.7%	11.9%	47.3%	44.4%	8.3%	43.6%	51.0%	5.4%

NOTE: 8 inch totals include 10.5 inch drives

TABLE 19

DISK CARTRIDGE DRIVES, MORE THAN 12 MEGABYTES

WORLDWIDE SHIPMENTS (000)

BREAKDOWN BY DISK DIAMETER

	1985 Shipments				1986				Forecast 1987				1988			1989		
	14"	8"	5.25"	<5.25"	14"	8"	5.25"	<5.25"	14"	8"	5.25"	<5.25"	8"	5.25"	<5.25"	8"	5.25"	<5.25"
U.S. MANUFACTURERS																		
Captive	1.1	8.1	--	--	.6	7.8	--	--	--	5.2	--	--	4.5	--	--	3.0	--	--
OEM	5.1	5.7	6.8	40.0	.4	6.4	15.1	52.0	--	8.3	28.9	41.0	10.4	45.2	29.0	12.3	57.1	18.0
TOTAL U.S. SHIPMENTS	6.2	13.8	6.8	40.0	1.0	14.2	15.1	52.0	--	13.5	28.9	41.0	14.9	45.2	29.0	15.3	57.1	18.0
NON-U.S. MANUFACTURERS																		
Captive	.5	1.7	--	--	.3	1.1	3.0	--	.1	.5	4.3	--	--	5.1	--	--	5.8	--
OEM	2.2	.6	1.6	--	.1	.3	17.0	--	--	--	31.3	--	--	39.5	--	--	46.0	--
TOTAL NON-U.S. SHIPMENTS	2.7	2.3	1.6	--	.4	1.4	20.0	--	.1	.5	35.6	--	--	44.6	--	--	51.8	--
WORLDWIDE RECAP																		
Captive	1.6	9.8	--	--	.9	8.9	3.0	--	.1	5.7	4.3	--	4.5	5.1	--	3.0	5.8	--
	-20.0%	-41.3%	--	--	-43.7%	-9.2%	--	--	-88.9%	-36.0%	+43.3%	--	-21.1%	+18.6%	--	-33.3%	+13.7%	--
OEM	7.3	6.3	8.4	40.0	.5	6.7	32.1	52.0	--	8.3	60.2	41.0	10.4	84.7	29.0	12.3	103.1	18.0
	-40.7%	-55.9%	+15.1%	--	-93.2%	+6.3%	+282.1%	+30.0%	--	+23.9%	+87.5%	-21.2%	+25.3%	+40.7%	-29.3%	+18.3%	+21.7%	-37.9%
Total Shipments	8.9	16.1	8.4	40.0	1.4	15.6	35.1	52.0	.1	14.0	64.5	41.0	14.9	89.8	29.0	15.3	108.9	18.0
	-37.8%	-48.1%	+15.1%	--	-84.3%	-3.1%	+317.9%	+30.0%	-92.9%	-10.3%	+83.8%	-21.2%	+6.4%	+39.2%	-29.3%	+2.7%	+21.3%	-37.9%
ANNUAL SHARE, BY DIAMETER	12.1%	21.9%	11.4%	54.6%	1.3%	15.0%	33.8%	49.9%	.1%	11.7%	54.0%	34.2%	11.1%	67.3%	21.6%	10.8%	76.7%	12.5%

NOTE: 8 inch totals include 10.5 inch drives

TABLE 20

DISK CARTRIDGE DRIVES, MORE THAN 12 MEGABYTES

APPLICATIONS SUMMARY
Percentage of Worldwide Shipments

	1985 Estimate		1989 Projection	
APPLICATION	Units (000)	%	Units (000)	%
MAINFRAME/SUPERMINI General purpose	11.9	16.2	3.3	2.3
MINICOMPUTERS AND MULTI-USER MICROS Business and professional, including networks	14.9	20.3	42.1	29.6
MICROCOMPUTERS Business and professional, single user	5.4	7.3	2.5	1.8
OFFICE SYSTEMS AND WORKSTATIONS Dedicated application	6.2	8.5	1.7	1.2
NON-OFFICE SYSTEMS AND WORKSTATIONS Technical, distribution, medical, other specialized	34.7	47.3	92.6	65.1
CONSUMER AND HOBBY COMPUTERS	--	--	--	--
OTHER APPLICATIONS	.3	.4	--	--
Total	73.4	100.0	142.2	100.0

TABLE 21

DISK CARTRIDGE DRIVES, MORE THAN 12 MEGABYTES

DISTRIBUTION CHANNEL SUMMARY
U.S. Non-Captive Disk Drives

Distribution channel	1985 U.S. Net Shipments Units (000)	%	FORECAST 1986 %	1987 %	1988 %	1989 %
Mainframe computer manufacturers	5.3	10.3	11.3	12.4	13.7	15.0
Mini/micro computer manufacturers	6.1	11.8	13.6	15.6	17.9	20.6
System OEMs/systems houses	17.1	33.1	38.7	45.3	53.0	59.7
Independent peripherals suppliers	12.6	24.3	20.0	14.7	8.5	2.6
Distributors, dealers, end users	10.6	20.5	16.4	12.0	6.9	2.1
TOTAL	51.8					

TABLE 22

DISK CARTRIDGE DRIVES, MORE THAN 12 MEGABYTES

MARKET SHARE SUMMARY
Worldwide Shipments of Non-Captive Disk Drives

Drive Manufacturers	1985 Net Shipments: To United States Destinations, Units (000) 14"	8"	5.25"	<5.25"	Total	%	1985 Net Shipments: Worldwide, Units (000) 14"	8"	5.25"	<5.25"	Total	%
SYQUEST	--	--	--	40.0	40.0	77.2	--	--	--	40.0	40.0	64.5
CONTROL DATA	.5	1.9	--	--	2.4	4.6	4.9	2.5	--	--	7.4	11.9
DMA SYSTEMS	--	--	4.1	--	4.1	7.9	--	--	5.0	--	5.0	8.1
AMCODYNE	--	2.6	--	--	2.6	5.0	--	3.2	--	--	3.2	5.2
Other U.S.	.2	--	1.7	--	1.9	3.7	.4	--	1.8	--	2.2	3.5
Other Non-U.S.	--	--	.8	--	.8	1.6	2.0	.6	1.6	--	4.2	6.8
TOTAL	.7	4.5	6.6	40.0	51.8	100.0	7.3	6.3	8.4	40.0	62.0	100.0

NOTE: 8 inch totals include 10.5 inch drives

DISK PACK DRIVES, LESS THAN 100 MB

DISK PACK DRIVES, LESS THAN 100 MEGABYTES

Coverage

Examples of disk drives in this group include:

14" disk diameter

Control Data	9762
ISOT	CM 5412, ES 5061

9" disk diameter

Control Data	9710

The Control Data 9760 series, the original "storage module drives", exerted broad influence in the industry following their 1974 introduction. "SMD" became the generally used term for drives using 3330 technology in packs with five data surfaces, as well as for the larger 19 data surface disk pack drives using similar interfaces. The SMD interface also became the dominant industry standard for high performance OEM disk drives. The term SMD is used throughout the DISK/TREND Report as a generic description for these 14" Control Data drives and competitive equivalents. The continuing Eastern Bloc production of drives equivalent to the older IBM 2314 is also included in this product group.

Control Data's 9" "RSD", or 9710, is functionally similar to the 80 MB SMD in every way except for smaller size and lower price. Its physical size is matched to the Control Data "FSD" 9" family of fixed disk drives.

This is the last year in which these products will be covered in a separate DISK/TREND group. Next year they will be combined with disk pack drives with capacities more than 100 MB in a single product group for disk pack drives.

Market status

DISK/TREND estimate of total market size:

Worldwide sales ($M)	1985	1986	1987	1988	1989
U.S. manufacturers	131.2	88.7	93.0	67.5	72.6
All manufacturers	220.3	168.5	153.7	125.1	127.1

After a brief upsurge in 1984, total worldwide shipments of drives in this group dropped 16.7% in 1985, down to 36,900 spindles. However, the reduction was entirely in 14" drives with OEM shipments by U.S. manufacturers leading the way. Shipments of 9" RSD disk pack drives by Control Data increased in 1985, and that trend continues in 1986.

Control Data continued to lead in shipments of non-captive drives for 1985, with 56.9% of the worldwide unit total, consisting of 8,000 14" and 7,200 9" drives. Bulgarian production by ISOT of disk pack drives using 2314 and SMD technology accounted for 42.3% of worldwide non-captive shipments, with a total of 11,300 drives.

During 1986, shipments of captive and OEM drives in this group by both U.S. and non-U.S. producers is declining, with the sole exception of 9" drive shipments by Control Data.

Marketing trends

It continues to appear that all U.S. production of 14" drives in this group will stop by 1988, as will all production in Japan and Western Europe -- leaving only Eastern Bloc shipments, for both captive and OEM applications. Even the Eastern Bloc production is expected to suffer a slow decline, however, as Bulgarian production of fixed disk drives increases.

Continued growth for OEM shipments of 9" drives is expected, driven by the security requirements of the U.S. government -- which requires that many types of applications connected with national defense utilize disk media which is removable, to facilitate secure storage of confidential data. 1989 OEM shipments of 9" drives are forecasted at 22,000 units.

This group has suffered from intense competition from fixed disk drives, first 14", then 8" and now 5.25" models -- offering lower price, improved reliability, and usually smaller size. Control Data's 9" RSD provides a smaller size for those system manufacturers who still want disk pack drives in this capacity range, but the limited size of the potential market is not likely to attract further competition.

Technical trends

Control Data has used a conservative approach in designing the RSD. Recording density is higher than the SMD, but well below the most advanced drives of today -- leaving adequate design margins for the double density version the firm originally planned to add. Today's RSD is well designed to take advantage of the existing SMD customer base, providing exactly the same capacity, performance, file organization and interface, but in half the space, at a significant price reduction. It is not clear whether CDC will follow through with the original plans to do a double density version.

Forecasting assumptions

1. Captive and OEM shipments of 14" drives in this group by Western nations will continue to decline through 1987, displaced by smaller disk pack drives and a variety of fixed disk drives.
2. RSD drives will dominate shipments through 1989.
3. CDC will remain the only manufacturer for 9" disk pack drives.

TABLE 23

DISK PACK DRIVES, LESS THAN 100 MEGABYTES

REVENUE SUMMARY

	DISK DRIVE REVENUES, BY SHIPMENT DESTINATION ($M)									
	1985 Revenues		Forecast 1986		1987		1988		1989	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM Captive	--	--	--	--	--	--	--	--	--	--
Other U.S. Captive	40.7	66.9	19.1	31.7	14.6	24.4	.9	.9	--	--
TOTAL U.S. CAPTIVE	40.7	66.9	19.1	31.7	14.6	24.4	.9	.9	--	--
PCM	.9	.9	--	--	--	--	--	--	--	--
OEM	31.1	63.4	44.9	57.0	55.8	68.6	59.8	66.6	65.3	72.6
TOTAL U.S. NON-CAPTIVE	32.0	64.3	44.9	57.0	55.8	68.6	59.8	66.6	65.3	72.6
TOTAL U.S. REVENUES	72.7	131.2	64.0	88.7	70.4	93.0	60.7	67.5	65.3	72.6
Non-U.S. Manufacturers										
Captive	--	35.7	--	27.2	--	16.0	--	14.4	--	12.8
PCM	--	--	--	--	--	--	--	--	--	--
OEM	--	53.4	--	52.6	--	44.7	--	43.2	--	41.7
TOTAL NON-U.S. REVENUES	--	89.1	--	79.8	--	60.7	--	57.6	--	54.5
Worldwide Recap										
TOTAL WORLDWIDE REVENUES	72.7	220.3	64.0	168.5	70.4	153.7	60.7	125.1	65.3	127.1
OEM Average Price ($000)	3.9	4.3	3.7	4.1	3.5	4.0	3.3	3.8	3.2	3.7

TABLE 24

DISK PACK DRIVES, LESS THAN 100 MEGABYTES

UNIT SHIPMENT SUMMARY

	DISK DRIVE UNIT SHIPMENTS, BY SHIPMENT DESTINATION (000)									
	1985		Forecast							
	Shipments		1986		1987		1988		1989	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM Captive	--	--	--	--	--	--	--	--	--	--
Other U.S. Captive	4.5	7.9	2.7	4.8	2.0	3.4	.1	.1	--	--
TOTAL U.S. CAPTIVE	4.5	7.9	2.7	4.8	2.0	3.4	.1	.1	--	--
PCM	.1	.1	--	--	--	--	--	--	--	--
OEM	7.9	15.2	12.1	14.8	15.6	18.6	17.6	19.6	19.8	22.0
TOTAL U.S. NON-CAPTIVE	8.0	15.3	12.1	14.8	15.6	18.6	17.6	19.6	19.8	22.0
TOTAL U.S. SHIPMENTS	12.5	23.2	14.8	19.6	17.6	22.0	17.7	19.7	19.8	22.0
Non-U.S. Manufacturers										
Captive	--	2.3	--	1.7	--	1.0	--	.9	--	.8
PCM	--	--	--	--	--	--	--	--	--	--
OEM	--	11.4	--	11.3	--	9.5	--	9.0	--	8.5
TOTAL NON-U.S. SHIPMENTS	--	13.7	--	13.0	--	10.5	--	9.9	--	9.3
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	12.5	36.9	14.8	32.6	17.6	32.5	17.7	29.6	19.8	31.3
Cumulative Shipments										
IBM	--	--	--	--	--	--	--	--	--	--
Non-IBM	214.9	379.5	229.7	412.1	247.3	444.6	265.0	474.2	284.8	505.5
WORLDWIDE TOTAL	214.9	379.5	229.7	412.1	247.3	444.6	265.0	474.2	284.8	505.5

TABLE 25

DISK PACK DRIVES, LESS THAN 100 MEGABYTES

WORLDWIDE REVENUES ($M)

BREAKDOWN BY DISK DIAMETER

	1985 Revenues		Forecast							
			1986		1987		1988		1989	
	14"	9"	14"	9"	14"	9"	14"	9"	14"	9"
U.S. MANUFACTURERS										
Captive	64.5	2.4	29.3	2.4	22.4	2.0	--	.9	--	--
PCM	.9	--	--	--	--	--	--	--	--	--
OEM	36.7	26.7	12.0	45.0	10.4	58.2	--	66.6	--	72.6
TOTAL U.S. REVENUES	102.1	29.1	41.3	47.4	32.8	60.2	--	67.5	--	72.6
NON-U.S. MANUFACTURERS										
Captive	35.7	--	27.2	--	16.0	--	14.4	--	12.8	--
OEM	53.4	--	52.6	--	44.7	--	43.2	--	41.7	--
TOTAL NON-U.S. REVENUES	89.1	--	79.8	--	60.7	--	57.6	--	54.5	--
WORLDWIDE RECAP										
Captive	100.2	2.4	56.5	2.4	38.4	2.0	14.4	.9	12.8	--
	-41.5%	--	-43.6%	--	-32.0%	-16.7%	-62.5%	-55.0%	-11.1%	--
PCM	.9	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--	--
OEM	90.1	26.7	64.6	45.0	55.1	58.2	43.2	66.6	41.7	72.6
	-32.6%	+48.3%	-28.3%	+68.5%	-14.7%	+29.3%	-21.6%	+14.4%	-3.5%	+9.0%
Total Revenues	191.2	29.1	121.1	47.4	93.5	60.2	57.6	67.5	54.5	72.6
	-37.5%	+61.7%	-36.7%	+62.9%	-22.8%	+27.0%	-38.4%	+12.1%	-5.4%	+7.6%
ANNUAL SHARE, BY DIAMETER	86.9%	13.1%	72.0%	28.0%	60.9%	39.1%	46.1%	53.9%	43.0%	57.0%

TABLE 26

DISK PACK DRIVES, LESS THAN 100 MEGABYTES

WORLDWIDE SHIPMENTS (000)

BREAKDOWN BY DISK DIAMETER

	1985 Shipments		Forecast							
	1986		1987		1988		1989			
	14"	9"	14"	9"	14"	9"	14"	9"	14"	9"
U.S. MANUFACTURERS										
Captive	7.7	.2	4.6	.2	3.2	.2	--	.1	--	--
PCM	.1	--	--	--	--	--	--	--	--	--
OEM	8.0	7.2	2.3	12.5	2.0	16.6	--	19.6	--	22.0
TOTAL U.S. SHIPMENTS	15.8	7.4	6.9	12.7	5.2	16.8	--	19.7	--	22.0
NON-U.S. MANUFACTURERS										
Captive	2.3	--	1.7	--	1.0	--	.9	--	.8	--
OEM	11.4	--	11.3	--	9.5	--	9.0	--	8.5	--
TOTAL NON-U.S. SHIPMENTS	13.7	--	13.0	--	10.5	--	9.9	--	9.3	--
WORLDWIDE RECAP										
Captive	10.0	.2	6.3	.2	4.2	.2	.9	.1	.8	--
	-13.0%	--	-37.0%	--	-33.3%	--	-78.6%	-50.0%	-11.1%	--
PCM	.1	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--	--
OEM	19.4	7.2	13.6	12.5	11.5	16.6	9.0	19.6	8.5	22.0
	-32.4%	+80.0%	-29.9%	+73.6%	-15.4%	+32.8%	-21.7%	+18.1%	-5.6%	+12.2%
Total Shipments	29.5	7.4	19.9	12.7	15.7	16.8	9.9	19.7	9.3	22.0
	-26.8%	+85.0%	-32.5%	+71.6%	-21.1%	+32.3%	-36.9%	+17.3%	-6.1%	+11.7%
ANNUAL SHARE, BY DIAMETER	80.0%	20.0%	61.1%	38.9%	48.4%	51.6%	33.5%	66.5%	29.8%	70.2%

TABLE 27

DISK PACK DRIVES, LESS THAN 100 MEGABYTES

APPLICATIONS SUMMARY
Percentage of Worldwide Shipments

APPLICATION	1985 Estimate Units (000)	1985 Estimate %	1989 Projection Units (000)	1989 Projection %
MAINFRAME/SUPERMINI General purpose	3.2	8.7	.9	2.8
MINICOMPUTERS AND MULTI-USER MICROS Business and professional, including networks	13.9	37.8	6.6	21.1
MICROCOMPUTERS Business and professional, single user	--	--	--	--
OFFICE SYSTEMS AND WORKSTATIONS Dedicated application	14.0	37.9	4.6	14.7
NON-OFFICE SYSTEMS AND WORKSTATIONS Technical, distribution, medical, other specialized	5.2	14.0	19.2	61.4
CONSUMER AND HOBBY COMPUTERS	--	--	--	--
OTHER APPLICATIONS	.6	1.6	--	--
Total	36.9	100.0	31.3	100.0

TABLE 28

DISK PACK DRIVES, LESS THAN 100 MEGABYTES

DISTRIBUTION CHANNEL SUMMARY
U.S. Non-Captive Disk Drives

Distribution channel	1985 U.S. Net Shipments Units (000)	%	FORECAST 1986 %	1987 %	1988 %	1989 %
Mainframe computer manufacturers	1.7	20.7	19.8	19.0	18.3	17.6
Mini/micro computer manufacturers	1.1	13.8	15.2	16.1	16.9	17.5
System OEMs/systems houses	3.7	46.7	50.7	54.0	56.5	58.5
Independent peripherals suppliers	.4	4.9	3.9	3.1	2.5	2.0
Distributors, dealers, end users	1.1	13.9	10.4	7.8	5.8	4.4
TOTAL	8.0					

TABLE 29

DISK PACK DRIVES, LESS THAN 100 MEGABYTES

MARKET SHARE SUMMARY
Worldwide Shipments of Non-Captive Disk Drives

Drive Manufacturers	1985 Net Shipments: To United States Destinations Units (000) 14"	8"	Total	%	Worldwide Units (000) 14"	8"	Total	%
CONTROL DATA	1.4	6.5	7.9	98.8	8.0	7.2	15.2	56.9
ISOT	--	--	--	--	11.3	--	11.3	42.3
Other U.S.	.1	--	.1	1.2	.1	--	.1	.4
Other Non-U.S.	--	--	--	--	.1	--	.1	.4
TOTAL	1.5	6.5	8.0	100.0	19.5	7.2	26.7	100.0

DISK PACK DRIVES, MORE THAN 100 MB

DISK PACK DRIVES, MORE THAN 100 MEGABYTES

Coverage

Examples of disk drives in this group include:

Burroughs	9484-13
Century Data Systems	T306
Control Data	9766
Data General	6060
Digital Equipment	RA60
Hewlett-Packard	7935H
ISOT	ES 5066, ES 5067
Kovo (Aritma)	4080, 5080
NEC	N7745

IBM's introduction of the 3330, with 19 data surfaces, in 1971 set the model for the physical configuration now in predominant use, even though the initial IBM drive had only 100 MB capacity. The major product still in new production today is the Control Data 300 MB SMD. Products introduced in more recent years include the Digital Equipment RA60 (14" 205 MB using 6 data surfaces) and the Hewlett-Packard 7935H (14" 404 MB using 13 data surfaces).

Market status

DISK/TREND estimate of total market size:

Worldwide sales ($M)	1985	1986	1987	1988	1989
U.S. manufacturers	395.7	330.6	247.0	163.7	90.1
All manufacturers	448.7	382.6	307.0	218.7	135.1

Large disk pack drives reversed a long-term decline during 1984, but resumed their downward trend in 1985, with worldwide shipments dropping to 34,900 spindles, down 31.7%. 1986 worldwide shipments are expected to be 31,700 units, a reduction of only 9.2%.

Although declining in total shipments, the market for large disk pack drives produced by U.S. companies has proven remarkably resilient during 1986. Fixed disk drives of equivalent capacity offer better cost per megabyte and are more reliable, but the removability of disk pack drives is a feature still valued for security applications and when exchangable data bases are required. Although U.S. captive drive shipments are expected to decline almost 3,000 units in 1986, OEM shipments will go down only about 400 units. Outside the U.S., the only remaining significant production of drives in this group is in Eastern Bloc countries.

Control Data remained the leader in worldwide shipments of OEM drives during 1985, as they have consistently done over the years, with 12,000 spindles, 62.5% of the worldwide total. The only other substantial producer of OEM drives in this group is ISOT, the Bulgarian computer peripherals manufacturer, with 24% of 1985 worldwide shipments.

Marketing trends

Although the DISK/TREND forecast for large disk pack drives has been increased slightly, in recognition that the product group provides the only available answer for certain function requirements, the trend remains downward over the years.

U.S. captive and OEM shipments are forecasted to drop from 1985's total of 30,000 spindles to 9,300 in 1989. Non-U.S. shipments are almost entirely within the Eastern Bloc, with modest increases forecasted through 1987, then a continuing decline as growing production of large fixed disk drives in Eastern Europe displaces older disk pack drives.

Nothing on the horizon is likely to reverse the basic trend. Competition from fixed disk drives, including 8", 10.5" and 14" versions, is

simply too effective, considering the improved reliability and lower cost they offer. The fixed disk drives are obviously being designed into most new systems requiring capacities in this range.

Technical trends

It remains unclear whether any significant new disk pack drives will be introduced. Higher effective areal densities have been achieved by DEC's RA60 and H-P's 7935H, partially through use of run length limited encoding. However, there are no known plans by any drive manufacturer to develop a new drive in this group using today's technology -- with the possible exception of Control Data, which has previously indicated to customers that the firm might produce a 160 megabyte version of its RSD 9" disk pack drive.

Forecasting assumptions

1. Worldwide shipments of drives in this group will decline, due to displacement by newer systems and disk drives.

TABLE 30

DISK PACK DRIVES, MORE THAN 100 MEGABYTES

REVENUE SUMMARY

	DISK DRIVE REVENUES, BY SHIPMENT DESTINATION ($M)									
	1985 Revenues		Forecast 1986		1987		1988		1989	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM Captive	--	--	--	--	--	--	--	--	--	--
Other U.S. Captive	129.9	266.6	98.3	217.8	60.0	142.5	39.2	93.8	19.5	49.4
TOTAL U.S. CAPTIVE	129.9	266.6	98.3	217.8	60.0	142.5	39.2	93.8	19.5	49.4
PCM	--	--	--	--	--	--	--	--	--	--
OEM	94.9	129.1	79.6	112.8	73.3	104.5	48.6	69.9	29.6	40.7
TOTAL U.S. NON-CAPTIVE	94.9	129.1	79.6	112.8	73.3	104.5	48.6	69.9	29.6	40.7
TOTAL U.S. REVENUES	224.8	395.7	177.9	330.6	133.3	247.0	87.8	163.7	49.1	90.1
Non-U.S. Manufacturers										
Captive	--	6.0	--	3.0	--	--	--	--	--	--
PCM	--	--	--	--	--	--	--	--	--	--
OEM	--	47.0	--	49.0	--	60.0	--	55.0	--	45.0
TOTAL NON-U.S. REVENUES	--	53.0	--	52.0	--	60.0	--	55.0	--	45.0
Worldwide Recap										
TOTAL WORLDWIDE REVENUES	224.8	448.7	177.9	382.6	133.3	307.0	87.8	218.7	49.1	135.1
OEM Average Price ($000)	8.9	9.1	8.0	8.5	7.7	8.4	7.5	8.4	7.4	8.5

TABLE 31

DISK PACK DRIVES, MORE THAN 100 MEGABYTES

UNIT SHIPMENT SUMMARY

	DISK DRIVE UNIT SHIPMENTS, BY SHIPMENT DESTINATION (000)									
	1985 Shipments		Forecast 1986		1987		1988		1989	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM Captive	--	--	--	--	--	--	--	--	--	--
Other U.S. Captive	8.0	15.5	6.1	12.6	4.0	9.5	2.8	6.7	1.5	3.8
TOTAL U.S. CAPTIVE	8.0	15.5	6.1	12.6	4.0	9.5	2.8	6.7	1.5	3.8
PCM	--	--	--	--	--	--	--	--	--	--
OEM	10.6	14.5	9.9	14.1	9.4	13.4	6.4	9.2	4.0	5.5
TOTAL U.S. NON-CAPTIVE	10.6	14.5	9.9	14.1	9.4	13.4	6.4	9.2	4.0	5.5
TOTAL U.S. SHIPMENTS	18.6	30.0	16.0	26.7	13.4	22.9	9.2	15.9	5.5	9.3
Non-U.S. Manufacturers										
Captive	--	.2	--	.1	--	--	--	--	--	--
PCM	--	--	--	--	--	--	--	--	--	--
OEM	--	4.7	--	4.9	--	6.0	--	5.5	--	4.5
TOTAL NON-U.S. SHIPMENTS	--	4.9	--	5.0	--	6.0	--	5.5	--	4.5
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	18.6	34.9	16.0	31.7	13.4	28.9	9.2	21.4	5.5	13.8
Cumulative Shipments										
IBM	41.3	72.6	41.3	72.6	41.3	72.6	41.3	72.6	41.3	72.6
Non-IBM	265.1	464.0	281.1	495.7	294.5	524.6	303.7	546.0	309.2	559.8
WORLDWIDE TOTAL	306.4	536.6	322.4	568.3	335.8	597.2	345.0	618.6	350.5	632.4

TABLE 32

DISK PACK DRIVES, MORE THAN 100 MEGABYTES

APPLICATIONS SUMMARY
Percentage of Worldwide Shipments

APPLICATION	1985 Estimate Units (000)	1985 Estimate %	1989 Projection Units (000)	1989 Projection %
MAINFRAME/SUPERMINI General purpose	10.3	29.4	2.7	19.5
MINICOMPUTERS AND MULTI-USER MICROS Business and professional, including networks	17.6	50.6	6.5	47.0
MICROCOMPUTERS Business and professional, single user	--	--	--	--
OFFICE SYSTEMS AND WORKSTATIONS Dedicated application	2.1	6.0	--	--
NON-OFFICE SYSTEMS AND WORKSTATIONS Technical, distribution, medical, other specialized	3.8	11.0	4.5	33.1
CONSUMER AND HOBBY COMPUTERS	--	--	--	--
OTHER APPLICATIONS	1.1	3.0	.1	.4
Total	34.9	100.0	13.8	100.0

TABLE 33

DISK PACK DRIVES, MORE THAN 100 MEGABYTES
DISTRIBUTION CHANNEL SUMMARY
U.S. Non-Captive Disk Drives

Distribution channel	1985 U.S. Net Shipments Units (000)	1985 U.S. Net Shipments %	FORECAST 1986 %	1987 %	1988 %	1989 %
Mainframe computer manufacturers	--	--	--	--	--	--
Mini/micro computer manufacturers	3.5	33.3	36.7	39.9	43.1	46.0
System OEMs/systems houses	5.6	52.5	52.8	53.0	52.7	51.8
Independent peripherals suppliers	.7	6.3	5.0	3.8	2.6	1.5
Distributors, dealers, end users	.8	7.9	5.5	3.3	1.6	.7
TOTAL	10.6					

TABLE 34

DISK PACK DRIVES, MORE THAN 100 MEGABYTES
MARKET SHARE SUMMARY
Worldwide Shipments of Non-Captive Disk Drives

Drive Manufacturers	1985 Net Shipments To United States Destinations Units (000)	To United States Destinations %	Worldwide Units (000)	Worldwide %
CONTROL DATA	8.4	79.2	12.0	62.5
ISOT	--	--	4.6	24.0
Other U.S.	2.2	20.8	2.5	13.0
Other Non-U.S.	--	--	.1	.5
TOTAL	10.6	100.0	19.2	100.0

FIXED DISK DRIVES, LESS THAN 30 MB

1986 DISK/TREND REPORT

FIXED DISK DRIVES, LESS THAN 30 MEGABYTES

Coverage

Examples of disk drives in this group include:

14" disk diameter

Data General	6100
Hewlett-Packard	7911

8 disk diameter

Data General	6220, 6227
Fujitsu	M2301, M2302
Hitachi	DK811-2
IBM	8101-A11
Quantum	Q2010, Q2020

5.25" disk diameter

Alps Electric	DRA010A*, DRA020A*
BASF	6188*
Bull	D506, D510
Cogito Systems	CG912*, PT925*
Control Data	9415-321, 9415-528
Epson	HD-830*, HD860*
Fujitsu	M2235AS
Hitachi	DK502-1/2/3, DK503-2*
IBM	5160-089, 5170-099
Josephine County Technology	JCT-100, JCT-110
Matsushita Communication Ind.	JU-614, JU-616, JU-664*
Microscience International	HH612*, HH-725*
Miniscribe	3212*, 3425*
Mitsubishi	MR521*, MR522*
NEC	D5244, D5126H*
Nippon Electric Industry	RD-4127, RD-2255*
Nippon Peripherals	NP02-26A*, NP04-26
Olivetti	HD662/12*, HD670/12*
Otari	C-514, C-526, C-226*
Quantum	Q520
Rodime	R0202E, R0204
Seagate Technology	ST225*, ST225N*, ST4026
Tandon	TM252*
TEAC	SD-510*, SD-520*
Tokico	DK502-3, DK505-2*
Tokyo Electric	TD-5526*
Tulin	TL226*, TL326*
Xebec	Owl I, Owl II

3.9" disk diameter

Nippon Systemhouse	SQ325F*
SyQuest Technology	SQ325F*

3.5" disk diameter

Alps Electric	DRM020A*, DRN020A*
Epson	HMD-720*
Fuji Electric	FK302-26*
Fujitsu	M2223A*, M2224A*
Hewlett-Packard	97501A, 97501B
Hitachi	DK301-1*, DK301-2*
IBM	WD-325*
LaPine Technology	LT200*
Matsushita Com. Ind.	JU-114*, JU-116*
Microscience International	HH-325*, Easycard*
Miniscribe	8425*, 8425S*
Mitsubishi Electric	MR321*, MR322*
NEC	D3126*
Nippon Peripherals	NP03-13*, NP03-20*
Olivetti	362*, 372*
Peripheral Technology	PT-225*
Plus Development	Hardcard, Hardcard 20
Rodime	R0352*, R0652*
Tandon	TM362*, Businesscard 21*
Victor Company of Japan	JD-3806M*, JD3812M*

*Indicates drives with maximum 41 mm height, or less.

All drives in this group use variations of the technology loosely described as "Winchester". Most use 3340/3350 type ferrite heads, and some use the newer "mini-Winchester" heads which employ ferrite cores in 3370-type sliders. The majority of drives in the group use conventional oxide disks, with others employing plated or sputtered disks.

Most of the 5.25" drives and some of the 8" and 14" drives use head positioning systems driven by stepping motors, with relatively slow average access times, but low costs. Some drives in the group use voice coil or torque motor actuators, rotary or linear, to produce access times suitable for high end single user personal computers or multiple workstation systems.

Market status

DISK/TREND estimate of total market size:

Worldwide sales ($M)	1985	1986	1987	1988	1989
U.S. manufacturers	1,143.3	1,342.1	1,414.8	1,793.2	2,161.2
All manufacturers	1,862.6	2,074.6	2,265.4	2,738.5	3,214.8

1985 growth in shipments for fixed disk drives less than 30 megabytes was slower than the frantic pace of the early 1980's, impacted by a lower growth rate in the personal computer industry. Nevertheless, worldwide shipments were 3,287,100 units in 1985, up 29.9%, with 1986 forecasted to achieve even higher growth, up 43.3%, to 4,709,400 units.

As expected, 3.5" inch drives were produced in large quantities for the first time during 1985, with shipments totaling 356,100 drives. In 1986, the movement to 3.5" drives is gaining momentum, with shipments estimated at 1,525,900 units, 32.3% of the group's worldwide total. As 5.25" drives continue to lose ground to 3.5" models, they also have undergone a transition from the original 3.25" high versions to half high configurations. 1986 5.25" drive shipments are estimated at 2,546,600 half high, compared to only 623,900 full size drives. 14" and 8" drives now account for only .3% of total worldwide shipments in this group.

Although there is a broad customer base for OEM 5.25" and 3.5" drives, consisting of hundreds of manufacturers of personal computers and other small systems, in this segment of the industry IBM has assumed a dominant role which cannot be overlooked.

IBM's actions, both as a customer and as a captive producer, thoroughly shook the stability of the leading manufacturers of 5.25" drives in this group during the 1984-85 period. With the introduction of the PC XT, IBM became the largest OEM customer for 10 megabyte 5.25" drives from

Seagate, Miniscribe and International Memories. And with the advent of the PC AT in 1984, IBM's purchases of 20 megabyte drives overwhelmed Computer Memories, eventually becoming over 80% of the firm's sales. Ironically, the managements of each of these companies were delighted with their huge sales to IBM, right up to the point of abrupt termination.

IBM's erratic buying patterns had created chaos among vendors of low-end 5.25" drives starting in early 1984, but the more severe stroke was establishment of major internal production programs by IBM for stepping motor 5.25" drives at Fujisawa and voice coil 5.25" drives at Rochester, Minnesota, and Havant, in England.

For over a year IBM appears to have relied completely on internal production of 5.25" stepping motor drives for the PC XT product family, finally adding a 20 megabyte model for the XT in 1986. In the autumn of this year IBM again started buying 5.25" stepping motor drives from Seagate, with a contract for 20 megabyte drives -- apparently a move to cover its internal production shortfall while the Fujisawa plant is being converted to manufacture 3.5" drives. Since 1985, IBM has also been obtaining 30 megabyte 5.25" drives from Seagate for the PC AT product line.

IBM's estimated 1986 shipments of 524,000 8", 5.25" and 3.5" drives will be five times the captive shipments of other U.S. producers, which consist mostly of Hewlett-Packard and Tandon. Captive production by non-U.S. firms is more widespread, with substantial 5.25" and/or 3.5" programs underway by most major Japanese disk drive producers and Olivetti.

Under pressure from both 3.5" drives and the growth of captive manufacturing programs, worldwide OEM shipments of 5.25" drives increased only 10% in 1985, and an estimated additional 10% in 1986. Worldwide OEM shipments of 3.5" drives increased 403% in 1985 and an estimated 261% in

1986. Seagate remained the leader in non-captive shipments, with 666,000 drives, all 5.25", for 24.4% of the worldwide total. NEC rose to 11.4% and Miniscribe fell to 11.0%, both shipping a combination of 5.25" and 3.5" drives.

Single user microcomputers, mostly personal computers, used 82.9% of the disk drives in this group in 1985, and this share is expected to increase to 88.3% in 1988. Modest decreases in share are anticipated in applications such as minicomputers, multiple user micros and dedicated application office systems, due to the movement to higher capacity drives.

Marketing trends

As usual in segments of the computer industry in which IBM has a dominant market position, the firm's product introductions become the major pacing factor in development of markets for new product configurations. Accordingly, the DISK/TREND forecasts for product mix and shipment volume in this group depend upon the assumption that IBM will substitute 3.5" for 5.25" drives in mid-range office personal computer models such as the PC XT. Thus IBM's last production of 5.25" drives in this group is expected in 1986, with 1987's 3.5" shipments increasing sharply, to at least 730,000 units -- and growing to 1,650,000 in 1989.

The overall effect of IBM's adoption of 3.5" drives as a standard peripheral for worldwide personal computer applications will be to ratify system planning decisions already made by many OEMs and to stampede others, including most of the manufacturers of IBM PC clones, to rapid utilization of 3.5" drives. These actions will increase the share of total worldwide shipments held by 3.5" drives to 50.8% in 1987, growing to 90.9% in 1989. During the 1987-89 period, worldwide unit shipments of

3.5" drives are expected to increase an average of 79.2% per year, while 5.25" drives will decline an average of 30.8% per year. In the midst of all of these changes in product mix the big loser is the original full size 5.25" drive format:

Worldwide captive & OEM Unit shipments (000)	1985	1986	1987	1988	1989
5.25" full size	1,122.8	623.9	106.0	51.0	48.0
	34.5%	13.3%	1.7%	.7%	.5%
5.25" half high	1,779.5	2,546.6	2,917.0	2,214.0	802.0
	54.6%	54.2%	47.3%	28.3%	8.5%
3.5" (including 3.9")	356.1	1,525.9	3,147.0	5,545.0	8,600.0
	10.9%	32.5%	51.0%	71.0%	91.0%

Full size 5.25" drives are already an insignificant factor in the OEM market, and captive shipments will drop further in 1987, in the absence of IBM production. Without Eastern Bloc shipments of full size drives, which will probably continue indefinitely, production of drives in this form factor would stop completely by 1988.

Due to the dramatic changes in the dollar/yen exchange rate during the last year, U.S. disk drive producers have held a larger share of the growing market for 3.5" OEM drives than was previously anticipated, even without the participation of Seagate, the 5.25" leader. U.S. manufacturers' share of worldwide OEM 3.5" drive shipments was 44% in 1985, but is expected to be 55% in 1986, leveling off at about 60% in 1988-89.

Technical trends

Large production volume and low cost are the key factors addressed in the engineering effort devoted to disk drives in this group. The problem is to achieve the high production volumes despite use of

continually higher recording densities, as disk diameters go down and users' appetite for more capacity go up.

Although several initially available 3.5" drives used disks with 40 mm inner diameters, 25 mm has been more widely used, to increase the recording area per disk. The result is linear densities in the 13,000 to 15,000 bits per inch range. Plated, sputtered and high density oxide disks suitable at this density range are all in use.

Two interrelated future developments may be expected to increase the cost effectiveness of 3.5" drives in this group. It will be cheaper to package the controller function within the disk drive, and drives with embedded SCSI controllers are already available. SCSI drives, plus those with embedded controllers for IBM personal computers, are expected to constitute a high percentage of OEM drive shipments in a few years.

Embedded controllers will also make it possible to take the next step in recording density without waiting for acceptance of a new interface standard, since the physical characteristics of drives will be masked from systems. As adequate heads and disks become available, production of 3.5" drives in the 20-30 megabyte range using only one disk will lower drive costs and make further miniaturization possible.

Forecasting assumptions

1. IBM will discontinue production of 5.25" drives in this product group and will rapidly accelerate production of 3.5" drives, with wide usage in its personal computer systems.
2. 3.5" drives will lead shipments in this group starting in 1987.
3. Continued growth in the overall office personal computer and portable computer markets will maintain average annual growth for this product group above 25%.

TABLE 35

FIXED DISK DRIVES, LESS THAN 30 MEGABYTES

REVENUE SUMMARY

	DISK DRIVE REVENUES, BY SHIPMENT DESTINATION ($M)									
	1985		Forecast							
	Revenues		1986		1987		1988		1989	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM Captive	301.4	401.4	407.0	579.4	372.0	547.5	546.0	826.0	689.0	1,072.5
Other U.S. Captive	48.2	53.7	51.5	67.4	73.0	81.6	85.9	101.2	89.6	112.0
TOTAL U.S. CAPTIVE	349.6	455.1	458.5	646.8	445.0	629.1	631.9	927.2	778.6	1,184.5
PCM	.6	.7	--	--	--	--	--	--	--	--
OEM	566.4	687.5	530.5	695.3	577.7	785.7	622.3	866.0	680.4	976.7
TOTAL U.S. NON-CAPTIVE	567.0	688.2	530.5	695.3	577.7	785.7	622.3	866.0	680.4	976.7
TOTAL U.S. REVENUES	916.6	1,143.3	989.0	1,342.1	1,022.7	1,414.8	1,254.2	1,793.2	1,459.0	2,161.2
Non-U.S. Manufacturers										
Captive	70.2	422.5	55.5	352.8	61.3	377.0	71.3	379.8	81.5	379.9
PCM	--	--	--	--	--	--	--	--	--	--
OEM	93.2	296.8	109.0	379.7	165.4	473.6	235.9	565.5	350.8	673.7
TOTAL NON-U.S. REVENUES	163.4	719.3	164.5	732.5	226.7	850.6	307.2	945.3	432.3	1,053.6
Worldwide Recap										
TOTAL WORLDWIDE REVENUES	1,080.0	1,862.6	1,153.5	2,074.6	1,249.4	2,265.4	1,561.4	2,738.5	1,891.3	3,214.8
OEM Average Price ($000)	.375	.360	.272	.279	.250	.254	.234	.238	.230	.233

TABLE 36

FIXED DISK DRIVES, LESS THAN 30 MEGABYTES

UNIT SHIPMENT SUMMARY

	DISK DRIVE UNIT SHIPMENTS, BY SHIPMENT DESTINATION (000)									
	1985 Shipments		Forecast 1986		1987		1988		1989	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM Captive	237.8	317.0	367.0	524.0	496.0	730.0	780.0	1,180.0	1,060.0	1,650.0
Other U.S. Captive	17.5	21.7	97.8	112.8	158.3	176.4	202.0	238.0	224.0	280.0
TOTAL U.S. CAPTIVE	255.3	338.7	464.8	636.8	654.3	906.4	982.0	1,418.0	1,284.0	1,930.0
PCM	.5	.6	--	--	--	--	--	--	--	--
OEM	1,478.6	1,826.4	1,945.7	2,553.9	2,329.3	3,164.3	2,670.5	3,715.0	2,966.0	4,257.0
TOTAL U.S. NON-CAPTIVE	1,479.1	1,827.0	1,945.7	2,553.9	2,329.3	3,164.3	2,670.5	3,715.0	2,966.0	4,257.0
TOTAL U.S. SHIPMENTS	1,734.4	2,165.7	2,410.5	3,190.7	2,983.6	4,070.7	3,652.5	5,133.0	4,250.0	6,187.0
Non-U.S. Manufacturers										
Captive	39.0	214.9	37.0	224.9	54.0	303.5	77.2	380.0	107.5	448.0
PCM	--	--	--	--	--	--	--	--	--	--
OEM	281.0	906.5	407.5	1,293.8	638.6	1,801.0	996.5	2,303.0	1,522.2	2,822.0
TOTAL NON-U.S. SHIPMENTS	320.0	1,121.4	444.5	1,518.7	692.6	2,104.5	1,073.7	2,683.0	1,629.7	3,270.0
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	2,054.4	3,287.1	2,855.0	4,709.4	3,676.2	6,175.2	4,726.2	7,816.0	5,879.7	9,457.0
Cumulative Shipments										
IBM	414.4	550.9	781.4	1,074.9	1,277.4	1,804.9	2,057.4	2,984.9	3,117.4	4,634.9
Non-IBM	5,004.8	7,308.4	7,492.8	11,493.8	10,673.0	16,939.0	14,619.2	23,575.0	19,438.9	31,382.0
WORLDWIDE TOTAL	5,419.2	7,859.3	8,274.2	12,568.7	11,950.4	18,743.9	16,676.6	26,559.9	22,556.3	36,016.9

TABLE 37

FIXED DISK DRIVES, LESS THAN 30 MEGABYTES

WORLDWIDE REVENUES ($M)

BREAKDOWN BY DISK DIAMETER

	1985 Revenues				Forecast													
					1986				1987				1988			1989		
	14"	8"	5.25"	3.5"	14"	8"	5.25"	3.5"	14"	8"	5.25"	3.5"	8"	5.25"	3.5"	8"	5.25"	3.5"
U.S. MANUFACTURERS																		
IBM Captive	--	51.1	350.3	--	--	28.4	364.0	187.0	--	--	--	547.5	--	--	826.0	--	--	1,072.5
Other U.S. Captive	11.7	24.5	7.5	10.0	2.0	3.0	.7	61.7	.9	1.5	--	79.2	--	--	101.2	--	--	112.0
PCM	--	--	.7	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
OEM	.2	10.4	621.7	55.2	--	2.5	483.1	209.7	--	.7	469.6	315.4	--	321.7	544.3	--	107.3	869.4
TOTAL U.S. REVENUES	11.9	86.0	980.2	65.2	2.0	33.9	847.8	458.4	.9	2.2	469.6	942.1	--	321.7	1,471.5	--	107.3	2,053.9
NON-U.S. MANUFACTURERS																		
Captive	--	--	407.5	15.0	--	--	313.3	39.5	--	--	242.9	134.1	--	166.2	213.6	--	122.3	257.6
OEM	--	10.2	228.0	58.6	--	9.0	227.7	143.0	--	7.2	237.9	228.5	13.2	189.4	362.9	15.4	78.3	580.0
TOTAL NON-U.S. REVENUES	--	10.2	635.5	73.6	--	9.0	541.0	182.5	--	7.2	480.8	362.6	13.2	355.6	576.5	15.4	200.6	837.6
WORLDWIDE RECAP																		
Captive	11.7	75.6	765.3	25.0	2.0	31.4	678.0	288.2	.9	1.5	242.9	760.8	--	166.2	1,140.8	--	122.3	1,442.1
	-57.0%	-51.3%	+47.5%	--	-82.9%	-58.5%	-11.4%	--	-55.0%	-95.2%	-64.2%	+164.0%	--	-31.6%	+49.9%	--	-26.4%	+26.4%
PCM	--	--	.7	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	--	--	-50.0%	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
OEM	.2	20.6	849.7	113.8	--	11.5	710.8	352.7	--	7.9	707.5	543.9	13.2	511.1	907.2	15.4	185.6	1,449.4
	-88.9%	-51.5%	-4.6%	+386.3%	--	-44.2%	-16.3%	+209.9%	--	-31.3%	-.5%	+54.2%	+67.1%	-27.8%	+66.8%	+16.7%	-63.7%	+59.8%
Total Revenues	11.9	96.2	1,615.7	138.8	2.0	42.9	1,388.8	640.9	.9	9.4	950.4	1,304.7	13.2	677.3	2,048.0	15.4	307.9	2,891.5
	-59.0%	-51.3%	+14.5%	+493.2%	-83.2%	-55.4%	-14.0%	+361.7%	-55.0%	-78.1%	-31.6%	+103.6%	+40.4%	-28.7%	+57.0%	+16.7%	-54.5%	+41.2%
ANNUAL SHARE, BY DIAMETER	.6%	5.2%	86.8%	7.4%	.1%	2.1%	67.0%	30.8%	--	.4%	42.1%	57.5%	.5%	24.7%	74.8%	.5%	9.6%	89.9%

NOTE: 3.5 inch totals include 3.9 inch drives

TABLE 38

FIXED DISK DRIVES, LESS THAN 30 MEGABYTES

WORLDWIDE SHIPMENTS (000)

BREAKDOWN BY DISK DIAMETER

	1985 Shipments				Forecast: 1986				1987				1988				1989		
	14"	8"	5.25"	3.5"	14"	8"	5.25"	3.5"	14"	8"	5.25"	3.5"	8"	5.25"	3.5"	8"	5.25"	3.5"
U.S. MANUFACTURERS																		
IBM Captive	--	7.0	310.0	--	--	4.0	350.0	170.0	--	--	--	730.0	--	--	1,180.0	--	--	1,650.0
Other U.S. Captive	1.8	4.9	5.0	10.0	.2	.6	2.0	110.0	.1	.3	--	176.0	--	--	238.0	--	--	280.0
PCM	--	--	.6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
OEM	.1	9.5	1,668.7	148.1	--	2.7	1,891.2	660.0	--	.8	1,950.5	1,213.0	--	1,399.0	2,316.0	--	477.0	3,780.0
TOTAL U.S. SHIPMENTS	1.9	21.4	1,984.3	158.1	.2	7.3	2,243.2	940.0	.1	1.1	1,950.5	2,119.0	--	1,399.0	3,734.0	--	477.0	5,710.0
NON-U.S. MANUFACTURERS																		
Captive	--	--	202.4	12.5	--	--	185.5	39.4	--	--	154.5	149.0	--	113.0	267.0	--	80.0	368.0
OEM	--	5.4	715.6	185.5	--	5.5	741.8	546.5	--	4.0	918.0	879.0	6.0	753.0	1,544.0	7.0	293.0	2,522.0
TOTAL NON-U.S. SHIPMENTS	--	5.4	918.0	198.0	--	5.5	927.3	585.9	--	4.0	1,072.5	1,028.0	6.0	866.0	1,811.0	7.0	373.0	2,890.0
WORLDWIDE RECAP																		
Captive	1.8	11.9	517.4	22.5	.2	4.6	537.5	319.4	.1	.3	154.5	1,055.0	--	113.0	1,685.0	--	80.0	2,298.0
	-56.1%	-53.0%	+228.7%	--	-88.9%	-61.3%	+3.9%	--	-50.0%	-93.5%	-71.3%	+230.3%	--	-26.9%	+59.7%	--	-29.2%	+36.4%
PCM	--	--	.6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	--	--	-33.3%	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
OEM	.1	14.9	2,384.3	333.6	--	8.2	2,633.0	1,206.5	--	4.8	2,868.5	2,092.0	6.0	2,152.0	3,860.0	7.0	770.0	6,302.0
	-91.7%	-59.0%	+10.2%	+403.2%	--	-45.0%	+10.4%	+261.7%	--	-41.5%	+8.9%	+73.4%	+25.0%	-25.0%	+84.5%	+16.7%	-64.2%	+63.3%
Total Shipments	1.9	26.8	2,902.3	356.1	.2	12.8	3,170.5	1,525.9	.1	5.1	3,023.0	3,147.0	6.0	2,265.0	5,545.0	7.0	850.0	8,600.0
	-64.2%	-56.5%	+25.0%	+437.1%	-89.5%	-52.2%	+9.2%	+328.5%	-50.0%	-60.2%	-4.7%	+106.2%	+17.6%	-25.1%	+76.2%	+16.7%	-62.5%	+55.1%
ANNUAL SHARE, BY DIAMETER	.1%	.8%	88.4%	10.7%	--	.3%	67.4%	32.3%	--	.1%	49.1%	50.8%	.1%	29.1%	70.8%	.1%	9.0%	90.9%

NOTE: 3.5 inch totals include 3.9 inch drives

TABLE 39

FIXED DISK DRIVES, LESS THAN 30 MEGABYTES

APPLICATIONS SUMMARY
Percentage of Worldwide Shipments

	1985 Estimate		1989 Projection	
APPLICATION	Units (000)	%	Units (000)	%
MAINFRAME/SUPERMINI				
General purpose	37.4	1.1	18.9	.2
MINICOMPUTERS AND MULTI-USER MICROS				
Business and professional, including networks	213.7	6.5	293.1	3.1
MICROCOMPUTERS				
Business and professional, single user	2,723.7	82.9	8,350.5	88.3
OFFICE SYSTEMS AND WORKSTATIONS				
Dedicated application	168.3	5.1	264.8	2.8
NON-OFFICE SYSTEMS AND WORKSTATIONS				
Technical, distribution, medical, other specialized	82.5	2.5	293.2	3.1
CONSUMER AND HOBBY COMPUTERS	50.0	1.5	208.1	2.2
OTHER APPLICATIONS	11.5	.4	28.4	.3
Total	3,287.1	100.0	9,457.0	100.0

TABLE 40

FIXED DISK DRIVES, LESS THAN 30 MEGABYTES

DISTRIBUTION CHANNEL SUMMARY
U.S. Non-Captive Disk Drives

Distribution channel	1985 U.S. Net Shipments Units (000)	%	FORECAST 1986 %	1987 %	1988 %	1989 %
Mainframe computer manufacturers	572.8	32.6	19.2	13.4	9.6	6.3
Mini/micro computer manufacturers	237.6	13.5	13.6	22.8	27.3	29.6
System OEMs/systems houses	419.4	23.8	25.2	42.4	50.7	54.9
Independent peripherals suppliers	263.7	15.0	8.2	4.6	2.7	1.3
Distributors, dealers, end users	266.6	15.1	33.8	16.8	9.7	7.9
TOTAL	1,760.1					

TABLE 41

FIXED DISK DRIVES, LESS THAN 30 MEGABYTES

MARKET SHARE SUMMARY
Worldwide Shipments of Non-Captive Disk Drives

Drive Manufacturers	1985 Net Shipments To United States Destinations Units (000) 14"	8"	5.25"	3.5"	Total	%	Worldwide Units (000) 14"	8"	5.25"	3.5"	Total	%
SEAGATE	--	--	533.0	--	533.0	30.3	--	--	666.0	--	666.0	24.4
NEC	--	--	50.0	22.5	72.5	4.1	--	--	275.8	34.6	310.4	11.4
MINISCRIBE	--	--	212.0	40.2	252.2	14.3	--	--	251.7	48.3	300.0	11.0
COMPUTER MEM	--	--	291.2	--	291.2	16.5	--	--	297.0	--	297.0	10.9
TANDON	--	--	131.9	6.8	138.7	7.9	--	--	207.9	10.8	218.7	8.0
RODIME	--	--	27.0	96.0	123.0	7.0	--	--	60.0	120.0	180.0	6.6
MICROSCIENCE	--	--	63.0	6.0	69.0	3.9	--	--	105.0	10.0	115.0	4.2
BASF	--	--	--	--	--	--	--	--	80.0	--	80.0	2.8
Other U.S.	.1	5.1	114.5	75.3	195.0	11.1	.1	9.5	141.7	79.0	230.3	8.4
Other Non-U.S.	--	2.1	56.4	27.0	85.5	4.9	--	5.4	299.8	30.9	336.1	12.3
TOTAL	.1	7.2	1479.0	273.8	1760.1	100.0	.1	14.9	2384.9	333.6	2733.5	100.0

NOTE: 3.5 inch totals include 3.9 inch drives

FIXED DISK DRIVES, 30-100 MB

1986 DISK/TREND REPORT

FIXED DISK DRIVES, 30-100 MEGABYTES

Coverage

Examples of disk drives in this group include:

14" disk diameter

Data General	6234
Hewlett-Packard	7912
Priam	6650

8" disk diameter

Fujitsu	M2303, M2312K, M2321K
Hitachi	DK 811-4, DK812S-8
IBM	3310, 4963-64A, 680
NEC	D2246, D2247
Northern Telecom	8204X
Priam	7050, 803
Quantum	Q2030, Q2040
Toshiba	MK-182FB

5.25" disk diameter

Atasi	2085, 3085
BASF	6192, 6195
Brand Technologies	BT 8085
Bull	D550, D570, D585
Control Data	94155, 94205*
Cybernex Adv. Storage Tech.	10203*, 10304*
Fujitsu	M2241, M2242, M2243
Hitachi	DK511-5, DK512-8
IBM	5364, 667-85
Maxtor	XT-1085, XT-2085
Memory Systems	MS 840-S, MS 880-S
Micropolis	1323A, 1373
Microscience International	HH-1050*
Miltope	RDS-5000
Miniscribe	6053, 6085
Mitsubishi Electric	MR533*, MR535*
NEC	D5146*, D5452
Newbury Data	1065, 1065
Nippon Peripherals	NP04-36, NP04-85
Olivetti	HD 674*
Priam	V150, V185
Quantum	Q540, Q250*, Q280*
Rodime	204E, 432*
Seagate	ST4038, ST277N*, ST4096
Tandon	TM703, TM755*

5.25" disk diameter (continued)

Teac	SD-540*
Tokico	DK5046*
Toshiba	MK-56FB
Tulin	TL 340*

3.9" disk diameter

Nippon Systemhouse	SQ328F
SyQuest Technology	SQ328F

3.5" disk diameter

Conner Peripherals	CP340*
Fujitsu	M2226AD*, M2227D*
Miltope	RDS-4000
Newbury Data	NDR 340*
Nippon Peripherals Ltd	NP03-38*
Peripheral Technology	PT-338*, PT-357R*
YE Data	3530*, 3540*

*Indicates drives with maximum 41 mm height, or less

These are all nominally "Winchester" drives, but many variations to that technology are used, including plated disks, sputtered disks, and ferrite heads with 3370 type sliders. Most use rotary or linear voice coil head positioning systems, but a few use other techniques, such as stepping or torque motors.

Market status

DISK/TREND estimate of total market size:

Worldwide sales ($M)	1985	1986	1987	1988	1989
U.S. manufacturers	935.0	1,463.4	1,556.1	1,536.1	1,456.5
All manufacturers	1,278.7	1,909.0	2,098.0	2,157.0	2,127.6

Worldwide shipments of 5.25" drives with 30-100 megabytes capacity more than doubled in 1985, at 693,400 units, for 84.3% of total unit shipments in this group. 1986 looks even stronger, with 5.25" drive shipments of 1,697,100 units projected worldwide, 94.7% of the group total.

Only a few 14" drives in this group will be shipped this year, with final shipments in 1987. 8" drives peaked in 1984 and declined 32.0% in 1985, with a further drop of 39.4% expected in 1986.

The 3.5" drive shipments shown in the disk diameter breakdown tables for 1985 consist primarily of 3.9" SyQuest drives, which are included with 3.5" drives in tables for fixed disk drives. However, the 22,300 units shown in 1986 for this disk diameter will consist of early shipments of a new wave of 3.5" drives with unformatted capacities in the 50 megabyte range, from companies such as Conner Peripherals, Newbury Data, Peripheral Technology, Fujitsu and YE Data -- with many more to come later.

By more than doubling its shipments of Wren I and Wren II 5.25" drives, Control Data became the leader in non-captive shipments for 1985, with 131,000 drives, 18.0% of the worldwide total. Quantum's shipments grew more modestly, to 111,700 drives, for 15.4%. Micropolis, which probably ships more 85 megabyte drives than any other company, held 12.0%, with 87,000 drives.

IBM's shipments of 5.25" drives in this group are expected to grow to 130,000 units during 1986, as the firm transitions to 30, 40 and 70 megabyte drives (formatted capacities) for various personal computer systems and related products, up from the 20 megabyte drives initially used with the PC AT family. This build-up of internal production will not have a broad impact on OEM disk drive manufacturers, however, since only Seagate is a major vendor to IBM for drives in this group.

Captive production by other U.S. system manufacturers continues to remains modest, with a significant portion of the 1986 total going to the new personal computer manufacturing program by Tandon. Non-U.S. captive shipments have a broader base, with 1986 production of 5.25" drives

expected from Fujitsu, Hitachi, NEC, Mitsubishi Electric, Toshiba, Bull, Olivetti and Nixdorf.

The applications mix for shipments in this group is expected to change considerably during the five year span covered by this report. In 1985, 45.9% of worldwide unit shipments of all drives in the group were used with general purpose minicomputers and multiple user micros, but by 1989 the lead is expected to move to single user microcomputers, mostly high end personal computers.

Marketing trends

The growth rate in unit shipments for this group is expected to slow down, especially for 5.25" drives and for the OEM distribution channel. 5.25" drive growth will feel the competition from 3.5" models and from 5.25" drives with higher capacities. And many customers for OEM drives will be the first to transition to higher capacity models.

Even though IBM has not been a major buyer of OEM disk drives in this product group, except from Seagate, its expected large scale production of 5.25" drives will tend to dampen the growth rate for manufacturers of OEM drives. IBM's combined shipments of 5.25" and 3.5" drives are expected to reach 590,000 units in 1989, with wide use anticipated for high end personal computers and other office and specialized systems.

The existence of this program means, of course, that IBM will not buy most of its drive requirements for these applications, thus restricting the OEM market opportunity to other system manufacturers. And, if IBM's personal computers continue to secure major market positions, the lower success level for IBM's system competitors will further limit the size of the OEM drive market.

Another factor affecting future growth in OEM shipments is the movement by several manufacturers of 85 megabyte drives to provide 170 megabyte versions by doubling linear density, thus responding to demand but moving a significant part of the shipment gains out of this product group. This is the reason, combined with rapid growth in IBM's internal production, that the 128.5% growth in 5.25" worldwide OEM shipments for 1986 is expected to drop to 8.4% in 1987, then in 1989 decline by 2%.

Shipments of 8" drives are falling rapidly and will be out of production by 1989, except in Eastern Bloc countries. The first Eastern Bloc production of 8" fixed disk drives started in 1985, and shipments in the capacity range represented by this product group will be an important factor in upgrading the many applications now served by older disk pack drives.

Full size models continued to dominate shipments of drives with disks smaller than 5.25" in 1985, with 95% of the total, but the situation is starting to change in 1986:

Worldwide captive & OEM Unit shipments (000)	1985	1986	1987	1988	1989
5.25" full size	663.7 95.0%	1,247.6 72.6%	1,292.5 61.1%	1,173.5 48.3%	743.0 27.5%
5.25" half high	29.7 4.3%	449.5 26.1%	726.5 34.4%	1,036.5 42.6%	1,340.0 49.6%
3.5" (including 3.9")	5.1 .7%	22.6 1.3%	96.0 4.5	220.0 9.1	617.0 22.9%

With half high 5.25" drives now available from numerous suppliers, with more to come, major growth in this form factor is underway in 1986. Without the expected competition from 3.5" drives, half high 5.25" models would be dominant by 1989. However, the group of 50 megabyte OEM 3.5"

drives being introduced this year are expected to achieve significant shipment levels in 1987, with excellent growth thereafter. The share for 3.5" will also be boosted by higher capacity drives also expected and by the anticipated IBM introduction of internally produced 3.5" drives in this group.

Technical trends

It has been difficult to combine high recording densities and small box sizes with the high production volume and low cost required for the 5.25" drives in this group. There have been severe sourcing problems with media, as manufacturers transition to plated, sputtered and high density oxide disks. The many new disk manufacturers have had trouble maintaining consistent quality and several have shut down operations from time to time to solve problems with production processes. Although media quality has improved greatly, drive manufacturers must still devote excessive resources to media test and inspection.

Although the technology used in recording heads is also changing, both thin film and advanced ferrite heads are usable with the densities now required, and both are in production. Drive manufacturers have been able to obtain "mini-sliders", heads using ferrite cores mounted in sliders with contours similar to IBM's 3370/3380 thin film heads. Limited quantities of thin film heads are also being used in production disk drives, with more expected as head vendors establish volume production.

Although not settled, the political battles over interface standards are calming down. Most 5.25" drives in this group are still being shipped with 5 megabit transfer rates, using Seagate type interfaces. But a growing number of system manufacturers are planning to use SCSI interfaces

and it is expected that the next several years will see many drives being offered with embedded SCSI. As the disk and head sourcing problems ease, 10 megabit per second drives are expected to grow in importance, many of which will use ESDI as the drive level interface.

Forecasting assumptions

1. IBM's requirements for 5.25" drives will continue to increase until 1989, when a transition to 3.5" drives will start rapid growth. IBM will rely primarily on internal manufacturing for drives in this group.

2. Growth for OEM 5.25" drives will end in 1988, limited by IBM's competitive inroads at the system level, by movement to higher capacities, and by a movement to 3.5" drives.

3. Availability of 3.5" drives will be adequate in 1987 to satisfy demand, and drives in the 80-100 megabyte range will go into production in 1987.

TABLE 42

FIXED DISK DRIVES, 30 - 100 MEGABYTES

REVENUE SUMMARY

	DISK DRIVE REVENUES, BY SHIPMENT DESTINATION ($M)									
	1985 Revenues		Forecast							
			1986		1987		1988		1989	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM Captive	237.1	349.5	306.0	451.2	423.2	628.0	449.7	681.6	445.4	687.5
Other U.S. Captive	52.0	80.8	64.8	90.2	46.4	63.2	53.6	72.2	53.2	69.4
TOTAL U.S. CAPTIVE	289.1	430.3	370.8	541.4	469.6	691.2	503.3	753.8	498.6	756.9
PCM	2.6	3.9	--	--	--	--	--	--	--	--
OEM	417.7	500.8	719.0	922.0	653.0	864.9	578.4	782.3	500.3	699.6
TOTAL U.S. NON-CAPTIVE	420.3	504.7	719.0	922.0	653.0	864.9	578.4	782.3	500.3	699.6
TOTAL U.S. REVENUES	709.4	935.0	1,089.8	1,463.4	1,122.6	1,556.1	1,081.7	1,536.1	998.9	1,456.5
Non-U.S. Manufacturers										
Captive	2.4	117.7	--	177.8	--	176.0	--	203.5	1.9	228.0
PCM	--	--	--	--	--	--	--	--	--	--
OEM	90.8	226.0	89.7	267.8	123.0	365.9	149.3	417.4	164.5	443.1
TOTAL NON-U.S. REVENUES	93.2	343.7	89.7	445.6	123.0	541.9	149.3	620.9	166.4	671.1
Worldwide Recap										
TOTAL WORLDWIDE REVENUES	802.6	1,278.7	1,179.5	1,909.0	1,245.6	2,098.0	1,231.0	2,157.0	1,165.3	2,127.6
OEM Average Price ($000)	.976	1.004	.756	.770	.708	.715	.634	.641	.566	.577

TABLE 43

FIXED DISK DRIVES, 30 - 100 MEGABYTES

UNIT SHIPMENT SUMMARY

	DISK DRIVE UNIT SHIPMENTS, BY SHIPMENT DESTINATION (000)									
	1985		Forecast							
	Shipments		1986		1987		1988		1989	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM Captive	43.3	62.0	112.1	162.0	231.0	340.0	303.1	458.0	383.0	590.0
Other U.S. Captive	7.5	11.6	28.9	34.7	23.8	29.2	31.6	39.5	35.1	43.0
TOTAL U.S. CAPTIVE	50.8	73.6	141.0	196.7	254.8	369.2	334.7	497.5	418.1	633.0
PCM	2.0	3.0	--	--	--	--	--	--	--	--
OEM	438.5	515.7	969.7	1,246.9	931.0	1,232.0	920.0	1,243.0	881.7	1,231.0
TOTAL U.S. NON-CAPTIVE	440.5	518.7	969.7	1,246.9	931.0	1,232.0	920.0	1,243.0	881.7	1,231.0
TOTAL U.S. SHIPMENTS	491.3	592.3	1,110.7	1,443.6	1,185.8	1,601.2	1,254.7	1,740.5	1,299.8	1,864.0
Non-U.S. Manufacturers										
Captive	.4	23.2	--	52.6	--	58.9	--	76.0	1.0	96.0
PCM	--	--	--	--	--	--	--	--	--	--
OEM	82.4	207.9	99.6	297.3	165.4	489.6	228.4	628.5	292.3	748.0
TOTAL NON-U.S. SHIPMENTS	82.8	231.1	99.6	349.9	165.4	548.5	228.4	704.5	293.3	844.0
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	574.1	823.4	1,210.3	1,793.5	1,351.2	2,149.7	1,483.1	2,445.0	1,593.1	2,708.0
Cumulative Shipments										
IBM	257.9	389.0	370.0	551.0	601.0	891.0	904.1	1,349.0	1,287.1	1,939.0
Non-IBM	1,067.6	1,575.3	2,165.8	3,206.8	3,286.0	5,016.5	4,466.0	7,003.5	5,676.1	9,121.5
WORLDWIDE TOTAL	1,325.5	1,964.3	2,535.8	3,757.8	3,887.0	5,907.5	5,370.1	8,352.5	6,963.2	11,060.5

TABLE 44

FIXED DISK DRIVES, 30 - 100 MEGABYTES

WORLDWIDE REVENUES ($M)

BREAKDOWN BY DISK DIAMETER

	1985 Revenues				Forecast													
	1986				1987				1988				1989					
	14"	8"	5.25"	3.5"	14"	8"	5.25"	3.5"	14"	8"	5.25"	3.5"	8"	5.25"	3.5"	8"	5.25"	3.5"
U.S. MANUFACTURERS																		
IBM Captive	--	312.0	37.5	--	--	243.2	208.0	--	--	148.0	480.0	--	57.6	602.0	22.0	--	422.5	265.0
Other U.S. Captive	28.1	19.2	33.5	--	11.2	--	79.0	--	2.2	--	61.0	--	--	72.2	--	--	69.4	--
PCM	--	--	3.9	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
OEM	6.9	64.9	427.1	1.9	1.4	33.7	875.4	11.5	--	14.4	803.1	47.4	3.2	691.7	87.4	--	567.0	132.6
TOTAL U.S. REVENUES	35.0	396.1	502.0	1.9	12.6	276.9	1,162.4	11.5	2.2	162.4	1,344.1	47.4	60.8	1,365.9	109.4	--	1,058.9	397.6
NON-U.S. MANUFACTURERS																		
Captive	3.3	73.8	40.3	.3	1.1	35.6	140.3	.8	--	--	175.1	.9	--	193.0	10.5	--	195.7	32.3
OEM	--	59.4	166.6	--	--	30.5	235.2	2.1	--	12.1	340.5	13.3	14.0	376.1	27.3	28.0	364.1	51.0
TOTAL NON-U.S. REVENUES	3.3	133.2	206.9	.3	1.1	66.1	375.5	2.9	--	12.1	515.6	14.2	14.0	569.1	37.8	28.0	559.8	83.3
WORLDWIDE RECAP																		
Captive	31.4	405.0	111.3	.3	12.3	278.8	427.3	.8	2.2	148.0	716.1	.9	57.6	867.2	32.5	--	687.6	297.3
	-57.0%	-40.5%	+69.4%	--	-60.8%	-31.2%	+283.9%	+166.7%	-82.1%	-46.9%	+67.6%	+12.5%	-61.1%	+21.1%	--	--	-20.7%	+814.8%
PCM	--	--	3.9	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	--	--	+116.7%	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
OEM	6.9	124.3	593.7	1.9	1.4	64.2	1,110.6	13.6	--	26.5	1,143.6	60.7	17.2	1,067.8	114.7	28.0	931.1	183.6
	-68.8%	-22.6%	+98.4%	+137.5%	-79.7%	-48.4%	+87.1%	+615.8%	--	-58.7%	+3.0%	+346.3%	-35.1%	-6.6%	+89.0%	+62.8%	-12.8%	+60.1%
Total Revenues	38.3	529.3	708.9	2.2	13.7	343.0	1,537.9	14.4	2.2	174.5	1,859.7	61.6	74.8	1,935.0	147.2	28.0	1,618.7	480.9
	-59.8%	-37.1%	+93.3%	+175.0%	-64.2%	-35.2%	+116.9%	+554.5%	-83.9%	-49.1%	+20.9%	+327.8%	-57.1%	+4.0%	+139.0%	-62.6%	-16.3%	+226.7%
ANNUAL SHARE, BY DIAMETER	3.0%	41.5%	55.4%	.1%	.7%	18.0%	80.7%	.6%	.1%	8.3%	88.7%	2.9%	3.5%	89.8%	6.7%	1.3%	76.2%	22.5%

NOTE: 3.5 inch totals include 3.9 inch drives
8 inch totals include 10.5 inch drives

TABLE 45

FIXED DISK DRIVES, 30 - 100 MEGABYTES

WORLDWIDE SHIPMENTS (000)

BREAKDOWN BY DISK DIAMETER

	1985 Shipments				Forecast													
	1986				1987				1988				1989					
	14"	8"	5.25"	3.5"	14"	8"	5.25"	3.5"	14"	8"	5.25"	3.5"	8"	5.25"	3.5"	8"	5.25"	3.5"
U.S. MANUFACTURERS																		
IBM Captive	--	40.0	22.0	--	--	32.0	130.0	--	--	20.0	320.0	--	8.0	430.0	20.0	--	325.0	265.0
Other U.S. Captive	2.5	2.4	6.7	--	1.0	--	33.7	--	.2	--	29.0	--	--	39.5	--	--	43.0	--
PCM	--	--	3.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
OEM	3.1	38.3	469.3	5.0	.6	21.0	1,205.3	20.0	--	9.0	1,144.0	79.0	2.0	1,085.0	156.0	--	981.0	250.0
TOTAL U.S. SHIPMENTS	5.6	80.7	501.0	5.0	1.6	53.0	1,369.0	20.0	.2	29.0	1,493.0	79.0	10.0	1,554.5	176.0	--	1,349.0	515.0
NON-U.S. MANUFACTURERS																		
Captive	.3	11.8	11.0	.1	.1	5.6	46.6	.3	--	--	58.5	.4	--	71.0	5.0	--	79.0	17.0
OEM	--	26.5	181.4	--	--	13.5	281.5	2.3	--	5.5	467.5	16.6	5.0	584.5	39.0	8.0	655.0	85.0
TOTAL NON-U.S. SHIPMENTS	.3	38.3	192.4	.1	.1	19.1	328.1	2.6	--	5.5	526.0	17.0	5.0	655.5	44.0	8.0	734.0	102.0
WORLDWIDE RECAP																		
Captive	2.8	54.2	39.7	.1	1.1	37.6	210.3	.3	.2	20.0	407.5	.4	8.0	540.5	25.0	--	447.0	282.0
	-58.2%	-37.1%	+203.1%	--	-60.7%	-30.6%	+429.7%	+200.0%	-81.8%	-46.8%	+93.8%	+33.3%	-60.0%	+32.6%	--	--	-17.3%	--
PCM	--	--	3.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	--	--	+150.0%	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
OEM	3.1	64.8	650.7	5.0	.6	34.5	1,486.8	22.3	--	14.5	1,611.5	95.6	7.0	1,669.5	195.0	8.0	1,636.0	335.0
	-65.6%	-26.9%	+122.6%	+400.0%	-80.6%	-46.8%	+128.5%	+346.0%	--	-58.0%	+8.4%	+328.7%	-51.7%	+3.6%	+104.0%	+14.3%	-2.0%	+71.8%
Total Shipments	5.9	119.0	693.4	5.1	1.7	72.1	1,697.1	22.6	.2	34.5	2,019.0	96.0	15.0	2,210.0	220.0	8.0	2,083.0	617.0
	-62.4%	-32.0%	+126.2%	+410.0%	-71.2%	-39.4%	+144.8%	+343.1%	-88.2%	-52.1%	+19.0%	+324.8%	-56.5%	+9.5%	+129.2%	-46.7%	-5.7%	+180.5%
ANNUAL SHARE, BY DIAMETER	.7%	14.5%	84.3%	.5%	.1%	4.0%	94.7%	1.2%	--	1.6%	94.0%	4.4%	.6%	90.5%	8.9%	.3%	77.0%	22.7%

NOTE: 3.5 inch totals include 3.9 inch drives
8 inch totals include 10.5 inch drives

TABLE 46

FIXED DISK DRIVES, 30 - 100 MEGABYTES

APPLICATIONS SUMMARY
Percentage of Worldwide Shipments

APPLICATION	1985 Estimate Units (000)	1985 Estimate %	1989 Projection Units (000)	1989 Projection %
MAINFRAME/SUPERMINI General purpose	2.7	.3	16.2	.6
MINICOMPUTERS AND MULTI-USER MICROS Business and professional, including networks	377.9	45.9	766.4	28.3
MICROCOMPUTERS Business and professional, single user	240.3	29.2	1,337.8	49.4
OFFICE SYSTEMS AND WORKSTATIONS Dedicated application	130.1	15.8	303.3	11.2
NON-OFFICE SYSTEMS AND WORKSTATIONS Technical, distribution, medical, other specialized	66.9	8.1	241.0	8.9
CONSUMER AND HOBBY COMPUTERS	1.7	.2	29.8	1.1
OTHER APPLICATIONS	3.8	.5	13.5	.5
Total	823.4	100.0	2,708.0	100.0

TABLE 47

FIXED DISK DRIVES, 30-100 MEGABYTES

DISTRIBUTION CHANNEL SUMMARY
U.S. Non-Captive Disk Drives

Distribution channel	1985 U.S. Net Shipments Units (000)	%	FORECAST 1986 %	1987 %	1988 %	1989 %
Mainframe computer manufacturers	39.9	7.6	24.3	10.9	6.8	6.5
Mini/micro computer manufacturers	169.3	32.4	28.1	37.7	42.4	45.1
System OEMs/systems houses	222.8	42.6	31.7	36.2	36.2	34.0
Independent peripherals suppliers	43.1	8.3	8.6	9.0	9.3	9.7
Distributors, dealers, end users	47.8	9.1	7.3	6.2	5.3	4.7
TOTAL	522.9					

TABLE 48

FIXED DISK DRIVES, 30 - 100 MEGABYTES

MARKET SHARE SUMMARY
Worldwide Shipments of Non-Captive Disk Drives

Drive Manufacturers	1985 Net Shipments: To United States Destinations, Units (000) 14"	8"	5.25"	3.5"	Total	%	1985 Net Shipments: Worldwide, Units (000) 14"	8"	5.25"	3.5"	Total	%
CONTROL DATA	--	--	115.4	--	115.4	22.1	--	--	131.0	--	131.0	18.0
QUANTUM	--	11.8	87.0	--	98.8	18.9	--	22.2	89.5	--	111.7	15.4
MICROPOLIS	--	.3	63.9	--	64.2	12.3	--	1.8	85.2	--	87.0	12.0
HITACHI	--	1.0	27.6	--	28.6	5.5	--	7.7	55.0	--	62.7	8.6
PRIAM	2.5	9.6	39.0	--	51.1	9.8	3.0	12.0	42.5	--	57.5	7.9
FUJITSU	--	3.5	20.9	--	24.4	4.6	--	11.7	42.0	--	53.7	7.4
RODIME	--	--	10.0	--	10.0	1.9	--	--	50.0	--	50.0	6.9
SEAGATE	--	--	28.0	--	28.0	5.4	--	--	35.0	--	35.0	4.8
Other U.S.	.1	2.3	76.6	4.0	83.0	15.8	.1	2.3	89.1	5.0	96.5	13.3
Other Non-U.S.	--	4.4	15.0	--	19.4	3.7	--	7.1	34.4	--	41.5	5.7
TOTAL	2.6	32.9	483.4	4.0	522.9	100.0	3.1	64.8	653.7	5.0	726.6	100.0

NOTE: 3.5 inch totals include 3.9 inch drives
8 inch totals include 10.5 inch drives

FIXED DISK DRIVES, 100-300 MB

1986 DISK/TREND REPORT

FIXED DISK DRIVES, 100-300 MEGABYTES

Coverage

Examples of disk drives in this group include:

14" disk diameter

Control Data	9730-160
Digital Equipment	RA80, RM80
Fujitsu	M2284
Hewlett-Packard	7914
IBM	4967-2CX, 5360-BXX
Priam	15450

10.5" disk diameter

Bull	D160/8

9" disk diameter

Control Data	9715-160

8" disk diameter

Fujitsu	M2322K, M2331K
Hitachi	DK812S-12, DK814S-17
IBM	9332-A11, 678-200
Mitsubishi Electric	M4870F
NEC	D2257, N7729
Northern Telecom	MFD/8208X, MFD/8210X
Pertec	DX199, DX265
Priam	806
Toshiba	MK184FB, MK284FC

5.25" disk diameter

Atasi	2128, 2170
Brand Technologies	BT8120, BT8170
Cybernex Adv. Storage Tech.	10305
Hitachi	DK512-17
Maxtor	XT-1140, XT-3280, EXT-4280
Micropolis	1354, 1374A, 1554
Miniscribe	6128E, 6170E
Mitsubishi Electric	MR5310
NEC	D5652
Newbury Data	NDR 1105, NDR 2190
Priam	514, 519, 725
Quantum	Q160
Rodime	433, 434

5.25" disk diameter (continued)

Seagate Technology	ST4144R
Siemens	1100, 1200
Toshiba	MK-154FA, MK-156FB
Toyo Soda	Dart 130, Dart 170

Previously the exclusive domain of 14" drives, the 1980's have seen numerous introductions of drives using smaller diameter disks in this group. A parade of 8" drives was launched at the beginning of the decade, followed by numerous 5.25" drives in the last two years.

These, as well as the older 14" drives, all use variations of Winchester technology. Disks used with the 14" and 8" drives are mostly oxide coated, but plated and sputtered disks are used on the 5.25" drives. Heads are mostly ferrite types, and several are "mini" types patterned after the 3370 slider. There is limited use of thin film heads, so far exclusively on 5.25" drives.

Market status

DISK/TREND estimate of total market size:

Worldwide sales ($M)	1985	1986	1987	1988	1989
U.S. manufacturers	646.6	611.3	889.3	1,110.4	1,294.7
All manufacturers	1,105.8	1,118.5	1,447.4	1,691.0	1,837.5

During 1986, shipments of 14" drives in this group are collapsing, shipments of 8" and 9" drives are starting to decline, and shipments of 5.25" drives have emerged as the dominant product type, with 1986 worldwide shipments of an estimated 142,400 units, 52.7% of the entire product group.

There are unusually strong contrasts in market penetration by U.S. vs. non-U.S. companies in this group. During 1986, U.S. companies will

ship 99% of the 23,300 14" drives forecasted for the year, mostly captive drives from IBM and other U.S. captive producers. Non-U.S. companies will ship 86% of the 104,100 8" drives expected for 1986, led by OEM drives from Fujitsu and several other leading Japanese disk drive manufacturers. On the other hand, U.S. companies will ship 77% of the forecasted 142,400 5.25 inch drives, dominated by Maxtor's 140 and 190 megabyte models, but also including growing shipments of 170 megabyte drives from other major producers of high end 5.25" drives such as Micropolis and Control Data.

Leadership in 1985 shipments of non-captive drives was again held by Fujitsu, which had shipments of 36,700 units, mostly 8" drives, for 26.9% of the worldwide total. Maxtor's 26,200 5.25" drives were 19.2% of the total, and Hitachi's 16,700 drives, mostly 8", were 12.2% of the total.

General purpose mincomputers and multiple user micros, including network applications, utilized 72.1% of worldwide unit shipments in 1985, with a modest increase in share forecasted to 1989, to 76.7%. Non-office systems and workstations, such as engineering workstations provided 11.6% of the market in 1985, and this application area is expected to grow to 15.3% in 1989.

Marketing trends

Shipments of OEM drives, predominantly from U.S. manufacturers, will provide most of the continuing growth in 5.25" drives expected in the 1987-89 time period for this product group. Fueling this surge will be the general availability of 170 megabyte drives from most of the manufacturers which have already established production for 85 megabyte models, with the double density drives offered at price per megabyte levels not previously available at these capacities. 1989 worldwide shipments of

5.25" drives are forecasted at 678,000 units, with 76% sold to OEMs.

IBM has relied on internal production for its disk drive requirements in this capacity range for the most part, and its captive drive programs have not had a significant effect on the market for OEM drives except to the extent that its system sales impact the market for OEM drives with competing system manufacturers. The 200 megabyte version of the 9332 8" drive introduced in 1986 is expected to start displacing IBM's older 14" and 8" drives during 1987. A 5.25" drive in this capacity range is expected from IBM in 1987, which in turn will start to displace some of the 9332's volume in 1989.

Also contributing to the growth in 5.25" shipments will be the addition of captive 5.25 inch drives from other U.S. and non-U.S. disk drive manufacturers, totaling an estimated 92,000 units in 1989. Captive 14" and 8" drive production is expected to end in 1988.

Technical trends

This product group continues to make severe demands on the key components used in achieving the high recording densities necessary to provide capacities in the 100-300 megabyte range in 5.25" and 3.5" drives. All of the 5.25" drives with capacities over 100 MB offered to date use either plated or sputtered disks, to facilitate the high linear densities used. With thin film heads now starting to be available at prices competitive to high density ferrite heads, some new drives offered in this product group will probably use them.

Marketability of drives with higher transfer rates will be directly affected by whether the industry reaches an early consensus on interface

standards suitable for higher transfer rates, paving the way for availability of appropriate controllers. Most drive manufacturers are offering ESDI interfaces with new 5.25" drives operating at 10 megabit/second transfer rates, and on-board SCSI interfaces are also available from a growing list of manufacturers.

It is still not clear just how quickly high performance 3.5" drives in this group will be generally available. Several development programs are known to exist, but the technical problems are substantial. Obviously, the recording densities will have to be extremely high, and the other necessities in high performance drives, such as very fast head positioning and sophisticated electronics packaging, will be especially difficult in the 3.5" form factor. This report forecasts first shipments of 3.5" drives in the 100-300 megabyte range in 1988, but earlier announcements are quite possible.

Forecasting assumptions

1. Growth in IBM's shipments will be concentrated in the 8" drives announced in 1986, plus a new 5.25" series to be introduced in 1987.

2. Most major producers of voice coil 5.25" OEM drives will be in production with 5.25" drives in this group in 1987, but U.S. manufacturers will continue to dominate OEM shipments due to their early market lead and favorable dollar/yen exchange rate.

3. Non-U.S. manufacturers will continue to dominate OEM shipments of 8" drives.

TABLE 49

FIXED DISK DRIVES, 100 - 300 MEGABYTES

REVENUE SUMMARY

	DISK DRIVE REVENUES, BY SHIPMENT DESTINATION ($M)									
	1985 Revenues		Forecast 1986		1987		1988		1989	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM Captive	224.1	335.6	196.7	287.0	271.7	378.5	343.0	498.4	366.3	560.8
Other U.S. Captive	108.5	158.5	56.7	88.4	68.8	95.5	88.0	124.2	126.6	193.3
TOTAL U.S. CAPTIVE	332.6	494.1	253.4	375.4	340.5	474.0	431.0	622.6	492.9	754.1
PCM	3.6	3.6	--	--	--	--	--	--	--	--
OEM	119.1	148.9	196.2	235.9	347.9	415.3	410.3	487.8	450.8	540.6
TOTAL U.S. NON-CAPTIVE	122.7	152.5	196.2	235.9	347.9	415.3	410.3	487.8	450.8	540.6
TOTAL U.S. REVENUES	455.3	646.6	449.6	611.3	688.4	889.3	841.3	1,110.4	943.7	1,294.7
Non-U.S. Manufacturers										
Captive	3.3	252.7	4.4	308.6	6.0	372.3	5.0	382.5	4.0	343.0
PCM	--	--	--	--	--	--	--	--	--	--
OEM	114.7	206.5	95.4	198.6	94.6	185.8	106.9	198.1	112.9	199.8
TOTAL NON-U.S. REVENUES	118.0	459.2	99.8	507.2	100.6	558.1	111.9	580.6	116.9	542.8
Worldwide Recap										
TOTAL WORLDWIDE REVENUES	573.3	1,105.8	549.4	1,118.5	789.0	1,447.4	953.2	1,691.0	1,060.6	1,837.5
OEM Average Price ($000)	2.6	2.6	2.0	2.0	1.6	1.6	1.4	1.4	1.3	1.3

TABLE 50

FIXED DISK DRIVES, 100 - 300 MEGABYTES

UNIT SHIPMENT SUMMARY

	DISK DRIVE UNIT SHIPMENTS, BY SHIPMENT DESTINATION (000)									
	1985 Shipments		Forecast 1986		1987		1988		1989	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM Captive	12.7	19.0	14.1	20.0	33.0	45.0	50.5	72.5	69.3	106.0
Other U.S. Captive	8.1	11.9	4.8	7.9	11.6	16.3	20.7	29.4	36.7	56.0
TOTAL U.S. CAPTIVE	20.8	30.9	18.9	27.9	44.6	61.3	71.2	101.9	106.0	162.0
PCM	.3	.3	--	--	--	--	--	--	--	--
OEM	43.3	53.3	100.4	119.3	221.2	264.7	293.3	349.0	349.8	420.0
TOTAL U.S. NON-CAPTIVE	43.6	53.6	100.4	119.3	221.2	264.7	293.3	349.0	349.8	420.0
TOTAL U.S. SHIPMENTS	64.4	84.5	119.3	147.2	265.8	326.0	364.5	450.9	455.8	582.0
Non-U.S. Manufacturers										
Captive	.3	25.3	.4	32.2	.6	42.0	.5	52.0	.4	57.0
PCM	--	--	--	--	--	--	--	--	--	--
OEM	45.8	83.0	44.6	90.4	47.9	93.9	66.2	121.0	79.7	139.0
TOTAL NON-U.S. SHIPMENTS	46.1	108.3	45.0	122.6	48.5	135.9	66.7	173.0	80.1	196.0
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	110.5	192.8	164.3	269.8	314.3	461.9	431.2	623.9	535.9	778.0
Cumulative Shipments										
IBM	34.5	51.3	48.6	71.3	81.6	116.3	132.1	188.8	201.4	294.8
Non-IBM	242.5	410.6	392.7	660.4	674.0	1,077.3	1,054.7	1,628.7	1,521.3	2,300.7
WORLDWIDE TOTAL	277.0	461.9	441.3	731.7	755.6	1,193.6	1,186.8	1,817.5	1,722.7	2,595.5

TABLE 51

FIXED DISK DRIVES, 100 - 300 MEGABYTES

WORLDWIDE REVENUES ($M)

BREAKDOWN BY DISK DIAMETER

	1985 Revenues			Forecast													
	1986			1987			1988				1989			
	14"	8"	5.25"	14"	8"	5.25"	14"	8"	5.25"	14"	8"	5.25"	3.5"	14"	8"	5.25"	3.5"
U.S. MANUFACTURERS																	
IBM Captive	324.0	11.6	--	216.0	71.0	--	122.5	166.0	90.0	70.1	288.8	139.5	--	17.5	240.9	302.4	--
Other U.S. Captive	150.7	7.8	--	70.0	10.4	8.0	25.1	10.0	60.4	7.5	3.6	113.1	--	--	--	187.3	6.0
PCM	3.6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
OEM	56.5	29.6	62.8	18.3	17.8	199.8	3.2	12.1	400.0	--	4.3	467.5	16.0	--	--	508.2	32.4
TOTAL U.S. REVENUES	534.8	49.0	62.8	304.3	99.2	207.8	150.8	188.1	550.4	77.6	296.7	720.1	16.0	17.5	240.9	997.9	38.4
NON-U.S. MANUFACTURERS																	
Captive	5.1	247.6	--	1.7	288.9	18.0	--	305.0	67.3	--	250.0	132.5	--	--	180.0	160.0	3.0
OEM	3.1	194.6	8.8	.4	147.6	50.6	--	117.4	68.4	--	84.0	114.1	--	--	46.2	141.6	12.0
TOTAL NON-U.S. REVENUES	8.2	442.2	8.8	2.1	436.5	68.6	--	422.4	135.7	--	334.0	246.6	--	--	226.2	301.6	15.0
WORLDWIDE RECAP																	
Captive	479.8	267.0	--	287.7	370.3	26.0	147.6	481.0	217.7	77.6	542.4	385.1	--	17.5	420.9	649.7	9.0
	-15.4%	+37.6%	--	-40.0%	+38.7%	--	-48.7%	+29.9%	+737.3%	-47.4%	+12.8%	+76.9%	--	-77.4%	-22.4%	+68.7%	--
PCM	3.6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	-30.8%	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
OEM	59.6	224.2	71.6	18.7	165.4	250.4	3.2	129.5	468.4	--	88.3	581.6	16.0	--	46.2	649.8	44.4
	-32.6%	+95.6%	+225.5%	-68.6%	-26.2%	+249.7%	-82.9%	-21.7%	+87.1%	--	-31.8%	+24.2%	--	--	-47.7%	+11.7%	+177.5%
Total Revenues	543.0	491.2	71.6	306.4	535.7	276.4	150.8	610.5	686.1	77.6	630.7	966.7	16.0	17.5	467.1	1,299.5	53.4
	-17.8%	+59.2%	+225.5%	-43.6%	+9.1%	+286.0%	-50.8%	+14.0%	+148.2%	-48.5%	+3.3%	+40.9%	--	-77.4%	-25.9%	+34.4%	+233.8%
ANNUAL SHARE, BY DIAMETER	49.2%	44.4%	6.4%	27.5%	47.9%	24.6%	10.4%	42.3%	47.3%	4.6%	37.4%	57.2%	.8%	1.0%	25.5%	70.7%	2.8%

NOTE: 8 inch totals include 9 and 10.5 inch drives

TABLE 52

FIXED DISK DRIVES, 100 - 300 MEGABYTES

WORLDWIDE SHIPMENTS (000)

BREAKDOWN BY DISK DIAMETER

	1985 Shipments			Forecast 1986			1987			1988				1989			
	14"	8"	5.25"	14"	8"	5.25"	14"	8"	5.25"	14"	8"	5.25"	3.5"	14"	8"	5.25"	3.5"
U.S. MANUFACTURERS																	
IBM Captive	18.0	1.0	--	12.0	8.0	--	7.0	20.0	18.0	4.0	37.5	31.0	--	1.0	33.0	72.0	--
Other U.S. Captive	11.3	.6	--	5.5	.8	1.6	2.0	.8	13.5	.6	.3	28.5	--	--	--	54.0	2.0
PCM	.3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
OEM	16.7	8.6	28.0	5.6	5.8	107.9	1.2	5.5	258.0	--	2.0	339.0	8.0	--	--	402.0	18.0
TOTAL U.S. SHIPMENTS	46.3	10.2	28.0	23.1	14.6	109.5	10.2	26.3	289.5	4.6	39.8	398.5	8.0	1.0	33.0	528.0	20.0
NON-U.S. MANUFACTURERS																	
Captive	.3	25.0	--	.1	29.1	3.0	--	30.5	11.5	--	25.0	27.0	--	--	18.0	38.0	1.0
OEM	.8	77.9	4.3	.1	60.4	29.9	--	48.9	45.0	--	36.5	84.5	--	--	21.0	112.0	6.0
TOTAL NON-U.S. SHIPMENTS	1.1	102.9	4.3	.2	89.5	32.9	--	79.4	56.5	--	61.5	111.5	--	--	39.0	150.0	7.0
WORLDWIDE RECAP																	
Captive	29.6	26.6	--	17.6	37.9	4.6	9.0	51.3	43.0	4.6	62.8	86.5	--	1.0	51.0	164.0	3.0
	+75.1%	+71.6%	--	-40.5%	+42.5%	--	-48.9%	+35.4%	+834.8%	-48.9%	+22.4%	+101.2%	--	-78.3%	-18.8%	+89.6%	--
PCM	.3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	-25.0%	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
OEM	17.5	86.5	32.3	5.7	66.2	137.8	1.2	54.4	303.0	--	38.5	423.5	8.0	--	21.0	514.0	24.0
	-30.8%	+131.9%	+223.0%	-67.4%	-23.5%	+326.6%	-78.9%	-17.8%	+119.9%	--	-29.2%	+39.8%	--	--	-45.5%	+21.4%	+200.0%
Total Shipments	47.4	113.1	32.3	23.3	104.1	142.4	10.2	105.7	346.0	4.6	101.3	510.0	8.0	1.0	72.0	678.0	27.0
	+11.3%	+114.2%	+223.0%	-50.8%	-8.0%	+340.9%	-56.2%	+1.5%	+143.0%	-54.9%	-4.2%	+47.4%	--	-78.3%	-28.9%	+32.9%	+237.5%
ANNUAL SHARE, BY DIAMETER	24.6%	58.8%	16.6%	8.6%	38.7%	52.7%	2.2%	22.9%	74.9%	.7%	16.2%	81.8%	1.3%	.1%	9.3%	87.2%	3.4%

NOTE: 8 inch totals include 9 and 10.5 inch drives

TABLE 53

FIXED DISK DRIVES, 100 - 300 MEGABYTES

APPLICATIONS SUMMARY
Percentage of Worldwide Shipments

APPLICATION	1985 Estimate Units (000)	1985 Estimate %	1989 Projection Units (000)	1989 Projection %
MAINFRAME/SUPERMINI General purpose	9.9	5.2	20.2	2.6
MINICOMPUTERS AND MULTI-USER MICROS Business and professional, including networks	139.0	72.1	596.7	76.7
MICROCOMPUTERS Business and professional, single user	11.0	5.7	21.8	2.8
OFFICE SYSTEMS AND WORKSTATIONS Dedicated application	9.1	4.7	16.4	2.1
NON-OFFICE SYSTEMS AND WORKSTATIONS Technical, distribution, medical, other specialized	22.3	11.6	119.0	15.3
CONSUMER AND HOBBY COMPUTERS	.8	.4	1.6	.2
OTHER APPLICATIONS	.7	.4	2.3	.3
Total	192.8	100.1	778.0	100.0

TABLE 54

FIXED DISK DRIVES, 100-300 MEGABYTES

DISTRIBUTION CHANNEL SUMMARY
U.S. Non-Captive Disk Drives

Distribution channel	1985 U.S. Net Shipments Units (000)	%	FORECAST 1986 %	1987 %	1988 %	1989 %
Mainframe computer manufacturers	18.5	20.7	14.5	10.9	8.7	7.4
Mini/micro computer manufacturers	21.8	24.4	27.7	29.3	29.5	29.3
System OEMs/systems houses	37.8	42.3	43.3	42.2	39.1	35.7
Independent peripherals suppliers	1.7	1.9	3.6	6.4	11.0	15.3
Distributors, dealers, end users	9.6	10.7	10.9	11.2	11.7	12.3
TOTAL	89.4					

TABLE 55

FIXED DISK DRIVES, 100 - 300 MEGABYTES

MARKET SHARE SUMMARY
Worldwide Shipments of Non-Captive Disk Drives

Drive Manufacturers	1985 Net Shipments: To United States Destinations, Units (000) 14"	8"	5.25"	Total	%	Worldwide, Units (000) 14"	8"	5.25"	Total	%
FUJITSU	.2	18.3	.9	19.4	21.7	.8	34.8	1.1	36.7	26.9
MAXTOR	--	--	22.8	22.8	25.5	--	--	26.2	26.2	19.2
HITACHI	--	6.0	.7	6.7	7.5	--	15.0	1.7	16.7	12.2
CONTROL DATA	7.4	4.7	--	12.1	13.5	10.4	5.9	--	16.3	11.9
TOSHIBA	--	9.0	--	9.0	10.1	--	14.0	--	14.0	10.2
NEC	--	8.5	--	8.5	9.5	--	11.8	--	11.8	8.6
PRIAM	5.0	1.3	--	6.3	7.0	6.0	2.5	--	8.5	6.3
Other U.S.	.6	.2	1.6	2.4	2.7	.6	.2	1.8	2.6	1.9
Other Non-U.S.	--	2.2	--	2.2	2.5	--	2.3	1.5	3.8	2.8
TOTAL	13.2	50.2	26.0	89.4	100.0	17.8	86.5	32.3	136.6	100.0

NOTE: 8 inch totals include 9 and 10.5 inch drives.

FIXED DISK DRIVES, 300-500 MB

1986 DISK/TREND REPORT

FIXED DISK DRIVES, 300-500 MEGABYTES

Coverage

Examples of disk drives in this group include:

14" disk diameter

Century Data Systems	AMS 315
Data General	6236, 6237
Digital Equipment	RA81
Fujitsu	M2294, F493
Hewlett-Packard	7933H
IBM	5360-BXA, 4967-3CA
Tecstor	3005, 3020

10.5" disk diameter

Fujitsu	M2350A, F6421

9" disk diameter

Control Data	9715-300, 9715-340
NEC	D2332

8" disk diameter

Century Data Systems	C2400, C2476
Control Data	9720 EMD
Fujitsu	M2333K
Hitachi	DKU-80, DK-814S
IBM	9332-A12, 678-400
Mitsubishi Electric	MR4875
NEC	D2268, D2268H
Northern Telecom	8310, 8212X
Pertec	DX332, DX368
Priam	807
Toshiba	MK-286FC, MK-287FC

5.25" disk diameter

Maxtor	XT-3380, EXT-4380, XT-8380E
Micropolis	1555, 1558
Newbury Data	NDR 4380
Priam	638, 738
Siemens	1300

Many of the older disk drives in this group were patterned after IBM's 3350 -- typically 317.5 megabyte floor-standing drives intended for use with mainframes.

During recent years, however, newer rack-mounted 14" drives have been introduced for both captive (IBM, DEC, Data General, Hewlett-Packard) and OEM (Tecstor, Century, Fujitsu) markets. Led by the successful Fujitsu 10.5" Eagle, other small drives have included the Control Data 9" FSD with 344 megabytes, the Hitachi 8" DKU-80 with 427 megabytes, and the Maxtor 5.25" EXT-4380 with 382 megabytes.

Market status

DISK/TREND estimate of total market size:

Worldwide sales ($M)	1985	1986	1987	1988	1989
U.S. manufacturers	769.6	726.3	1,179.2	1,403.0	1,444.5
All manufacturers	1,332.1	1,292.7	1,794.8	2,111.9	2,284.7

Until 1984, the 300-500 megabyte range was almost exclusively the domain of 14" and 10.5" drives, but the product mix is now changing rapidly, with such drives sinking to less than half of the total unit shipments for 1986. Worldwide shipments of 14" and 10.5" drives peaked in 1985 with 94,100 spindles, 78.3% of the total for all drives in the group.

Captive U.S. producers ship the majority of 14" drives, led by Digital Equipment's RA81, but also including drives from IBM, Hewlett-Packard and Data General. Fujitsu has also been a substantial captive user of 10.5" drives. However, captive 14" drive shipments in this group are peaking in 1986, as system manufacturers migrate in two directions: To larger capacity 14" drives and to 8" or 9" drives for requirements in the 300-500 megabyte range.

The last remaining evidence of the once-thriving business in making 317 megabyte drives for IBM and compatible mainframes is the plug compatible version of Fujitsu's 10.5" Eagle I, sold in North America and Europe by Amdahl. For PCM markets this drive is formatted to 317 megabytes, to compete with IBM's original 3350 in capacity, performance and price. Shipments peaked in 1985, at 15,800 spindles worldwide. PCM shipment of 14" drives is expected to end in 1986, as Amdahl upgrades its plug compatible program to emphasize the 630 megabyte Eagle II.

The strong market for OEM drives in this group has benefited 8"/9" drives for several years and is now starting to welcome 5.25" drives from Maxtor and others. In contrast to the 100-300 megabyte range, where Japanese firms dominate of the 8"/9" OEM drive market, Japanese and U.S. firms have approximately equal shares of the 1986 OEM market for 300-500 megabyte drives, mostly because of renewed Control Data vigor in both 8" and 9" drives. Maxtor alone generated most of the early 5.25" shipments in this group, but many other companies will follow. Siemens is already shipping, followed by announced drives from Micropolis, Priam and Newbury Data -- with the major Japanese disk drive manufacturers expected soon.

Fujitsu's strong shipments of both PCM and OEM drives in this group during 1985 gave the company 61.8% of worldwide unit shipments, totaling 42,300 drives, including 14", 10.5" and 8" models. Control Data held 15.0% with 10,300 drives, mostly 9" FSD models.

During 1985, mainframe and supermini applications accounted for 49.8% of unit shipments, a figure inflated by shipments of plug compatible drives for use with mainframes. However, by 1989 minicomputers and multiple user micros, including network applications, are expected to utilize 52.4% of drives in the group, with mainframes and superminis down to 34.8%.

An interesting application area to watch will be the use of multiple spindle subsystems with mainframe computers. Sperry is now offering a subsystem using 8" drives, assembled as a subsystem by Amperif. Compared to usage of high capacity 14" drives, this approach potentially offers improvements in cost, floor space utilization, and performance -- and may be the pathfinder for similar subsystems using 8" or 5.25" drives to be offered by other system manufacturers or plug compatible drive suppliers.

Marketing trends

Worldwide unit shipments for this group are expected to more than double by 1989, with 385,800 drives, an average annual growth rate of 30%.

With the introduction of the 400 megabyte version of the 8" 9332 during mid-1986, IBM is expected to take a larger share of captive shipments in this product group, with the 1989 total reaching 53,000 drives. Other captive drive producers will also see a substantial increase in shipments of 8" drives through 1989 -- but by that time 5.25" drives will also be starting to rival 8" models in shipment volume.

In the OEM market, 14" drives will probably be out of production after 1988, but Fujitsu's 10.5" drives are expected to survive several years longer, due to their wide usage. 8" and 9" drives are expected to continue growing through 1989, holding slightly over half of worldwide OEM shipments during each of the years in the 1987-89 time period. 5.25" drives will achieve the highest growth rate, averaging 127% per year through 1989. U.S. companies, taking advantage of early market position and the dollar/yen exchange rate, will hold their lead in 5.25" drives, and with renewed activity levels by Control Data and Century Data Systems will probably also lead in 8" and 9" drives.

Technical trends

Development activities in this product group will strive to squeeze more capacity into smaller boxes and to improve performance during the next few years. Control Data's 340 megabyte version of the 9" FSD was designed to a conservative linear density specification of 9,492 BPI. The FSD's 230 mm disk provides more recording area than the 195-210 mm disks used with 8" drives, allowing use of less ambitious specifications and making it easier to produce the drive in large quantities.

Maxtor was the lonely pioneer in 5.25" drives in the 300-500 megabyte range, but the firm's successful production of such drives has inspired competitors to take on the twin challenges of fitting enough disks into the standard 5.25" form factor and finding ways to improve head positioning time below the sub-20 ms average now required to be competitive. Would-be producers of 5.25" drives in this product group have had to develop innovative design solutions, such as Maxtor's placement of the drive motor inside the inner diameter of the stack of disks and to completely redesign head positioning systems for faster access.

The demand for more capacity in small spaces will continue. Expect to see extensive use of thin film heads and disks, run length limited encoding methods, intelligent interfaces, extensive use of VLSI in drive electronics, and maybe even perpendicular recording.

Forecasting assumptions

1. IBM will introduce no new drives in this group through 1989.
2. Sustained growth for superminicomputers, large workstation clusters and specialized systems will create significant growth for both captive and OEM drives in this group for both 8/9" and 5.25" drives.

TABLE 56

FIXED DISK DRIVES, 300 - 500 MEGABYTES

REVENUE SUMMARY

	DISK DRIVE REVENUES, BY SHIPMENT DESTINATION ($M)									
	1985		Forecast							
	Revenues		1986		1987		1988		1989	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM Captive	42.0	60.0	161.2	226.5	235.6	340.1	394.2	585.0	442.1	670.0
Other U.S. Captive	397.0	602.5	241.9	325.9	405.3	566.1	359.1	506.4	286.0	437.8
TOTAL U.S. CAPTIVE	439.0	662.5	403.1	552.4	640.9	906.2	753.3	1,091.4	728.1	1,107.8
PCM	--	--	--	--	--	--	--	--	--	--
OEM	93.9	107.1	152.9	173.9	236.3	273.0	256.8	311.6	262.0	336.7
TOTAL U.S. NON-CAPTIVE	93.9	107.1	152.9	173.9	236.3	273.0	256.8	311.6	262.0	336.7
TOTAL U.S. REVENUES	532.9	769.6	556.0	726.3	877.2	1,179.2	1,010.1	1,403.0	990.1	1,444.5
Non-U.S. Manufacturers										
Captive	--	263.6	6.0	261.5	10.2	352.0	13.2	420.1	17.6	523.5
PCM	18.2	110.6	5.2	46.8	--	--	--	--	--	--
OEM	127.6	188.3	168.6	258.1	172.5	263.6	193.6	288.8	201.1	316.7
TOTAL NON-U.S. REVENUES	145.8	562.5	179.8	566.4	182.7	615.6	206.8	708.9	218.7	840.2
Worldwide Recap										
TOTAL WORLDWIDE REVENUES	678.7	1,332.1	735.8	1,292.7	1,059.9	1,794.8	1,216.9	2,111.9	1,208.8	2,284.7
OEM Average Price ($000)	5.6	5.6	4.3	4.5	3.5	3.6	2.9	3.0	2.6	2.7

TABLE 57

FIXED DISK DRIVES, 300 - 500 MEGABYTES

UNIT SHIPMENT SUMMARY

	DISK DRIVE UNIT SHIPMENTS, BY SHIPMENT DESTINATION (000)									
	1985		Forecast							
	Shipments		1986		1987		1988		1989	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM Captive	2.1	3.0	9.4	13.0	16.0	23.0	30.0	44.5	36.3	55.0
Other U.S. Captive	25.4	38.6	34.0	48.4	29.6	40.7	31.6	43.9	32.8	50.3
TOTAL U.S. CAPTIVE	27.5	41.6	43.4	61.4	45.6	63.7	61.6	88.4	69.1	105.3
PCM	--	--	--	--	--	--	--	--	--	--
OEM	19.2	21.9	36.0	40.9	70.7	81.8	90.9	111.1	104.8	136.0
TOTAL U.S. NON-CAPTIVE	19.2	21.9	36.0	40.9	70.7	81.8	90.9	111.1	104.8	136.0
TOTAL U.S. SHIPMENTS	46.7	63.5	79.4	102.3	116.3	145.5	152.5	199.5	173.9	241.3
Non-U.S. Manufacturers										
Captive	--	10.3	.4	12.1	.6	20.4	.8	28.1	1.1	40.5
PCM	2.6	15.8	.8	7.2	--	--	--	--	--	--
OEM	20.3	30.8	37.1	53.6	45.0	65.5	59.8	85.5	71.7	104.0
TOTAL NON-U.S. SHIPMENTS	22.9	56.9	38.3	72.9	45.6	85.9	60.6	113.6	72.8	144.5
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	69.6	120.4	117.7	175.2	161.9	231.4	213.1	313.1	246.7	385.8
Cumulative Shipments										
IBM	118.4	201.3	127.8	214.3	143.8	237.3	173.8	281.8	210.1	336.8
Non-IBM	204.9	373.5	313.2	535.7	459.1	744.1	642.2	1,012.7	852.6	1,343.5
WORLDWIDE TOTAL	323.3	574.8	441.0	750.0	602.9	981.4	816.0	1,294.5	1,062.7	1,680.3

TABLE 58

FIXED DISK DRIVES, 300 - 500 MEGABYTES

WORLDWIDE REVENUES ($M)

BREAKDOWN BY DISK DIAMETER

	1985 Revenues			Forecast											
	1986			1987			1988			1989		
	14"	8"	5.25"	14"	8"	5.25"	14"	8"	5.25"	14"	8"	5.25"	14"	8"	5.25"
U.S. MANUFACTURERS															
IBM Captive	60.0	--	--	160.0	66.5	--	114.0	226.1	--	81.0	504.0	--	34.0	636.0	--
Other U.S. Captive	601.0	1.5	--	233.5	92.4	--	383.1	180.0	3.0	228.0	239.8	38.6	69.8	278.0	90.0
PCM	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
OEM	47.1	59.1	.9	29.2	127.4	17.3	10.8	184.0	78.2	3.6	201.6	106.4	--	210.8	125.9
TOTAL U.S. REVENUES	708.1	60.6	.9	422.7	286.3	17.3	507.9	590.1	81.2	312.6	945.4	145.0	103.8	1,124.8	215.9
NON-U.S. MANUFACTURERS															
Captive	254.6	9.0	--	195.3	40.2	26.0	147.5	144.5	60.0	106.6	214.5	99.0	67.5	304.0	152.0
PCM	110.6	--	--	46.8	--	--	--	--	--	--	--	--	--	--	--
OEM	125.0	63.3	--	96.5	129.6	32.0	63.8	147.0	52.8	46.8	166.0	76.0	42.5	182.4	91.8
TOTAL NON-U.S. REVENUES	490.2	72.3	--	338.6	169.8	58.0	211.3	291.5	112.8	153.4	380.5	175.0	110.0	486.4	243.8
WORLDWIDE RECAP															
Captive	915.6	10.5	--	588.8	199.1	26.0	644.6	550.6	63.0	415.6	958.3	137.6	171.3	1,218.0	242.0
	+3.8%	-59.5%	--	-35.7%	--	--	+9.5%	+176.5%	+142.3%	-35.5%	+74.0%	+118.4%	-58.8%	+27.1%	+75.9%
PCM	110.6	--	--	46.8	--	--	--	--	--	--	--	--	--	--	--
	-16.8%	--	--	-57.7%	--	--	--	--	--	--	--	--	--	--	--
OEM	172.1	122.4	.9	125.7	257.0	49.3	74.6	331.0	131.0	50.4	367.6	182.4	42.5	393.2	217.7
	+9.3%	+361.9%	--	-27.0%	+110.0%	--	-40.7%	+28.8%	+165.7%	-32.4%	+11.1%	+39.2%	-15.7%	+7.0%	+19.4%
Total Revenues	1,198.3	132.9	.9	761.3	456.1	75.3	719.2	881.6	194.0	466.0	1,325.9	320.0	213.8	1,611.2	459.7
	+2.2%	+153.6%	--	-36.5%	+243.2%	--	-5.5%	+93.3%	+157.6%	-35.2%	+50.4%	+64.9%	-54.1%	+21.5%	+43.7%
ANNUAL SHARE, BY DIAMETER	90.1%	9.9%	--	59.0%	35.3%	5.7%	40.2%	49.1%	10.7%	22.1%	62.9%	15.0%	9.4%	70.6%	20.0%

NOTE: 14 inch totals include 10.5 inch drives
8 inch totals include 9 inch drives

TABLE 59

FIXED DISK DRIVES, 300 - 500 MEGABYTES

WORLDWIDE SHIPMENTS (000)

BREAKDOWN BY DISK DIAMETER

	1985 Shipments			Forecast											
	1986			1987			1988			1989					
	14"	8"	5.25"	14"	8"	5.25"	14"	8"	5.25"	14"	8"	5.25"	14"	8"	5.25"
U.S. MANUFACTURERS															
IBM Captive	3.0	--	--	8.0	5.0	--	6.0	17.0	--	4.5	40.0	--	2.0	53.0	--
Other U.S. Captive	38.5	.1	--	40.7	7.7	--	25.2	15.0	.5	15.1	21.8	7.0	4.5	27.8	18.0
PCM	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
OEM	9.2	12.5	.2	4.6	30.8	5.5	1.8	46.0	34.0	.6	54.5	56.0	--	62.0	74.0
TOTAL U.S. SHIPMENTS	50.7	12.6	.2	53.3	43.5	5.5	33.0	78.0	34.5	20.2	116.3	63.0	6.5	142.8	92.0
NON-U.S. MANUFACTURERS															
Captive	9.8	.5	--	7.8	2.3	2.0	5.9	8.5	6.0	4.1	13.0	11.0	2.5	19.0	19.0
PCM	15.8	--	--	7.2	--	--	--	--	--	--	--	--	--	--	--
OEM	17.8	13.0	--	13.0	30.6	10.0	8.5	35.0	22.0	6.0	41.5	38.0	5.0	48.0	51.0
TOTAL NON-U.S. SHIPMENTS	43.4	13.5	--	28.0	32.9	12.0	14.4	43.5	28.0	10.1	54.5	49.0	7.5	67.0	70.0
WORLDWIDE RECAP															
Captive	51.3	.6	--	56.5	15.0	2.0	37.1	40.5	6.5	23.7	74.8	18.0	9.0	99.8	37.0
	+10.6%	-60.0%	--	+10.1%	--	--	-34.3%	+170.0%	+225.0%	-36.1%	+84.7%	+176.9%	-62.0%	+33.4%	+105.6%
PCM	15.8	--	--	7.2	--	--	--	--	--	--	--	--	--	--	--
	+18.8%	--	--	-54.4%	--	--	--	--	--	--	--	--	--	--	--
OEM	27.0	25.5	.2	17.6	61.4	15.5	10.3	81.0	56.0	6.6	96.0	94.0	5.0	110.0	125.0
	+.7%	+442.6%	--	-34.8%	+140.8%	--	-41.5%	+31.9%	+261.3%	-35.9%	+18.5%	+67.9%	-24.2%	+14.6%	+33.0%
Total Shipments	94.1	26.1	.2	81.3	76.4	17.5	47.4	121.5	62.5	30.3	170.8	112.0	14.0	209.8	162.0
	+8.8%	+321.0%	--	-13.6%	+192.7%	--	-41.7%	+59.0%	+257.1%	-36.1%	+40.6%	+79.2%	-53.8%	+22.8%	+44.6%
ANNUAL SHARE, BY DIAMETER	78.3%	21.7%	--	46.5%	43.6%	9.9%	20.5%	52.6%	26.9%	9.7%	54.7%	35.6%	3.6%	54.5%	41.9%

NOTE: 14 inch totals include 10.5 inch drives
8 inch totals include 9 inch drives

TABLE 60

FIXED DISK DRIVES, 300 - 500 MEGABYTES

APPLICATIONS SUMMARY
Percentage of Worldwide Shipments

APPLICATION	1985 Estimate Units (000)	1985 Estimate %	1989 Projection Units (000)	1989 Projection %
MAINFRAME/SUPERMINI General purpose	60.0	49.8	134.3	34.8
MINICOMPUTERS AND MULTI-USER MICROS Business and professional, including networks	45.2	37.6	202.1	52.4
MICROCOMPUTERS Business and professional, single user	--	--	--	--
OFFICE SYSTEMS AND WORKSTATIONS Dedicated application	2.1	1.8	2.3	.6
NON-OFFICE SYSTEMS AND WORKSTATIONS Technical, distribution, medical, other specialized	12.9	10.7	47.1	12.2
CONSUMER AND HOBBY COMPUTERS	--	--	--	--
OTHER APPLICATIONS	.2	.2	--	--
Total	120.4	100.1	385.8	100.0

TABLE 61

FIXED DISK DRIVES, 300-500 MEGABYTES

DISTRIBUTION CHANNEL SUMMARY
U.S. Non-Captive Disk Drives

Distribution channel	1985 U.S. Net Shipments Units (000)	%	FORECAST 1986 %	1987 %	1988 %	1989 %
Mainframe computer manufacturers	2.3	5.4	4.9	4.4	3.9	3.5
Mini/micro computer manufacturers	19.0	45.2	45.6	41.9	37.7	33.8
System OEMs/systems houses	7.3	17.4	24.5	30.4	36.3	41.4
Independent peripherals suppliers	7.3	17.4	17.9	18.4	19.0	19.5
Distributors, dealers, end users	6.2	14.6	7.1	4.9	3.1	1.8
TOTAL	42.1					

TABLE 62

FIXED DISK DRIVES, 300 - 500 MEGABYTES

MARKET SHARE SUMMARY
Worldwide Shipments of Non-Captive Disk Drives

Drive Manufacturers	1985 Net Shipments: To United States Destinations, Units (000) 14"	8"	5.25"	Total	%	Worldwide, Units (000) 14"	8"	5.25"	Total	%
FUJITSU	14.1	6.6	--	20.7	49.2	33.3	9.0	--	42.3	61.8
CONTROL DATA	--	9.3	--	9.3	22.1	--	10.3	--	10.3	15.0
CENTURY DATA	6.1	.7	--	6.8	16.2	6.2	.7	--	6.9	10.1
Other U.S.	1.9	1.0	.2	3.1	7.3	3.0	1.5	.2	4.7	6.8
Other Non-U.S.	--	2.2	--	2.2	5.2	.3	4.0	--	4.3	6.3
TOTAL	22.1	19.8	.2	42.1	100.0	42.8	25.5	.2	68.5	100.0

NOTE: 14 inch totals include 10.5 inch drives
8 inch totals include 9 inch drives

FIXED DISK DRIVES, MORE THAN 500 MB

1986 DISK/TREND REPORT

FIXED DISK DRIVES, MORE THAN 500 MEGABYTES

Coverage

Examples of disk drives in this group include:

14" disk diameter

Alpha Data	Atlas 520
Burroughs	9494-12
Century Data Systems	AMS 513, AMS 571
Control Data	9771, 9772, 9775
Data General	6239, 6290
Fujitsu	M2298
Hitachi	DKU-97S, DKU-85I-D14
Ibis	1400
IBM	3370, 3375, 3380D/E, 9335-B01
Memorex	3680, 3680 HDP
NEC	N7761, N7765
Nippon Peripherals	NP-37
Storage Technology	8380-B4, 8380-BE4

10.5" disk diameter

Fujitsu	F6425, M2361A

9" disk diameter

Control Data	9715-500
Hitachi	DK815-5
NEC	D2352, N7756

8" disk diameter

Century Data Systems	C2600, C2800
Northern Telecom	8312
Pertec	DX548
Toshiba	MK-288FC

5.25" disk diameter

Maxtor	XT-8760E

Until recently, disk drives in this group consisted mostly of PCM, IBM and other captive floor-standing drives intended for use with mainframe systems. The list of OEM drives was expanded during the last

few years, however, with the addition of several rack-mounted models intended for sale in the growing superminicomputer market.

Control Data's 9" FSD was the pioneer product among drives with disk diameters less than 10.5", but in the past year several 8" drives with capacities more than 500 megabytes have been announced, and more announcements are expected from other manufacturers of high performance drives.

Market status

DISK/TREND estimate of total market size:

Worldwide sales ($M)	1985	1986	1987	1988	1989
U.S. manufacturers	6,180.2	6,427.1	8,458.8	11,494.8	12,670.3
All manufacturers	7,198.8	7,880.4	10,454.2	13,931.2	15,772.1

Disk drives with capacities more than 500 megabytes now generate over $7 billion in revenues for disk drive manufacturers -- with over $5 billion going to IBM. The giant is not satisfied, however, especially with its flat performance in 1986.

It is believed that IBM had fonder hopes for the sales prospects of its 3380E double capacity drive than have so far been achieved, and, in fact, higher expectations for its total sales of the 3380 series than will have been realized in 1986. Sales of double capacity drives have grown from an estimated one third of the 3380 total in 1985 to two thirds of the total in 1986, but the combined 3380 total has apparently not grown significantly, at 110,500 spindles for 1986 -- despite a 10% price cut for 3380E drives in October, 1985, and other sales gimmicks in 1986.

IBM's overall unit shipment total for this product group was an estimated 138,400 spindles in 1985, declining to 133,500 spindles in 1986. In addition to the dominant 3380, these totals include shipments of 3370,

3375, and the new 9335. IBM indicated in public statements this year that the total number of 3380 drives produced worldwide through the end of 1985 was 160,000 boxes (320,000 spindles). The DISK/TREND shipment history and current estimates have been revised to be consistent with this information, resulting in an increase from previous estimates.

Worldwide PCM shipments increased 33.5% in 1985, but only 10.7% in 1986, to 30,000 spindles. Most of the 1986 PCM shipments will be 3380-type drives, but less than 30% will be double capacity models, since only one PCM vendor had significant shipments in the first half of 1986.

Hitachi led in non-captive shipments for 1985 with 25.2% of the worldwide total, representing 12,300 spindles, mostly PCM drives. Control Data shipped 11,600 spindles for 23.7%, both 14" and 9" drives, including the close-out of the firm's terminated PCM 3380 compatible program.

Shipments by captive producers other than IBM are also flat in 1986, with worldwide shipments of 14" and 10.5" drives increasing by only 1,200 units, to 39,400 spindles. 8" and 9" shipments are expected to rise from 4,700 units in 1985 to 10,000 in 1986.

Marketing trends

DISK/TREND forecasts indicate 1989 revenues for this product group totaling $15.7 billion, representing an average annual increase of 26.4% during the 1987-89 period. IBM's share of total revenues is expected to be $9.3 billion in 1989, 59.3% of the total for the group and down significantly from 1985's 72.3% share. The difference is to be found in higher growth levels for other captive and OEM drives.

Other U.S. captive drive shipments will attain the highest growth level through 1989, spurred initially by new 14" drives from Digital

Equipment, then by 8" and 9" drives from DEC and others. Non-U.S. captive drive producers are also expected to achieve growing shipments with new 8" and 9" drives.

OEM drives will also grow rapidly, but not 14" models. 8" and 9" drives are already shipping in larger quantities and by 1989 are expected to provide 68% of worldwide unit shipments in the group. It is expected that the 9" OEM drives already offered by Control Data, Hitachi and NEC, plus the 8" models from Century, Northern Telecom, Pertec and Toshiba, will be joined soon by new drives from every manufacturer of high performance disk drives. Maxtor has already announced 1987 availability of a 765 megabyte 5.25" drive, which will also inspire additional competition.

IBM's management is undoubtedly sifting through its options, to find the best way to attract more enthusiasm from its customers for big disk drives. It is expected that the existing single density models will be out of production by 1989. It is possible that a decision may be made for another mid-life enhancement to the 3380, probably an additional 50% increase in capacity and transfer rate, to improve cost effectivity.

Whether or not that is done, a new high performance drive, with disks smaller than 14" and faster time-to-data, is expected in 1988. Such a drive is needed badly to pacify a growing portion of IBM's mainframe customers with large on-line applications, and who find the 3380 to have inadequate performance for the capacity represented per actuator.

The growth rate for PCM drives will have its ups and downs, as usual. The outlook is for a more stable group of PCM vendors, with Storage Technology emerging from bankruptcy. But the going will not be easy, as IBM attempts to increase sales with new products and occasional price cuts.

Technical trends

If Maxtor can offer a 5.25" drive with areal density of 43 megabits per square inch, it stands to reason that IBM can do better than that with a drive designed for mainframe applications. (IBM's highest current areal density is 25 megabits per square inch, used on both the 9332 and 9335.)

As always, IBM will have several options, but it is likely that system functional requirements and customers' sarcasm will steer development efforts in the directions suggested earlier in this section: Toward smaller physical size and specialized drives with improved performance. It is probable that a majority of IBM's mainframe customers still merely want improved cost per megabyte in their next drive, but others are already finding troublesome performance limitations with today's drives.

An obvious answer will be to develop drives using disks less than 14" diameter, using the higher areal densities now attainable. These drives will be smaller, quieter, cheaper and require less power -- and could be configured in subsystems with a large number of spindles. A variation of the same drive could readily contain the performance features needed with high-throughput applications, notably multiple head sliders, providing access to many additional tracks by electronic switching, without the delay of actuator movement.

Forecasting assumptions

1. IBM will utilize the 3380 family, with potential enhancements, as its basic disk drive for large mainframes through 1989, and ship a new 8"-10" high performance drive in 1988.

2. Other captive and OEM products will both experience strong growth, driven by mainframe and supermini markets.

TABLE 63

FIXED DISK DRIVES, MORE THAN 500 MEGABYTES

REVENUE SUMMARY

	DISK DRIVE REVENUES, BY SHIPMENT DESTINATION ($M)									
	1985 Revenues		Forecast 1986		1987		1988		1989	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM Captive	2,850.9	5,204.6	3,084.7	5,370.8	3,671.1	6,420.2	5,063.4	8,730.0	5,539.2	9,360.0
Other U.S. Captive	324.8	598.4	313.9	556.8	746.8	1,236.9	1,080.2	1,776.5	1,150.4	1,907.8
TOTAL U.S. CAPTIVE	3,175.7	5,803.0	3,398.6	5,927.6	4,417.9	7,657.1	6,143.6	10,506.5	6,689.6	11,267.8
PCM	121.3	181.2	136.2	187.6	347.4	475.7	461.5	657.4	729.6	1,075.4
OEM	103.5	196.0	192.5	311.9	209.6	326.0	211.6	330.9	207.2	327.1
TOTAL U.S. NON-CAPTIVE	224.8	377.2	328.7	499.5	557.0	801.7	673.1	988.3	936.8	1,402.5
TOTAL U.S. REVENUES	3,400.5	6,180.2	3,727.3	6,427.1	4,974.9	8,458.8	6,816.7	11,494.8	7,626.4	12,670.3
Non-U.S. Manufacturers										
Captive	--	556.4	--	779.0	--	1,068.3	--	1,359.3	--	1,670.8
PCM	152.2	388.8	173.2	497.1	276.0	664.6	342.2	759.8	496.8	1,105.2
OEM	25.8	73.4	94.5	177.2	148.5	262.5	178.3	317.3	187.4	325.8
TOTAL NON-U.S. REVENUES	178.0	1,018.6	267.7	1,453.3	424.5	1,995.4	520.5	2,436.4	684.2	3,101.8
Worldwide Recap										
TOTAL WORLDWIDE REVENUES	3,578.5	7,198.8	3,995.0	7,880.4	5,399.4	10,454.2	7,337.2	13,931.2	8,310.6	15,772.1
OEM Average Price ($000)	10.7	12.3	8.6	10.0	8.7	9.4	7.9	8.6	6.6	7.2

TABLE 64

FIXED DISK DRIVES, MORE THAN 500 MEGABYTES

UNIT SHIPMENT SUMMARY

	DISK DRIVE UNIT SHIPMENTS, BY SHIPMENT DESTINATION (000)									
	1985 Shipments		Forecast							
			1986		1987		1988		1989	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM Captive	74.2	138.4	75.5	133.5	87.2	152.5	104.4	180.0	115.4	195.0
Other U.S. Captive	10.4	19.4	11.0	19.4	29.1	48.3	42.6	70.1	45.8	75.9
TOTAL U.S. CAPTIVE	84.6	157.8	86.5	152.9	116.3	200.8	147.0	250.1	161.2	270.9
PCM	5.7	8.6	5.9	8.4	11.1	15.2	13.9	19.8	19.2	28.3
OEM	8.4	15.0	19.4	28.5	22.6	33.0	26.4	39.0	31.7	48.0
TOTAL U.S. NON-CAPTIVE	14.1	23.6	25.3	36.9	33.7	48.2	40.3	58.8	50.9	76.3
TOTAL U.S. SHIPMENTS	98.7	181.4	111.8	189.8	150.0	249.0	187.3	308.9	212.1	347.2
Non-U.S. Manufacturers										
Captive	--	23.5	--	30.0	--	41.5	--	53.3	--	67.1
PCM	7.4	18.5	8.1	21.6	10.3	24.8	11.8	26.2	13.8	30.7
OEM	3.6	6.8	13.9	20.2	18.3	29.5	22.5	36.0	27.4	42.5
TOTAL NON-U.S. SHIPMENTS	11.0	48.8	22.0	71.8	28.6	95.8	34.3	115.5	41.2	140.3
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	109.7	230.2	133.8	261.6	178.6	344.8	221.6	424.4	253.3	487.5
Cumulative Shipments										
IBM	231.9	441.4	307.4	574.9	394.6	727.4	499.0	907.4	614.4	1,102.4
Non-IBM	128.4	281.0	186.7	409.1	278.1	601.4	395.3	845.8	533.2	1,138.3
WORLDWIDE TOTAL	360.3	722.4	494.1	984.0	672.7	1,328.8	894.3	1,753.2	1,147.6	2,240.7

TABLE 65

FIXED DISK DRIVES, MORE THAN 500 MEGABYTES

WORLDWIDE REVENUES ($M)

BREAKDOWN BY DISK DIAMETER

	1985 Revenues		Forecast									
			1986		1987		1988			1989		
	14"	8"	14"	8"	14"	8"	14"	8"	5.25"	14"	8"	5.25"
U.S. MANUFACTURERS												
IBM Captive	5,204.6	--	5,370.8	--	6,420.2	--	8,730.0	--	--	9,360.0	--	--
Other U.S. Captive	565.4	33.0	446.8	110.0	972.9	264.0	1,089.2	687.3	--	736.6	1,171.2	--
PCM	181.2	--	187.6	--	475.7	--	657.4	--	--	1,075.4	--	--
OEM	164.2	31.8	224.6	87.3	218.5	107.5	204.8	121.6	4.5	175.5	137.3	14.3
TOTAL U.S. REVENUES	6,115.4	64.8	6,229.8	197.3	8,087.3	371.5	10,681.4	808.9	4.5	11,347.5	1,308.5	14.3
NON-U.S. MANUFACTURERS												
Captive	486.0	70.4	670.4	108.6	864.0	204.3	1,080.0	279.3	--	1,303.8	367.0	--
PCM	388.8	--	497.1	--	664.6	--	759.8	--	--	1,105.2	--	--
OEM	65.8	7.6	117.4	59.8	172.5	90.0	216.0	101.3	--	204.0	114.8	7.0
TOTAL NON-U.S. REVENUES	940.6	78.0	1,284.9	168.4	1,701.1	294.3	2,055.8	380.6	--	2,613.0	481.8	7.0
WORLDWIDE RECAP												
Captive	6,256.0	103.4	6,488.0	218.6	8,257.1	468.3	10,899.2	966.6	--	11,400.4	1,538.2	--
	+33.6%	--	+3.7%	+111.4%	+27.3%	+114.2%	+32.0%	+106.4%	--	+4.6%	+59.1%	--
PCM	570.0	--	684.7	--	1,140.3	--	1,417.2	--	--	2,180.6	--	--
	+10.0%	--	+20.1%	--	+66.5%	--	+24.3%	--	--	+53.9%	--	--
OEM	230.0	39.4	342.0	147.1	391.0	197.5	420.8	222.9	4.5	379.5	252.1	21.3
	+86.1%	+282.5%	+48.7%	+273.4%	+14.3%	+34.3%	+7.6%	+12.9%	--	-9.8%	+13.1%	+373.3%
Total Revenues	7,056.0	142.8	7,514.7	365.7	9,788.4	665.8	12,737.2	1,189.5	4.5	13,960.5	1,790.3	21.3
	+32.5%	+871.4%	+6.5%	+156.1%	+30.3%	+82.1%	+30.1%	+78.7%	--	+9.6%	+50.5%	+373.3%
ANNUAL SHARE, BY DIAMETER	98.1%	1.9%	95.5%	4.5%	93.7%	6.3%	91.5%	8.5%	--	88.6%	11.4%	--

NOTE: 14 inch totals include 10.5 inch drives
8 inch totals include 9 inch drives

TABLE 66

FIXED DISK DRIVES, MORE THAN 500 MEGABYTES

WORLDWIDE SHIPMENTS (000)

BREAKDOWN BY DISK DIAMETER

	1985 Shipments		Forecast									
			1986		1987		1988			1989		
	14"	8"	14"	8"	14"	8"	14"	8"	5.25"	14"	8"	5.25"
U.S. MANUFACTURERS												
IBM Captive	138.4	--	133.5	--	152.5	--	180.0	--	--	195.0	--	--
Other U.S. Captive	17.9	1.5	14.4	5.0	36.3	12.0	41.1	29.0	--	27.9	48.0	--
PCM	8.6	--	8.4	--	15.2	--	19.8	--	--	28.3	--	--
OEM	9.8	5.2	12.1	16.4	11.5	21.5	10.5	27.0	1.5	9.0	33.5	5.5
TOTAL U.S. SHIPMENTS	174.7	6.7	168.4	21.4	215.5	33.5	251.4	56.0	1.5	260.2	81.5	5.5
NON-U.S. MANUFACTURERS												
Captive	20.3	3.2	25.0	5.0	32.0	9.5	40.0	13.3	--	49.2	17.9	--
PCM	18.5	--	21.6	--	24.8	--	26.2	--	--	30.7	--	--
OEM	5.0	1.8	8.0	12.2	11.5	18.0	13.5	22.5	--	12.0	28.0	2.5
TOTAL NON-U.S. SHIPMENTS	43.8	5.0	54.6	17.2	68.3	27.5	79.7	35.8	--	91.9	45.9	2.5
WORLDWIDE RECAP												
Captive	176.6	4.7	172.9	10.0	220.8	21.5	261.1	42.3	--	272.1	65.9	--
	+31.9%	--	-2.1%	+112.8%	+27.7%	+115.0%	+18.3%	+96.7%	--	+4.2%	+55.8%	--
PCM	27.1	--	30.0	--	40.0	--	46.0	--	--	59.0	--	--
	+23.7%	--	+10.7%	--	+33.3%	--	+15.0%	--	--	+28.3%	--	--
OEM	14.8	7.0	20.1	28.6	23.0	39.5	24.0	49.5	1.5	21.0	61.5	8.0
	+72.1%	+366.7%	+35.8%	+308.6%	+14.4%	+38.1%	+4.3%	+25.3%	--	-12.5%	+24.2%	+433.3%
Total Shipments	218.5	11.7	223.0	38.6	283.8	61.0	331.1	91.8	1.5	352.1	127.4	8.0
	+32.9%	+588.2%	+2.1%	+229.9%	+27.3%	+58.0%	+16.7%	+50.5%	--	+6.3%	+38.8%	+433.3%
ANNUAL SHARE, BY DIAMETER	95.0%	5.0%	85.3%	14.7%	82.4%	17.6%	78.1%	21.6%	.3%	72.3%	26.1%	1.6%

NOTE: 14 inch totals include 10.5 inch drives
8 inch totals include 9 inch drives

TABLE 67

WORLDWIDE SHIPMENTS OF IBM AND PCM FIXED DISK DRIVES FOR MAINFRAMES

PRODUCT MIX ANALYSIS

	DISK DRIVE SHIPMENTS, BY SHIPMENT DESTINATION (000)									
	1985		FORECAST							
	---Shipments--		-----1986-----		-----1987-----		-----1988-----		-----1989-----	
	US	WW	US	WW	US	WW	US	WW	US	WW
3350 Type										
PCM 317 MB*	2.6	15.8	.8	7.2	--	--	--	--	--	--
3370 Type (729 MB)										
IBM	5.9	14.8	3.2	8.0	2.0	5.0	1.2	3.0	--	--
PCM	.4	1.3	--	.2	--	--	--	--	--	--
TOTAL	6.3	16.1	3.2	8.2	2.0	5.0	1.2	3.0	--	--
3375 Type (819 MB)										
IBM	6.4	14.3	4.4	10.0	3.4	8.0	2.5	6.0	--	--
PCM	.1	.5	--	.1	--	--	--	--	--	--
TOTAL	6.5	14.8	4.4	10.1	3.4	8.0	2.5	6.0	--	--
9335 Type (856 MB)										
IBM	--	--	3.5	5.0	13.2	24.0	16.6	32.0	19.5	39.0
3380 Type (1260 MB)										
IBM	40.5	73.6	21.2	38.5	7.4	13.5	1.7	3.0	--	--
PCM**	12.6	25.3	10.9	21.2	5.7	11.0	2.1	4.0	--	--
TOTAL	53.1	98.9	32.1	59.7	13.1	24.5	3.8	7.0	--	--
3380E Type (2520 MB)***										
IBM	21.4	35.7	43.2	72.0	61.2	102.0	76.8	128.0	79.8	133.0
PCM**	--	--	3.1	8.5	15.7	29.0	23.6	42.0	33.0	59.0
TOTAL	21.4	35.7	46.3	80.5	76.9	131.0	100.4	170.0	112.8	192.0
Not yet announced (1500 MB)										
IBM	--	--	--	--	--	--	5.6	8.0	16.1	23.0
TOTAL SPINDLES	89.9	181.3	90.3	170.7	108.6	192.5	130.1	226.0	148.4	254.0
TOTAL CAPACITY (Terabytes)		243.4		298.9		391.7		483.7		551.7
		+35%		+23%		+31%		+24%		+14%

*Includes 10.5" drives in 317 MB 3350 format.
**Includes: All 10.5" drives, counted as equivalent to IBM 3380 (two 10.5" spindles = one IBM 3380 spindle).
Some 14" drives, counted as equivalent to IBM 3380 (two 14" spindles = one IBM 3380 spindle).
***Includes future enhancements.

TABLE 68

FIXED DISK DRIVES, MORE THAN 500 MEGABYTES

APPLICATIONS SUMMARY
Percentage of Worldwide Shipments

APPLICATION	1985 Estimate Units (000)	1985 Estimate %	1989 Projection Units (000)	1989 Projection %
MAINFRAME/SUPERMINI General purpose	210.6	91.5	417.3	85.6
MINICOMPUTERS AND MULTI-USER MICROS Business and professional, including networks	9.7	4.2	40.9	8.4
MICROCOMPUTERS Business and professional, single user	--	--	--	--
OFFICE SYSTEMS AND WORKSTATIONS Dedicated application	1.7	.7	1.0	.2
NON-OFFICE SYSTEMS AND WORKSTATIONS Technical, distribution, medical, other specialized	7.3	3.2	27.8	5.7
CONSUMER AND HOBBY COMPUTERS	--	--	--	--
OTHER APPLICATIONS	.9	.4	.5	.1
Total	230.2	100.0	487.5	100.0

TABLE 69

FIXED DISK DRIVES, MORE THAN 500 MEGABYTES

DISTRIBUTION CHANNEL SUMMARY
U.S. Non-Captive Disk Drives

Distribution channel	1985 U.S. Net Shipments Units (000)	%	FORECAST 1986 %	1987 %	1988 %	1989 %
Mainframe computer manufacturers	3.0	12.1	8.9	6.4	5.4	4.3
Mini/micro computer manufacturers	5.2	20.6	35.9	33.1	32.3	30.8
System OEMs/systems houses	2.8	11.0	21.1	21.2	22.4	23.3
Independent peripherals suppliers	1.0	4.1	4.5	5.0	5.4	5.8
Distributors, dealers, end users	13.1	52.2	29.6	34.3	34.5	35.8
TOTAL	25.1					

TABLE 70

FIXED DISK DRIVES, MORE THAN 500 MEGABYTES

MARKET SHARE SUMMARY
Worldwide Shipments of Non-Captive Disk Drives

Drive Manufacturers	1985 Net Shipments To United States Destinations Units (000) 14"	8"	Total	%	1985 Net Shipments Worldwide Units (000) 14"	8"	Total	%
HITACHI	3.2	--	3.2	12.7	12.3	--	12.3	25.2
CONTROL DATA	2.8	4.0	6.8	27.1	6.6	5.0	11.6	23.7
FUJITSU	5.8	--	5.8	23.1	9.4	--	9.4	19.2
STORAGE TECHNOLOGY	2.7	--	2.7	10.7	4.0	--	4.0	8.2
MEMOREX	1.8	--	1.8	7.2	3.1	--	3.1	6.3
Other U.S.	2.6	.2	2.8	11.2	4.7	.2	4.9	10.0
Other Non-U.S.	.5	1.5	2.0	8.0	1.8	1.8	3.6	7.4
TOTAL	19.4	5.7	25.1	100.0	41.9	7.0	48.9	100.0

NOTE: 14 inch totals include 10.5 inch drives

RIGID DISK DRIVE SPECIFICATIONS

1986 DISK/TREND REPORT

RIGID MAGNETIC DISK DRIVE SPECIFICATIONS

Coverage

This section includes most disk drives intended for computer data storage which are now in new production or announced, arranged alphabetically by manufacturer.

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. Not listed in most cases are captive drives which are similar to OEM models made by the same manufacturer.

Generic type

Where applicable, model numbers of IBM or other manufacturers are used to describe the general physical form of drives and media, since these designations are well known throughout the industry. However, such usage of a specific model number is not meant to imply interchangeability, due to variations in media, recording formats and interfaces.

Technology type

IBM drive model numbers are also used as a general guide to type of heads and recording disks when appropriate, using a broad interpretation of IBM specifications. The term "3370 (ferrite)" indicates heads with the shape of IBM's 3370/3380 sliders, but using ferrite cores.

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 OEM drives, so please be alert to the need to check for manufacturers' latest information if you need precise data.

OEM prices

For the majority of OEM drives sold in the United States, OEM prices at the 100 unit level are provided. When prices for higher quantities have been used, the applicable quantity is shown in parentheses. Since prices may be changed by manufacturers without notice, please use them with the appropriate caution.

Capacities

Capacities are listed as "U" for unformatted or "F" for formatted. In general, unformatted capacities are shown for OEM drives, and formatted capacities are given for captive and PCM drives, plus OEM drives with intelligent interfaces, such as SCSI.

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.

1986 DISK/TREND product groups for rigid magnetic disk drives

REMOVABLE MAGNETIC MEDIA:	1.	Disk cartridge drives, less than 12 MB
	2.	Disk cartridge drives, more than 12 MB
	3.	Disk pack drives, less than 100 MB
	4.	Disk pack drives, more than 100 MB
FIXED MAGNETIC MEDIA:	5.	Fixed disk drives, less than 30 MB
	6.	Fixed disk drives, 30-100 MB
	7.	Fixed disk drives, 100-300 MB
	8.	Fixed disk drives, 300-500 MB
	9.	Fixed disk drives, more than 500 MB

MANUFACTURER	ALPHA DATA	ALPS ELECTRIC	ALPS ELECTRIC	ALPS ELECTRIC	ALPS ELECTRIC
DRIVE	Atlas 520	DRA010A	DRA020A	DRL010A	DRM010A
DISK/TREND GROUP	9	5	5	5	5
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	14"	130 mm OD 40 mm ID	130 mm OD 40 mm ID	95 mm OD 25 mm ID	95 mm OD 25 mm ID
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Thin Film	Thin Film
DRIVE: Technology type	Special	Modified 3350	Modified 3350	3370 (Ferrite)	3370 (Ferrite)
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	ESMD	ST412	ST412	ST412	ST412,SCSI
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 520	U: 12.75	U: 25.5	U: 12.75	U: 12.75
REMOVABLE		--	--	--	--
Capacity per track (Bytes)	U: 30,240	U: 10,416	U: 10,416	U: 10,416	U: 10,416
Data surfaces per spindle	7.6	4	4	4	2
Heads per data surface	10	1	1	1	1
Tracks per surface	2250	306	615	306	615
Track density (TPI)	1000	360	720	500	880
Maximum linear density (BPI)	11700	8944	8944	11800	12720
Rotational speed (RPM)	3600	3600	3545	3600	3545
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Band, Stepping Motor	Rotary, Band, Stepping Motor	Rotary, Band, Stepping Motor	Rotary, Band, Stepping Motor
Average positioning time (msec)	18	85 (including settling)	80 (including settling)	80 (including settling)	80 (including settling)
Average rotational delay (msec)	8.3	8.3	8.46	8.3	8.46
Average access time (msec)	26.3	93.3	88.46	88.3	88.46
Data transfer rate (KBytes/sec)	1800	625	625	625	625
FIRST CUSTOMER SHIPMENT	2Q86	6/85	8/85	6/86	10/85
U.S. OEM PRICE FOR 100 UNITS	$7,495	--	--	--	--
COMMENTS		41 mm High	41 mm High	41 mm High	41 mm High

MANUFACTURER	ALPS ELECTRIC	ALPS ELECTRIC	ALPS ELECTRIC	AMCODYNE	AMCODYNE
DRIVE	DRM020A	DRN010A	DRN020A	7110 Arapahoe	7130 Tomahawk
DISK/TREND GROUP	5	5	5	2	2
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	8" Cartridge	8" Cartridge
Nominal disk diameter	95 mm OD	95 mm OD	95 mm OD	200 mm OD	200 mm OD
Recording medium	25 mm ID Thin Film	25 mm ID Thin Film	25 mm ID Thin Film	63.5 mm ID Oxide Coated	63.5 mm ID Oxide Coated
DRIVE: Technology type	3370 (Ferrite)	3370 (Ferrite)	3370 (Ferrite)	3370 (Ferrite)	3370 (Ferrite)
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	ST412,SCSI	ST412,IBM PC	ST412,IBM PC	SMD,SCSI	SMD,SCSI
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 25.5	U: 12.75	U: 25.5	U: 26.9	U: 80.9
REMOVABLE	--	--	--	U: 26.9	U: 26.9
Capacity per track (Bytes)	U: 10,416	U: 10,416	U: 10,416	U: 20,928	U: 20,928
Data surfaces per spindle	4	2	4	4	8
Heads per data surface	1	1	1	1	1
Tracks per surface	615	615	615	644	644
Track density (TPI)	880	880	880	550	555
Maximum linear density (BPI)	12350	12720	12720	10986 BPI* 7324 FCI	10986 BPI* 7324 FCI
Rotational speed (RPM)	3545	3545	3545	3523	3600
PERFORMANCE					
Actuator type	Rotary, Band, Stepping Motor	Rotary, Band, Stepping Motor	Rotary, Band, Stepping Motor	Linear, Voice Coil	Linear, Voice Coil
Average positioning time (msec)	80 (including settling)	85 (including settling)	85 (including settling)	35**	25
Average rotational delay (msec)	8.46	8.46	8.46	8.45	8.3
Average access time (msec)	88.46	93.46	93.46	43.45	33.3
Data transfer rate (KBytes/sec)	625	625	625	1229	1229
FIRST CUSTOMER SHIPMENT	1/86	4086	4086	1083	1/86
U.S. OEM PRICE FOR 100 UNITS	--	--	--	$3,275	$3,850
COMMENTS	41 mm High	30 mm High	30 mm High	Embedded Servo *2,7 RLL Code **25 ms available	Embedded Servo *2,7 RLL Code

MANUFACTURER	AMCODYNE	ATASI	ATASI	ATASI	ATASI
DRIVE	7130E Tomahawk	2053	2085	3051	3085
DISK/TREND GROUP	2	6	6	6	6
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	8" Cartridge	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	200 mm OD 63.5 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	3370 (Ferrite)	3370 (Ferrite)	3370 (Ferrite)	Modified 3350	3370 (Ferrite)
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	SMD	SCSI	SCSI	ST412	ST412
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 120.16	U: 53.3	U: 85.3	U: 51.3	U: 85.3
REMOVABLE	U: 40.05	--	--	--	--
Capacity per track (Bytes)	U: 21,582	U: 10,416	U: 10,416	U: 10,416	U: 10,416
Data surfaces per spindle	8	5	8	7	8
Heads per data surface	1	1	1	1	1
Tracks per surface	928	1024	1024	704	1024
Track density (TPI)	743	1029	1029	800	1029
Maximum linear density (BPI)	11526 BPI* 7684 FCI	9716	9716	9053	9716
Rotational speed (RPM)	3416	3600	3600	3600	3600
PERFORMANCE					
Actuator type	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil
Average positioning time (msec)	27	25	25	30	29
Average rotational delay (msec)	8.78	8.3	8.3	8.3	8.3
Average access time (msec)	35.78	33.3	33.3	38.3	37.3
Data transfer rate (KBytes/sec)	1229	625	625	625	625
FIRST CUSTOMER SHIPMENT	4/86	3Q86	3Q86	1/85	3Q85
U.S. OEM PRICE FOR 100 UNITS	$4,150	--	--	$725	$890
COMMENTS	Embedded Servo *2,7 RLL Code				

MANUFACTURER	ATASI	ATASI	BASF	BASF	BASF
DRIVE	2128	2170	6188	6188R-12	6188R-25
DISK/TREND GROUP	7	7	5	6	6
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	3370 (Ferrite)	3370 (Ferrite)	Modified 3350	Modified 3350	Modified 3350
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	SCSI	SCSI	ST412	ST412	ST412
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 128.0	U: 170.6	U: 15.0	U: 12.7	U: 25.4
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 15,624	U: 15,624	U: 10,416	U: 10,416	U: 10,416
Data surfaces per spindle	8	8	4	2	4
Heads per data surface	1	1	1	1	1
Tracks per surface	1024	1366	360	612	612
Track density (TPI)	1029	1373	406	585	585
Maximum linear density (BPI)	14574 BPI* 9716 FCI	14574 BPI* 9716 FCI	8900	9800	9800
Rotational speed (RPM)	3600	3600	3600	3600	3600
PERFORMANCE					
Actuator type	Linear, Voice Coil	Linear, Voice Coil	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor
Average positioning time (msec)	25	25	93(including settling)	93(including settling)	93(including settling)
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	33.3	33.3	101.3	101.3	101.3
Data transfer rate (KBytes/sec)	937.5	937.5	625	625	625
FIRST CUSTOMER SHIPMENT	3Q86	3Q86	1984	1Q86	1Q86
U.S. OEM PRICE FOR 100 UNITS	$1,250	$2,170	--	--	--
COMMENTS	*2,7 RLL Code	*2,7 RLL Code	41 mm High		

MANUFACTURER	BASF	BASF	BASF	BASF	BRAND TECHNOLOGIES
DRIVE	6192	6193	6194	6195	BT8085
DISK/TREND GROUP	6	6	6	6	6
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID
Recording medium	Thin Film	Thin Film	Thin Film	Thin Film	Oxide Coated
DRIVE: Technology type	Modified 3350	Modified 3350	Modified 3350	Modified 3350	3370 (Ferrite)
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	ST412	ST412	ST412	ST412	ST412
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 52	U: 73	U: 94	U: 83	U: 85
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 10,416	U: 10,416	U: 10,416	U: 10,416	U: 10,416
Data surfaces per spindle	5	7	9	8	8
Heads per data surface	1	1	1	1	1
Tracks per surface	1000	1000	1000	1000	1024
Track density (TPI)	1000	1000	1000	1000	1000
Maximum linear density (BPI)	10000	10000	10000	10000	10000
Rotational speed (RPM)	3600	3600	3600	3600	3600
PERFORMANCE					
Actuator type	Rotary, Voice coil	Rotary, Voice coil	Rotary, Voice coil	Rotary, Voice coil	Rotary, DC Motor
Average positioning time (msec)	30	30	30	30	26
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	38.3	38.3	38.3	38.3	34.3
Data transfer rate (KBytes/sec)	625	625	625	625	625
FIRST CUSTOMER SHIPMENT	2Q86	2Q86	2Q86	2Q86	1Q87
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	$800
COMMENTS					

MANUFACTURER	BRAND TECHNOLOGIES	BRAND TECHNOLOGIES	BULL	BULL	BULL
DRIVE	BT8120	BT8170	D140 D142 Cynthia	D526	D530
DISK/TREND GROUP	7	7	2	2	6
MARKET	OEM	OEM	Captive, OEM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Special Cartridge	5.25" Cartridge	Fixed
Nominal disk diameter	130 mm OD 40 mm ID	130 mm OD 40 mm ID	10.5" OD 6.6" ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID
Recording medium	Oxide Coated	Thin Film	Oxide Coated	Oxide Coated	Thin Film
DRIVE: Technology type	3370 (Ferrite)	3370 (Ferrite)	3330-11	Modifed 3350	Modified 3350
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	ST412	ESDI, SCSI	Cynthia	ST412	ST412
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 128	U: 170	F: 10.0	F: 10.485	U: 30.8
REMOVABLE	--	--	F: 10.0	F: 10.485	--
Capacity per track (Bytes)	U: 15,624	U: 20,832	F: 12,800	F: 8.192	U: 10,416
Data surfaces per spindle	8	8	4	4	3
Heads per data surface	1	1	1	1	1
Tracks per surface	1024	1024	392	640	987
Track density (TPI)	1000	1000	500	860	960
Maximum linear density (BPI)	15000 BPI* 10000 FCI	20000 BPI* 13333 FCI	4750	9445	9920
Rotational speed (RPM)	3600	3600	3600	3392	3600
PERFORMANCE					
Actuator type	Rotary, DC Motor	Rotary, DC Motor	Linear, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Average positioning time (msec)	26	26	50	50	30
Average rotational delay (msec)	8.3	8.3	8.3	8.8	8.3
Average access time (msec)	34.3	34.3	58.3	58.8	38.3
Data transfer rate (KBytes/sec)	937.5	1250	920	625	625
FIRST CUSTOMER SHIPMENT	1Q87	3Q87	4Q79	4/86	4Q83
U.S. OEM PRICE FOR 100 UNITS	$900	$1,200	$2,675	--	$1,450
COMMENTS	*2,7 RLL Code	*2,7 RLL Code	Embedded Servo	Embedded Servo	Mfg. Under Vertex Peripherals License

MANUFACTURER	BULL	BULL	BULL	BULL	BURROUGHS
DRIVE	D550	D570	D585	D160/8 D162/8 Cynthia	9484-13
DISK/TREND GROUP	6	6	6	7	4
MARKET	OEM	OEM	OEM	OEM	Captive
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	3336-11
Nominal disk diameter	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	10.5" OD 6.6" ID	14"
Recording medium	Thin Film	Thin Film	Thin Film	Oxide Coated	Oxide Coated
DRIVE: Technology type	Modified 3350	Modified 3350	Modified 3350	3350	3330-11
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	ST412	ST412	ST412	Cynthia	Burroughs
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 51.4	U: 72.0	U: 85.0	F: 120.42	--
REMOVABLE	--	--	--	--	F: 252
Capacity per track (Bytes)	U: 10,416	U: 10,416	U: 10,416	F: 12,800	F: 16,200
Data surfaces per spindle	5	7	7	8	19
Heads per data surface	1	1	1	1	1
Tracks per surface	987	987	1166	1176	815
Track density (TPI)	960	960	1047	900	384
Maximum linear density (BPI)	9920	9920	10526	4850	6060
Rotational speed (RPM)	3600	3600	3600	3600	3600
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Linear, Voice Coil	Linear, Voice Coil
Average positioning time (msec)	30	30	30	40	28.50
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.33
Average access time (msec)	38.3	38.3	38.3	48.3	36.83
Data transfer rate (KBytes/sec)	625	625	625	920	1209
FIRST CUSTOMER SHIPMENT	4Q83	4Q83	1Q85	3Q81	1Q83
U.S. OEM PRICE FOR 100 UNITS	$1,580	$1,850	$1,930	$3,350	--
COMMENTS	Mfg. Under Vertex Peripherals License	Mfg. Under Vertex Peripherals License	Mfg. Under Vertex Peripherals License	Embedded Servo	B2900 B7900 B7800 B4900 A3,A9,A15 V300

MANUFACTURER	BURROUGHS	BURROUGHS	BURROUGHS	CENTURY DATA SYSTEMS	CENTURY DATA SYSTEMS
DRIVE	MD-3	MD-4	9494-12	T306 Trident	AMS 315
DISK/TREND GROUP	7	7	9	4	8
MARKET	Captive	Captive	Captive	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	3330-11	Fixed
Nominal disk diameter	210 mm OD 100 mm ID	210 mm OD 100 mm ID	14"	14"	14"
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	Modified 3350	Modified 3350	3380	3330-11	Modified 3350
Heads	Ferrite	Ferrite	Thin Film	Ferrite	Ferrite
Interface	Burroughs	Burroughs	Burroughs	SMD	SMD
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	(3 Spindles) F: 405	(4 Spindles) F: 528	F: 870	--	U: 315.2
REMOVABLE	--	--	--	U: 315.2	--
Capacity per track (Bytes)	F: 16,384	F: 16,000	F: 32,781	U: 20,160	U: 20,160
Data surfaces per spindle	10	10	15	19	9.5
Heads per data surface	1	1	2	1	2
Tracks per surface	833	833	1768	823	1646
Track density (TPI)	900	900	806	384	712
Maximum linear density (BPI)	9000	9000	15240 BPI	6060	6363
Rotational speed (RPM)	3600	3600	3600	3600	3600
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Dual, Linear Voice Coil	Linear, Voice Coil	Linear, Voice Coil
Average positioning time (msec)	28	28	16	30	25
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	36.3	36.3	24.3	38.3	33.3
Data transfer rate (KBytes/sec)	1210	1210	3000	1209	1209
FIRST CUSTOMER SHIPMENT	12/84	12/84	1Q85	8/76	11/82
U.S. OEM PRICE FOR 100 UNITS	--	--	--	$10,255	$6,780
COMMENTS	XE5XX Mfg. by Toshiba	A3,A9,V300 B4500 Mfg. by Toshiba	B7900 B4900 A9,A10, A15,V300 Drive has two spindles		

MANUFACTURER	CENTURY DATA SYSTEMS	CENTURY DATA SYSTEMS	CENTURY DATA SYSTEMS	CENTURY DATA SYSTEMS	CENTURY DATA SYSTEMS
DRIVE	C2400	C2476	AMS 513	AMS 571	C2600
DISK/TREND GROUP	8	8	9	9	9
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	200 mm OD 63.5 mm ID	200 mm OD 63.5 mm ID	14"	14"	200 mm OD 63.5 mm ID
Recording medium	Hi Dens Oxide	Hi Dens Oxide	Oxide Coated	Oxide Coated	Hi Dens Oxide
DRIVE: Technology type	3370	3370	Modified 3350	3370	3370
Heads	Thin Film	Thin Film	Ferrite	Thin Film	Thin Film
Interface	SMD	Modified SMD	SMD	Modified SMD	Modified SMD
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 408.8	U: 475.9	U: 513.7	U: 615	U: 613
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 20,160	U: 28,160	U: 32,064	U: 33,012	U: 30,240
Data surfaces per spindle	12	10	9.5	9.5	12
Heads per data surface	2	2	2	2	2
Tracks per surface	1690	1690	1690	1882	1690
Track density (TPI)	960	1143	712	800	1143
Maximum linear density (BPI)	9500	17,900*	10000	10295	19200*
Rotational speed (RPM)	3600	3961	2400	3600	3600
PERFORMANCE					
Actuator type	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil
Average positioning time (msec)	15	15	25	19	15
Average rotational delay (msec)	8.3	7.57	12.5	8.3	8.3
Average access time (msec)	23.3	22.57	37.5	27.3	23.3
Data transfer rate (KBytes/sec)	1209	1859	1280	1980	1813
FIRST CUSTOMER SHIPMENT	5/85	3/85	1/83	8/83	3Q85
U.S. OEM PRICE FOR 100 UNITS	$6,610	$7,450	$7,200	$8,740	$8,670
COMMENTS		*2,7 RLL Code			*2,7 RLL Code

MANUFACTURER	CENTURY DATA SYSTEMS	COGITO SYSTEMS	COGITO SYSTEMS	CONNER PERIPHERALS	CONTROL DATA
DRIVE	C2800	CG912	PT 925	CP340	9457 Lark
DISK/TREND GROUP	9	5	5	6	2
MARKET	OEM	OEM	OEM	OEM	OEM, Captive
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Lark Module Drive
Nominal disk diameter	200 mm OD 63.5 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	95 mm OD 25 mm ID	195 mm OD 100 mm ID
Recording medium	Thin Film	Oxide Coated	Thin Film	Thin Film	Oxide Coated
DRIVE: Technology type	3370	Modified 3350	Modified 3350	3370 (Ferrite)	Modified 3350
Heads	Thin Film	Ferrite	Ferrite	Ferrite	Ferrite
Interface	Modified SMD	ST412	ST412	SCSI	LDI, SMD
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 830	U: 12.76	U: 25.52	F: 40	U: 25.0
REMOVABLE	--	--	--	--	U: 25.0
Capacity per track (Bytes)	U: 40,960	U: 10,416	U: 10,416	F: 13,312	U: 20,672
Data surfaces per spindle	12	4	4	4	4
Heads per data surface	2	1	1	1	1
Tracks per surface	845	306	612	752	606
Track density (TPI)	1400	345	527	1000	715
Maximum linear density (BPI)	21382*	8783	11000	21379 BPI* 14253 FCI	10161 BPI* 6774 FCI
Rotational speed (RPM)	3600	3600	3600	3600	3510
PERFORMANCE					
Actuator type	Linear, Voice Coil	Band, Stepping Motor	Band, Stepping Motor	Rotary, Voice Coil	Linear, Voice Coil
Average positioning time (msec)	15	85 (including settling)	85 (including settling)	29	35
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.55
Average access time (msec)	23.3	93.3	93.3	37.3	43.55
Data transfer rate (KBytes/sec)	2400	625	625	1000	1209
FIRST CUSTOMER SHIPMENT	8/86	6/83	2Q86	8/86	4Q82
U.S. OEM PRICE FOR 100 UNITS	$9,510	$265	$295	--	$3,440
COMMENTS	*2,7 RLL Code	41 mm High	41 mm High	*2,7 RLL Code Embedded Servo	*2,7 RLL Code Embedded Servo

MANUFACTURER	CONTROL DATA	CONTROL DATA	CONTROL DATA	CONTROL DATA	CONTROL DATA
DRIVE	9710 RSD	9762 SMD	9766 SMD	9415-321 Wren I	9415-521 Wren I
DISK/TREND GROUP	3	3	4	5	5
MARKET	OEM	OEM, Captive	OEM, Captive	Captive, OEM	Captive, OEM
MEDIA: Generic type	Removable Storage Drive	Storage Module Drive	3336-11	Fixed	Fixed
Nominal disk diameter	230 mm OD 100 mm ID	14"	14"	130 mm OD 40 mm ID	130 mm OD 40 mm ID
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	Modified 3350	3330-11	3330-11	Modified 3350	Modified 3350
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	SMD	SMD	SMD	Finch	ST412
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	--	--	--	U: 21.0	U: 21.0
REMOVABLE	U: 82.9	U: 82.9	U: 315.2	--	--
Capacity per track (Bytes)	U: 20,160	U: 20,160	U: 20,160	U: 10,080	U: 10,080
Data surfaces per spindle	5	5	19	3	3
Heads per data surface	1	1	1	1	1
Tracks per surface	823	823	823	697	697
Track density (TPI)	550	384	384	800	800
Maximum linear density (BPI)	10000*	6038	6038	8730	8730
Rotational speed (RPM)	3600	3600	3600	3600	3600
PERFORMANCE					
Actuator type	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Average positioning time (msec)	30	30	30	40	40
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	38.3	38.3	38.3	48.3	48.3
Data transfer rate (KBytes/sec)	1209	1209	1209	605	605
FIRST CUSTOMER SHIPMENT	1Q83	3/75	3/76	2Q83	2Q83
U.S. OEM PRICE FOR 100 UNITS	$4,915	$6,715	$12,355	$1,105	$1,105
COMMENTS	*2,7 RLL Code				

MANUFACTURER	CONTROL DATA	CONTROL DATA	CONTROL DATA	CONTROL DATA	CONTROL DATA
DRIVE	9415-528 Wren I	9415-335 Wren I	9415-536 Wren I	94155-48 Wren II	94155-67 Wren II
DISK/TREND GROUP	5	6	6	6	6
MARKET	Captive, OEM	Captive, OEM	Captive, OEM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	Modified 3350	Modified 3350	Modified 3350	Modified 3350	Modified 3350
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	ST412	Finch	ST412	ST412	ST412
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 28.0	U: 36.0	U: 36.0	U: 48.1	U: 67.4
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 10,080	U: 10,080	U: 10,080	U: 10,416	U: 10,416
Data surfaces per spindle	4	5	5	5	7
Heads per data surface	1	1	1	1	1
Tracks per surface	697	697	697	925	925
Track density (TPI)	800	800	800	960	960
Maximum linear density (BPI)	8730	8730	8730	9540	9540
Rotational speed (RPM)	3600	3600	3600	3600	3600
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Average positioning time (msec)	40	40	40	30	30
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	48.3	48.3	48.3	38.3	38.3
Data transfer rate (KBytes/sec)	605	605	605	625	625
FIRST CUSTOMER SHIPMENT	2Q83	2Q83	2Q83	2Q84	2Q84
U.S. OEM PRICE FOR 100 UNITS	$1,175	$1,225	$1,225	$1,270	$1,455
COMMENTS					

MANUFACTURER	CONTROL DATA	CONTROL DATA	CONTROL DATA	CONTROL DATA	CONTROL DATA
DRIVE	94155-86 Wren II	94156-48 Wren II	94156-67 Wren II	94156-86 Wren II	94205 Wren II HH
DISK/TREND GROUP	6	6	6	6	6
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	Modified 3350	Modified 3350	Modified 3350	Modified 3350	3370 (Ferrite)
Heads	Thin Film	Ferrite	Ferrite	Thin Film	Ferrite
Interface	ST412	ESDI	ESDI	ESDI	ST412
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 86.7	U: 48.1	U: 67.4	U: 86.7	U: 51.5
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 10,416	U: 10,416	U: 10,416	U: 10,416	U: 10,416
Data surfaces per spindle	9	5	7	9	5
Heads per data surface	1	1	1	1	1
Tracks per surface	925	925	925	925	989
Track density (TPI)	960	960	960	960	960
Maximum linear density (BPI)	9540	9540	9540	9540	9400
Rotational speed (RPM)	3600	3600	3600	3600	3600
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Average positioning time (msec)	30	30	30	30	28
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	38.3	38.3	38.3	38.3	36.3
Data transfer rate (KBytes/sec)	625	625	625	625	625
FIRST CUSTOMER SHIPMENT	2Q84	2Q84	2Q84	2Q84	1Q86
U.S. OEM PRICE FOR 100 UNITS	$1,640	$1,270	$1,455	$1,640	$1,335
COMMENTS					41 mm High

MANUFACTURER	CONTROL DATA	CONTROL DATA	CONTROL DATA	CONTROL DATA	CONTROL DATA
DRIVE	94166-101 Wren III	94166-141 Wren III	94166-182 Wren III	9715-160 FSD	9730-160 MMD
DISK/TREND GROUP	7	7	7	7	7
MARKET	OEM	OEM	OEM	OEM	OEM, Captive
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	130 mm OD	130 mm OD	130 mm OD	230 mm OD	14"
Recording medium	40 mm ID Thin Film	40 mm ID Thin Film	40 mm ID Thin Film	100 mm ID Oxide Coated	Oxide Coated
DRIVE: Technology type	3370 (Ferrite)	3370 (Ferrite)	3370 (Ferrite)	Modified 3350	Modified 3350
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	ESDI, SCSI	ESDI, SCSI	ESDI, SCSI	SMD	SMD
CAPACITY/RECORDING DENSITY					0.96 or 1.93 MB Fixed Head Option
Total capacity (MBytes) FIXED	U: 101	U: 141	U: 182	U: 165.9	U: 165.9
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 20,832	U: 20,832	U: 20,832	U: 20,160	U: 20,160
Data surfaces per spindle	5	7	9	10	5
Heads per data surface	1	1	1	1	2
Tracks per surface	969	969	969	823	1646
Track density (TPI)	960	960	960	550	680
Maximum linear density (BPI)	19058*	19058*	19058*	10000*	6220
Rotational speed (RPM)	3600	3600	3600	3600	3600
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Average positioning time (msec)	16.4	16.4	16.4	30	30
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	24.7	24.7	24.7	38.3	38.3
Data transfer rate (KBytes/sec)	1250	1250	1250	1209	1209
FIRST CUSTOMER SHIPMENT	2Q86	2Q86	2Q86	4Q82	2Q79
U.S. OEM PRICE FOR 100 UNITS	$1,785	$1,935	$2,085	$4,960	--
COMMENTS	*2,7 RLL Code	*2,7 RLL Code	*2,7 RLL Code	*2,7 RLL Code	

MANUFACTURER	CONTROL DATA	CONTROL DATA	CONTROL DATA	CONTROL DATA	CONTROL DATA
DRIVE	9715-300 FSD	9715-340 FSD	9720 EMD	885-42	9715-500 FSD
DISK/TREND GROUP	8	8	8	9	9
MARKET	OEM	OEM	OEM	Captive	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	230 mm OD 100 mm ID	230 mm OD 100 mm ID	210 mm OD 100 mm ID	14"	230 mm OD 100 mm ID
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	3380	3380	3370	Modified 3350	3380
Heads	Thin Film	Thin Film	Thin Film	Ferrite	Thin Film
Interface	SMD	SMD	SMD, SMD-E	CDC	Mod.SMD,IPI-2
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 315	U: 344.0	U: 368.0	U: 673.0	U: 516.0
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 20,160	U: 20,160	U: 30,240	U: 20,160	U: 30,240
Data surfaces per spindle	9.5	12	10	20	12
Heads per data surface	2/1	2	1	2	2
Tracks per surface	1646	1422	1217	1686	1422
Track density (TPI)	1040	960	960	660	960
Maximum linear density (BPI)	10000	10000	15185*	6350	15159*
Rotational speed (RPM)	3600	3600	3600	3600	3600
PERFORMANCE					
Actuator type	Linear, Voice Coil	Linear, Voice Coil	Rotary, Voice Coil	Linear, Voice Coil	Linear, Voice Coil
Average positioning time (msec)	20	18	18	25	18
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	28.3	26.3	26.3	33.3	26.3
Data transfer rate (KBytes/sec)	1209	1209	1815	4788	1825
FIRST CUSTOMER SHIPMENT	4Q85	4Q83	11/85	1982	4Q83
U.S. OEM PRICE FOR 100 UNITS	$5,055	$6,490	$4,850	--	$7,290
COMMENTS			*2,7 RLL Code	Cyber 865 & 875 4 track parallel data transfer. Drive has two spindles.	*2,7 RLL Code

MANUFACTURER	CONTROL DATA	CONTROL DATA	CONTROL DATA	CONTROL DATA	CYBERNEX ADV.STORAGE TECHNOLOGY
DRIVE	9771 XMD	9772 XMD-II	9775 FMD	97704-700 Hydra	10203
DISK/TREND GROUP	9	9	9	9	6
MARKET	OEM	OEM	OEM	Captive, OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed Module Drive	Fixed	Fixed
Nominal disk diameter	14"	14"	14"	14"	130 mm OD 40 mm ID
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Thin Film
DRIVE: Technology type	3380	3370	Modified 3350	3370	3370
Heads	Thin Film	Thin Film	Ferrite	Thin Film	Thin Film
Interface	Modified SMD	SMD-E	SMD	ISI	ESDI/SCSI
CAPACITY/RECORDING DENSITY			1.9 MB Fixed Head Option		
Total capacity (MBytes) FIXED	U: 825.0	U: 858.0	U: 675.0	U: 703	U: 65
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 50,400	U: 50,400	U: 20,160	U: 49,728	U: 20,880
Data surfaces per spindle	8	8	20	8	3
Heads per data surface	2	2	2	2	1
Tracks per surface	2046	2128	1686	1776	1050
Track density (TPI)	960	960	660	800	1050
Maximum linear density (BPI)	15400*	15400*	6350	15200*	19405 BPI* 12937 FCI
Rotational speed (RPM)	2160	3600	3600	3620	3600
PERFORMANCE					
Actuator type	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil
Average positioning time (msec)	16	16	25	16	28
Average rotational delay (msec)	13.89	8.3	8.3	8.29	8.3
Average access time (msec)	29.89	24.3	33.3	24.29	36.3
Data transfer rate (KBytes/sec)	1825	3000	1209	12000	1250
FIRST CUSTOMER SHIPMENT	3Q83	10/85	4/80	2Q86	11/85
U.S. OEM PRICE FOR 100 UNITS	$10,660	$9,475	$15,155	$29,900	$1,350
COMMENTS	*2,7 RLL Code	*2,7 RLL Code		*2,7 RLL Code 4 track parallel data transfer	41 mm High *2,7 RLL Code

MANUFACTURER	CYBERNEX ADV.STORAGE TECHNOLOGY	CYBERNEX ADV.STORAGE TECHNOLOGY	DATA GENERAL	DATA GENERAL	DATA GENERAL
DRIVE	10304	10305	6060	6122	6100 6103 6104 6105
DISK/TREND GROUP	6	7	4	4	5
MARKET	OEM	OEM	Captive	Captive	Captive
MEDIA: Generic type	Fixed	Fixed	3336-1	3336-11	Fixed
Nominal disk diameter	130 mm OD 40 mm ID	130 mm OD 40 mm ID	14"	14"	14"
Recording medium	Thin Film	Thin Film	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	3370	3370	3330-11	3330-11	3340
Heads	Thin Film	Thin Film	Ferrite	Ferrite	Ferrite
Interface	ESDI/SCSI	ESDI/SCSI	Data General	Data General	Data General
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 87	U: 110	--	--	F: 25.16
REMOVABLE	--	--	F: 95.957	F: 277.491	--
Capacity per track (Bytes)	U: 20,880	U: 20,880	F: 12,288	F: 17,920	F: 16,384
Data surfaces per spindle	4	5	19	19	4
Heads per data surface	1	1	1	1	2
Tracks per surface	1050	1050	411	815	384
Track density (TPI)	1050	1050	192	370	166
Maximum linear density (BPI)	19405 BPI* 12937 FCI	19405 BPI* 12937 FCI	4040	6060	5760
Rotational speed (RPM)	3600	3600	3600	3600	2964
PERFORMANCE					
Actuator type	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil	Band, Stepping Motor
Average positioning time (msec)	28	28	35	35	60 (including settling)
Average rotational delay (msec)	8.3	8.3	8.3	8.3	10.1
Average access time (msec)	36.3	36.3	43.3	43.3	70.1
Data transfer rate (KBytes/sec)	1250	1250	806	1209	910.6
FIRST CUSTOMER SHIPMENT	11/85	11/85	1976	1Q80	4Q79
U.S. OEM PRICE FOR 100 UNITS	$1,525	$1,700	--	--	--
COMMENTS	41 mm High *2,7 RLL Code	41 mm High *2,7 RLL Code			

MANUFACTURER	DATA GENERAL	DATA GENERAL	DATA GENERAL	DATA GENERAL	DATA GENERAL
DRIVE	6220 6225	6222 6227	6234	6236 6237	6239 6290 6240 6350
DISK/TREND GROUP	5	5	6	8	9
MARKET	Captive	Captive	Captive	Captive	Captive
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	200 mm OD 63.5 mm OD	200 mm OD 63.5 mm OD	14"	14"	14"
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	3350	3350	3350	Modified 3350	Modified 3350
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	Data General	Data General	Data General	Data General	Data General
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	F: 5.0	F: 15.0	F: 50.7	F: 354.1	F: 592.2
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 10,240	F: 10,240	F: 22,016	F: 28,672	F: 38,400
Data surfaces per spindle	2	6	6	8	8
Heads per data surface	1	1	2	2	2
Tracks per surface	245	245	384	1572	1956
Track density (TPI)	200	200	166	714	800
Maximum linear density (BPI)	6500	6500	7678	10438*	14154*
Rotational speed (RPM)	3155	3155	2385	3000	2940
PERFORMANCE					
Actuator type	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Linear, Voice Coil	Linear, Voice Coil
Average positioning time (msec)	66 (including settling)	66 (including settling)	60 (including settling)	20	21
Average rotational delay (msec)	9.5	9.5	12.5	10	10.2
Average access time (msec)	75.5	75.5	72.5	30	31.2
Data transfer rate (KBytes/sec)	625	625	971	1680	2200
FIRST CUSTOMER SHIPMENT	9/82	9/82	3/83	9/83	2/85
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	--
COMMENTS				*2,7 RLL Code 6237-3 Spindles	*2,7 RLL Code 6239-1 Spindles 6290-2 Spindles 6240-3 Spindles 6350-9 Spindles

MANUFACTURER	DIGITAL EQUIPMENT CORPORATION	DIGITAL EQUIPMENT CORPORATION	DIGITAL EQUIPMENT CORPORATION	DIGITAL EQUIPMENT CORPORATION	DIGITAL EQUIPMENT CORPORATION
DRIVE	RL02	RC25	RA60	RA80	RM80
DISK/TREND GROUP	1	2	4	7	7
MARKET	Captive	Captive	Captive	Captive	Captive
MEDIA: Generic type	5440	Special Cartridge	Special Disk Pack	Fixed	Fixed
Nominal disk diameter	14"	8"	14"	14"	14"
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	3330-1	Modified 3350	Modified 3330	Modified 3350	Modified 3350
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	Unibus, LSI-11	Unibus,Q-Bus	Unibus	Unibus	Massbus
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	--	F: 26	--	F: 121.0	F: 124.0
REMOVABLE	F: 10.48	F: 26	F: 205.0	--	--
Capacity per track (Bytes)	F: 10,240	F: 15,872	F: 21,504	F: 15,872	F: 16,384
Data surfaces per spindle	2	4	6	7	7
Heads per data surface	1	1	1	2	2
Tracks per surface	512	821	1600	1092	1122
Track density (TPI)	250	1000	779	478	478
Maximum linear density (BPI)	3725	12350	9668 BPI* 7251 FCI	6339	6339
Rotational speed (RPM)	2400	2850	3600	3600	3600
PERFORMANCE					
Actuator type	Linear, Voice Coil	Rotary, Voice Coil	Linear, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Average positioning time (msec)	55	35	41.7	25	25
Average rotational delay (msec)	12.5	10.5	8.3	8.3	8.3
Average access time (msec)	67.5	45.5	50.0	33.3	33.3
Data transfer rate (KBytes/sec)	512.5	1250	1980	1200	1200
FIRST CUSTOMER SHIPMENT	1979	4Q83	3Q83	1/82	1981
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	--
COMMENTS	Embedded Servo	Embedded Servo	*2,7 RLL Code Embedded Servo		

MANUFACTURER	DIGITAL EQUIPMENT CORPORATION	DMA SYSTEMS	EPSON	EPSON	EPSON
DRIVE	RA81	360	HD-830	HD-860	HMD-710
DISK/TREND GROUP	8	2	5	5	5
MARKET	Captive	OEM	OEM	OEM	OEM
MEDIA: Generic type	Fixed	"Micro-Magnum"	Fixed	Fixed	Fixed
Nominal disk diameter	14"	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	95 mm OD 25 mm ID
Recording medium	Oxide Coated	Oxide Coated	Thin Film	Thin Film	Thin Film
DRIVE: Technology type	Modified 3350	Modified 3350	3370 (Ferrite)	3370 (Ferrite)	3370 (Ferrite)
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	Unibus	ST506	ST412	ST412	ST412
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	F: 456.0	U: 12.75	U: 12.8	U: 25.6	U: 12.7
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 26,112	U: 10,416	U: 10,416	U: 10,416	U: 10,416
Data surfaces per spindle	7	2	2	4	2
Heads per data surface	2	1	1	1	1
Tracks per surface	2496	612	612	612	615
Track density (TPI)	960	612	600	600	910
Maximum linear density (BPI)	11400 BPI* 8550 FCI	10894	9700	9700	12900
Rotational speed (RPM)	3600	3473	3600	3600	3528
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rack & Pinion Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Rotary, Stepping Motor
Average positioning time (msec)	28	98(including settling)	85 (including settling)	85 (including settling)	69 (including settling)
Average rotational delay (msec)	8.3	8.6	8.3	8.3	8.5
Average access time (msec)	36.3	106.6	93.3	93.3	77.5
Data transfer rate (KBytes/sec)	2200	625	625	625	625
FIRST CUSTOMER SHIPMENT	9/82	5/84	8/85	8/85	3Q86
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	--
COMMENTS	*2,7 RLL Code Embedded Servo	41 mm High Embedded Servo	41 mm High	41 mm High	41 mm High

MANUFACTURER	EPSON	FUJI ELECTRIC	FUJI ELECTRIC	FUJI ELECTRIC	FUJITSU, LTD.
DRIVE	HMD-720	FK301	FK302-13	FK302-26	F6417
DISK/TREND GROUP	5	5	5	5	2
MARKET	OEM	OEM	OEM	OEM	Captive
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Special Cartridge
Nominal disk diameter	95 mm OD 25 mm ID	95 mm OD 25 mm ID	95 mm OD 25 mm ID	95 mm OD 25 mm ID	14"
Recording medium	Thin Film	Thin Film	Thin Film	Thin Film	Oxide Coated
DRIVE: Technology type	3370 (Ferrite)	Modified 3350	Modified 3350	Modified 3350	3330-11
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	ST412	ST412	ST412	ST412	Fujitsu
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 25.5	U: 12.7	U: 12.8	U: 25.6	--
REMOVABLE	--	--	--	--	F: 67.6
Capacity per track (Bytes)	U: 10,416	U: 10,416	U: 10,416	U: 10,416	F: 16,736
Data surfaces per spindle	4	4	2	4	5
Heads per data surface	1	1	1	1	1
Tracks per surface	615	306	615	615	808
Track density (TPI)	910	508	756	756	370
Maximum linear density (BPI)	12900	11742	14667	14667	5636
Rotational speed (RPM)	3528	3600	3550	3550	2400
PERFORMANCE					
Actuator type	Rotary, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Linear, Voice Coil
Average positioning time (msec)	69 (including settling)	80 (including settling)	80 (including settling)	80 (including settling)	30
Average rotational delay (msec)	8.5	8.3	8.45	8.45	12.5
Average access time (msec)	77.5	88.3	88.45	88.45	42.5
Data transfer rate (KBytes/sec)	625	625	625	625	717
FIRST CUSTOMER SHIPMENT	3Q86	7/85	10/85	10/85	4Q79
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	--
COMMENTS	41 mm High	41 mm High	41 mm High	41 mm High	

MANUFACTURER	FUJITSU, LTD	FUJITSU, LTD	FUJITSU, LTD	FUJITSU, LTD	FUJITSU, LTD
DRIVE	M2220A	M2223A	M2223AD	M2224A	M2225AD
DISK/TREND GROUP	5	5	5	5	5
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	95 mm OD 25 mm ID	95 mm OD 25 mm ID	95 mm OD 25 mm ID	95 mm OD 25 mm ID	95 mm OD 25 mm ID
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	Modified 3350	Modified 3350	Modified 3350	Modified 3350	Modified 3350
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	ST412	ST412	ST412	ST412	ST412
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 6.37	U: 12.74	U: 12.81	U: 19.12	U: 25.62
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 10,416	U: 10,416	U: 10,416	U: 10,416	U: 10,416
Data surfaces per spindle	2	4	2	6	4
Heads per data surface	1	1	1	1	1
Tracks per surface	306	306	615	306	615
Track density (TPI)	440	440	846	440	846
Maximum linear density (BPI)	13500	13500	13330	13500	13330
Rotational speed (RPM)	3600	3600	3600	3600	3600
PERFORMANCE					
Actuator type	Rotary, Band, Stepping Motor	Rotary, Band, Stepping Motor	Rotary, Band Stepping Motor	Rotary, Band, Stepping Motor	Rotary, Band Stepping Motor
Average positioning time (msec)	85 (including settling)	85 (including settling)	85 (including settling)	85 (including settling)	85 (including settling)
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	93.3	93.3	93.3	93.3	93.3
Data transfer rate (KBytes/sec)	625	625	625	625	625
FIRST CUSTOMER SHIPMENT	10/85	10/85	4Q86	10/85	4Q86
U.S. OEM PRICE FOR 100 UNITS	--	$430	$430	$500	--
COMMENTS	41 mm High	41 mm High	41 mm High	41 mm High	41 mm High

MANUFACTURER	FUJITSU, LTD	FUJITSU, LTD.	FUJITSU, LTD	FUJITSU, LTD.	FUJITSU, LTD
DRIVE	M2230AS/B	M2230AT M2230BT	M2233AS/B	M2233AT M2233BT	M2234AS/B
DISK/TREND GROUP	5	5	5	5	5
MARKET	OEM	Captive,OEM	OEM	Captive,OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	Modified 3350	Modified 3350	Modified 3350	Modified 3350	Modified 3350
Heads	Ferrite AS=ST412 B=SA4000	Ferrite	Ferrite AS=ST412 B=SA4000	Ferrite	Ferrite AS=ST412 B=SA4000
Interface		ST412/SA4000		ST412/SA4000	
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 6.66	U: 6.66	U: 13.3	U: 13.33	U: 20.0
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 10,416	U: 10,416	U: 10,416	U: 10,416	U: 10,416
Data surfaces per spindle	2	2	4	4	6
Heads per data surface	1	1	1	1	1
Tracks per surface	320	320	320	320	320
Track density (TPI)	300	300	300	300	300
Maximum linear density (BPI)	10200	10200	10200	10200	10200
Rotational speed (RPM)	3600	3600	3600	3600	3600
PERFORMANCE					
Actuator type	Rotary, Stepping Motor	Rotary,Band, Stepping Motor	Rotary, Stepping Motor	Rotary,Band, Stepping Motor	Rotary, Stepping Motor
Average positioning time (msec)	83 (including settling)	95 (including settling)	83 (including settling)	95 (including settling)	83 (including settling)
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	91.3	103.3	91.3	103.3	91.3
Data transfer rate (KBytes/sec)	625	625	625	625	625
FIRST CUSTOMER SHIPMENT	4/83	5/84	4/83	5/84	4/83
U.S. OEM PRICE FOR 100 UNITS	--	--	--	$445	--
COMMENTS		41 mm High		41 mm High	

MANUFACTURER	FUJITSU, LTD	FUJITSU, LTD.	FUJITSU, LTD.	FUJITSU, LTD.	FUJITSU, LTD.
DRIVE	M2235AS	M2301B/K	M2301BE/KE	M2302B/K	M2302BE/KE
DISK/TREND GROUP	5	5	5	5	5
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	130 mm OD 40 mm ID	200 mm OD 100 mm ID	200 mm OD 100 mm ID	200 mm OD 100 mm ID	200 mm OD 100 mm ID
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	Modified 3350	3340	Modified 3350	3340	Modified 3350
Heads	Ferrite AS=ST412 B=SA4000	Ferrite B=SA4000, K= Bidirectional	Ferrite BE=SA4000, KE= Bidirectional	Ferrite B=SA4000, K= Bidirectional	Ferrite BE=SA4000, KE= Bidirectional
Interface					
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 26.66	U: 11.712	U: 11.87	U: 23.424	U: 23.74
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 10,416	U: 12,000	U: 24,320	U: 12,000	U: 24,320
Data surfaces per spindle	8	4	2	8	4
Heads per data surface	1	1	1	1	1
Tracks per surface	320	244	244	244	244
Track density (TPI)	300	195	195	195	195
Maximum linear density (BPI)	10200	6100	12360	6100	12360
Rotational speed (RPM)	3600	2964	2964	2964	2964
PERFORMANCE					
Actuator type	Rotary, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor
Average positioning time (msec)	83 (including settling)	70 (including settling)	70 (including settling)	70 (including settling)	70 (including settling)
Average rotational delay (msec)	8.3	10.1	10.1	10.1	10.1
Average access time (msec)	91.3	80.1	80.1	80.1	80.1
Data transfer rate (KBytes/sec)	625	593	1200	593	1200
FIRST CUSTOMER SHIPMENT	10/83	7/80	9/82	7/80	9/82
U.S. OEM PRICE FOR 100 UNITS	$585	--	--	--	--
COMMENTS					

MANUFACTURER	FUJITSU, LTD	FUJITSU, LTD	FUJITSU, LTD	FUJITSU, LTD.	FUJITSU, LTD.
DRIVE	M2226AD	M2226D	M2227D	M2241AS M2241B	M2242AS M2242B
DISK/TREND GROUP	6	6	6	6	6
MARKET	OEM	OEM	OEM	Captive,OEM	Captive,OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	95 mm OD 25 mm ID	95 mm OD 25 mm ID	95 mm OD 25 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	Modified 3350	Modified 3350	Modified 3350	Modified 3350	Modified 3350
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	ST412	ST412	ST412	ST412, SA4000	ST412, SA4000
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 38.43	U: 38.43	U: 51.24	U: 31.4	U: 54.9
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 10,416	U: 10,416	U: 10,416	U: 10,416	U: 10,416
Data surfaces per spindle	6	6	8	4	7
Heads per data surface	1	1	1	1	1
Tracks per surface	615	615	615	754	754
Track density (TPI)	846	841	841	760	760
Maximum linear density (BPI)	13330	14845	14845	10200	10200
Rotational speed (RPM)	3600	3600	3600	3600	3600
PERFORMANCE					
Actuator type	Rotary, Band Stepping Motor	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Average positioning time (msec)	85 (including settling)	45	45	33	33
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	93.3	53.3	53.3	41.3	41.3
Data transfer rate (KBytes/sec)	625	625	625	625	625
FIRST CUSTOMER SHIPMENT	4Q86	4Q86	4Q86	5/84	5/84
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	$1,435
COMMENTS	41 mm High	41 mm High	41 mm High		

MANUFACTURER	FUJITSU, LTD.	FUJITSU, LTD	FUJITSU, LTD	FUJITSU, LTD	FUJITSU, LTD.
DRIVE	M2243AS M2243B	M2244E/S	M2245E/S	M2246E/S	M2303BE/KE
DISK/TREND GROUP	6	6	6	6	6
MARKET	Captive,OEM	Captive,OEM	Captive,OEM	Captive,OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	200 mm OD 100 mm ID
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	Modified 3350	Modified 3350	Modified 3350	Modified 3350	Modified 3350
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	ST412, SA4000	ESDI, SCSI	ESDI, SCSI	ESDI, SCSI	B=SA4000, K= Bidirectional
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 86.3	U: 85.8	U: 120.0	U: 171.7	U: 47.47
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 10,416	U: 20,864	U: 20,864	U: 20,864	U: 24,320
Data surfaces per spindle	11	5	7	10	8
Heads per data surface	1	1	1	1	1
Tracks per surface	754	823	823	823	244
Track density (TPI)	760	850	850	850	195
Maximum linear density (BPI)	10200	20400*	20400*	20400*	12360
Rotational speed (RPM)	3600	3600	3600	3600	2964
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Band, Stepping Motor
Average positioning time (msec)	33	25	25	25	70 (including settling)
Average rotational delay (msec)	8.3	8.3	8.3	8.3	10.1
Average access time (msec)	41.3	33.3	33.3	33.3	80.1
Data transfer rate (KBytes/sec)	625	1,250	1,250	1,250	1200
FIRST CUSTOMER SHIPMENT	5/84	3Q85	3Q85	3Q85	9/82
U.S. OEM PRICE FOR 100 UNITS	$1,725	--	--	$2,545	--
COMMENTS		*2,7 RLL Code SCSI FCS 4Q86	*2,7 RLL Code SCSI FCS 4Q86	*2,7 RLL Code SCSI FCS 4Q86	

MANUFACTURER	FUJITSU, LTD	FUJITSU, LTD	FUJITSU, LTD	FUJITSU, LTD	FUJITSU, LTD
DRIVE	M2311K/S	M2312K/S	M2321K/S	M2284	M2322K/S
DISK/TREND GROUP	6	6	6	7	7
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	200 mm OD 100 mm ID	200 mm OD 100 mm ID	210 mm OD 100 mm ID	14"	210 mm OD 100 mm ID
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	Modified 3350	Modified 3350	Modified 3350	Modified 3350	Modified 3350
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	SMD, SCSI	SMD, SCSI	SMD, SCSI	SMD	SMD, SCSI
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 48.25	U: 84.44	U: 84.2	U: 168.6	U: 168.5
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 20,480	U: 20,480	U: 20,480	U: 20,480	U: 20,480
Data surfaces per spindle	4	7	5	5	10
Heads per data surface	1	1	1	2	1
Tracks per surface	589	589	823	1646	823
Track density (TPI)	720	720	683	680	683
Maximum linear density (BPI)	9550	9550	9867	6580	9867
Rotational speed (RPM)	3600	3600	3600	2964	3600
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Average positioning time (msec)	20	20	20	27	20
Average rotational delay (msec)	8.3	8.3	8.3	10.12	8.3
Average access time (msec)	28.3	28.3	28.3	37.12	28.3
Data transfer rate (KBytes/sec)	1229	1229	1229	1012	1229
FIRST CUSTOMER SHIPMENT	4/81	4/81	11/83	4Q79	11/83
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	$3,450
COMMENTS					

periods

MANUFACTURER	FUJITSU, LTD.	FUJITSU, LTD.	FUJITSU, LTD.	FUJITSU, LTD	FUJITSU, LTD.
DRIVE	M2331K/KS	F493	F6421	M2294K/N	M2333K/KS/P
DISK/TREND GROUP	7	8	8	8	8
MARKET	OEM	Captive	Captive	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	210 mm OD 100 mm ID	14"	10.5" OD 4.0" ID	14"	210 mm OD 100 mm ID
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	Modified 3350	3350	Modified 3350	Modified 3350	Modified 3350
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	MOD SMD, SCSI	Fujitsu	Fujitsu	SMD	SMD,SCSI,IPI-2
CAPACITY/RECORDING DENSITY		1.144 MB Fixed Head Option	1.607 or 1.144 MB Fixed Head Option		
Total capacity (MBytes) FIXED	U: 168.5	F: 317.5	F: 446/317.5	U: 335.5	U: 337.1
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 40,960	F: 19,069	F: 26,793/ 19,069	U: 20,480	U: 40,960
Data surfaces per spindle	5	15	10	8	10
Heads per data surface	1	2	2	2	1
Tracks per surface	823	1110	1680	2048	823
Track density (TPI)	683	480	880	858	683
Maximum linear density (BPI)	19734*	6362	12790	6500	19734*
Rotational speed (RPM)	3600	3600	3961	2964	3600
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Linear, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Average positioning time (msec)	20	20	18	27	20
Average rotational delay (msec)	8.3	8.3	7.5	10.12	8.3
Average access time (msec)	28.3	28.3	25.5	37.12	28.3
Data transfer rate (KBytes/sec)	2458	1198	1859	1012	2458
FIRST CUSTOMER SHIPMENT	11/84	4Q79	3Q81	5/83	11/84
U.S. OEM PRICE FOR 100 UNITS	--	--	--	$5,800	$4,425
COMMENTS	*2,7 RLL Code	Drive has two spindles	Drive has four spindles		*2,7 RLL Code

MANUFACTURER	FUJITSU, LTD	FUJITSU, LTD.	FUJITSU, LTD.	FUJITSU, LTD	FUJITSU, LTD
DRIVE	M2350A	M2351A	F6425	F6425K4/L4	F6425M4/N4
DISK/TREND GROUP	8	8	9	9	9
MARKET	OEM	OEM	Captive	Captive	Captive
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	10.5" OD 4.0" ID	10.5" OD 4.0" ID	10.5" OD 4.0" ID	10.5" OD 4.0" ID	10.5" OD 4.0" ID
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	Modified 3350	Modified 3350	Special	Special	Special
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	Modified SMD	Modified SMD	Fujitsu	Fujitsu	Fujitsu
CAPACITY/RECORDING DENSITY		1.69 MB Fixed Head Option			
Total capacity (MBytes) FIXED	U: 473.6	U: 474.214	F: 630.0	F: 630.0	F: 1,260.0
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 28,160	U: 28,160	F: 47,476	F: 47,476	F: 47,476
Data surfaces per spindle	10	10	8	8	12
Heads per data surface	2	2	2	2	2
Tracks per surface	1684	1684	1770	1770	2360
Track density (TPI)	880	880	905	905	1160
Maximum linear density (BPI)	12790	12790	24420*	24420*	24989*
Rotational speed (RPM)	3961	3961	3620	3620	3620
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Average positioning time (msec)	18	18	15	15	17
Average rotational delay (msec)	7.5	7.5	8.3	8.3	8.3
Average access time (msec)	25.5	25.5	23.3	23.3	25.3
Data transfer rate (KBytes/sec)	1860/7440/9300	1859	3000	3,000	3,000
FIRST CUSTOMER SHIPMENT	2/84	3/82	3Q83	3Q86	3Q86
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	--
COMMENTS	Parallel data transfer, 4 or 5 channels		*2,7 RLL Code Drive has four spindles	*2,7 RLL Code Drive has four spindles	*2,7 RLL Code Drive has four spindles

RSPEC-33

MANUFACTURER	FUJITSU, LTD	FUJITSU, LTD	FUJITSU, LTD	HEWLETT-PACKARD	HEWLETT-PACKARD
DRIVE	M2298K/N	M2360A	M2361A	7907A	7935H
DISK/TREND GROUP	9	9	9	2	4
MARKET	OEM	OEM	OEM	Captive	Captive
MEDIA: Generic type	Fixed	Fixed	Fixed	8" Cartridge	Special Disk Pack
Nominal disk diameter	14"	10.5" OD 4.0" ID	10.5" OD 4.0" ID	200 mm OD 63.5 mm ID	14"
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	Modified 3350	Modified 3350	Modified 3350	3370 (Ferrite)	Modified 3330
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	Modified SMD	Modified SMD	Modified SMD	HPIB	HPIB
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 671	U: 689.8	U: 689.8	F: 20.5	--
REMOVABLE	--	--	--	F: 20.5	F: 404.4
Capacity per track (Bytes)	U: 40,960	U: 40,960	U: 40,960	F: 16,384	F: 23,552
Data surfaces per spindle	8	10	10	4	13
Heads per data surface	2	2	2	1	2
Tracks per surface	2048	1684	1684	644	1321
Track density (TPI)	858	880	880	550	625
Maximum linear density (BPI)	13000 BPI* 8667 FCI	18620*	18620*	10986 BPI* 7324 FCI	8320*
Rotational speed (RPM)	2722	3600	3600	3523	2700
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Linear, Voice Coil	Linear, Voice Coil
Average positioning time (msec)	27	18	18	30	24.0
Average rotational delay (msec)	11	8.3	8.3	8.45	11.1
Average access time (msec)	38	26.3	26.3	38.45	35.1
Data transfer rate (KBytes/sec)	1859	2458/9830/12290	2,458	1229	1000
FIRST CUSTOMER SHIPMENT	10/84	3Q86	2Q85	7/85	4/83
U.S. OEM PRICE FOR 100 UNITS	$7.045	--	--	--	--
COMMENTS	*2,7 RLL Code	*2,7 RLL Code Parallel Data Transfer, 4 or 5 channels	*2,7 RLL Code	*2,7 RLL Code Embedded Servo Disk Drive Mfg. By Amcodyne	*Uses RLL Code

MANUFACTURER	HEWLETT-PACKARD	HEWLETT-PACKARD	HEWLETT-PACKARD	HEWLETT-PACKARD	HEWLETT-PACKARD
DRIVE	7911	7941A 7942A	97501A	97501B	7912
DISK/TREND GROUP	5	5	5	5	6
MARKET	Captive	Captive	Captive, OEM	Captive, OEM	Captive
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	14"	130 mm OD 40 mm ID	95 mm OD 25 mm ID	95 mm OD 25 mm ID	14"
Recording medium	Oxide Coated	Thin Film	Thin Film	Thin Film	Oxide Coated
DRIVE: Technology type	3350	3370 (Ferrite)	3370 (Ferrite)	3370 (Ferrite)	3350
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	HPIB	HPIB	HP	HP	HPIB
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	F: 28.1	F: 23.789	F: 10	F: 20	F: 65.6
REMOVABLE	--	--			--
Capacity per track (Bytes)	F: 16,384	F: 8,129	F: 7,168	F: 7,168	F: 16,384
Data surfaces per spindle	1.5	3	2	2	3.5
Heads per data surface	2	1	1	1	2
Tracks per surface	1144	968	698	1400	1144
Track density (TPI)	478	960	1100	1850	478
Maximum linear density (BPI)	6161	9897	12000	12700	6161
Rotational speed (RPM)	3600	3600	3000	3000	3600
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Band Stepping Motor	Rotary, Band, Stepping Motor	Rotary, Voice Coil
Average positioning time (msec)	26.7	30	75 (including settling)	75 (including settling)	26.7
Average rotational delay (msec)	8.3	8.3	10	10	8.3
Average access time (msec)	35.0	38.3	85	85	35.0
Data transfer rate (KBytes/sec)	983	625	500	500	983
FIRST CUSTOMER SHIPMENT	10/81	6/84	3/85	12/85	10/81
U.S. OEM PRICE FOR 100 UNITS	--	--	$460	$605	--
COMMENTS		7942A Includes Tape Cartridge Drive Disk Drive Mfg. By Priam	51 mm High Embedded Servo	51 mm High Embedded Servo	

MANUFACTURER	HEWLETT-PACKARD	HEWLETT-PACKARD	HEWLETT-PACKARD	HITACHI, LTD.	HITACHI, LTD.
DRIVE	7945A 7946A	7914	7933H	DK301-1	DK301-2
DISK/TREND GROUP	6	7	8	5	5
MARKET	Captive	Captive	Captive	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	130 mm OD 40 mm ID	14"	14"	95 mm OD 25 mm ID	95 mm OD 25 mm ID
Recording medium	Thin Film	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	3370 (Ferrite)	3350	Modified 3330	Modified 3350	Modified 3350
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	HPIB	HPIB	HPIB	ST412	ST412
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	F: 55,508	F: 132.1	F: 404.4	U: 12.7	U: 19.1
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 8,129	F: 16,384	F: 23,552	U: 10,416	U: 10,416
Data surfaces per spindle	7	3.5	13	4	6
Heads per data surface	1	2	2	1	1
Tracks per surface	968	2288	1321	306	306
Track density (TPI)	960	910	625	485	485
Maximum linear density (BPI)	9897	6161	8320*	12600	12600
Rotational speed (RPM)	3600	3600	2700	3600	3600
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Linear, Voice Coil	Band, Stepping Motor	Band, Stepping Motor
Average positioning time (msec)	30	26.7	24.0	85 (including settling)	85 (including settling)
Average rotational delay (msec)	8.3	8.3	11.1	8.3	8.3
Average access time (msec)	38.3	35.0	35.1	93.3	93.3
Data transfer rate (KBytes/sec)	625	983	1000	625	625
FIRST CUSTOMER SHIPMENT	10/84	2/83	12/81	6/85	6/85
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	--
COMMENTS	7946A Includes Tape Cartridge Drive Disk Drive Mfg. By Priam		*Uses RLL Code	41 mm High	41 mm High

MANUFACTURER	HITACHI, LTD.	HITACHI, LTD.	HITACHI, LTD.	HITACHI, LTD.	HITACHI, LTD.
DRIVE	DK502-1	DK502-2	DK502-3	DK503-1	DK503-2
DISK/TREND GROUP	5	5	5	5	5
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	Modified 3350	Modified 3350	Modified 3350	Modified 3350	Modified 3350
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	ST412	ST412	ST412	ST412	ST412
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 13.3	U: 20.0	U: 26.6	U: 6.7	U: 13.3
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 10,416	U: 10,416	U: 10,416	U: 10,416	U: 10,416
Data surfaces per spindle	4	6	8	2	4
Heads per data surface	1	1	1	1	1
Tracks per surface	320	320	320	320	320
Track density (TPI)	360	360	360	360	360
Maximum linear density (BPI)	9260	9260	9260	9260	9260
Rotational speed (RPM)	3600	3600	3600	3600	3600
PERFORMANCE					
Actuator type	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor
Average positioning time (msec)	85 (including settling)	85 (including settling)	85 (including settling)	85 (including settling)	85 (including settling)
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	93.3	93.3	93.3	93.3	93.3
Data transfer rate (KBytes/sec)	625	625	625	625	625
FIRST CUSTOMER SHIPMENT	10/83	10/83	10/83	10/83	10/83
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	--
COMMENTS	Mfg. by Tokico	Mfg. by Tokico	Mfg. by Tokico	41 mm High Mfg. by Tokico	41 mm High Mfg. by Tokico

MANUFACTURER	HITACHI, LTD.	HITACHI, LTD.	HITACHI, LTD.	HITACHI, LTD.	HITACHI, LTD.
DRIVE	DK505-2	DK811-2	DK511-3	DK511-5	DK511-8
DISK/TREND GROUP	5	5	6	6	6
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	130 mm OD 40 mm ID	210 mm OD 100 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	Modified 3350	Modified 3350	Modified 3350	Modified 3350	Modified 3350
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	ST412	Modified SMD	ST412, SCSI	ST412, SCSI	ST412, SCSI
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 25.62	U: 24.0 F: 20.0	U: 36.4	U: 51.0	U: 85.7
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 10,416	F: 12,800	U: 10,416	U: 10,416	U: 10,416
Data surfaces per spindle	4	3	5	7	10
Heads per data surface	1	1	1	1	1
Tracks per surface	615	521	699	699	823
Track density (TPI)	650	480	784	784	925
Maximum linear density (BPI)	9490	7495	9340	9340	9250
Rotational speed (RPM)	3550	3521	3600	3600	3600
PERFORMANCE					
Actuator type	Band, Stepping Motor	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Average positioning time (msec)	85 (including settling)	25	30	30	23
Average rotational delay (msec)	8.45	8.5	8.3	8.3	8.3
Average access time (msec)	93.45	33.5	38.3	38.3	31.3
Data transfer rate (KBytes/sec)	625	904	625	625	625
FIRST CUSTOMER SHIPMENT	3/85	10/80	1Q84	1Q84	--
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	--
COMMENTS	41 mm High Mfg. by Tokico				

MANUFACTURER	HITACHI, LTD.	HITACHI, LTD.	HITACHI, LTD.	HITACHI, LTD.	HITACHI, LTD.
DRIVE	DK512-8	DK811-4	DK811-8	DK812S-5	DK812S-8
DISK/TREND GROUP	6	6	6	6	6
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	130 mm OD 40 mm ID	210 mm OD 100 mm ID	210 mm OD 100 mm ID	210 mm OD 100 mm ID	210 mm OD 100 mm ID
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	3370 (Ferrite)	3350	3350	Modified 3350	Modified 3350
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	ESDI, SMD	Modified SMD	Modified SMD	SMD	SMD
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 86.1	U: 48.0 F: 40.0	U: 89.1 F: 71.1	U: 51	U: 85
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 20,944	F: 12,800	F: 12,800	U: 20,672	U: 20,672
Data surfaces per spindle	5	6	11	3	5
Heads per data surface	1	1	1	1	1
Tracks per surface	823	521	526	823	823
Track density (TPI)	925	480	480	760	760
Maximum linear density (BPI)	18500*	7495	7495	9650 BPI* 6433 FCI	9650 BPI* 6433 FCI
Rotational speed (RPM)	3482	3521	3521	3510	3510
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Average positioning time (msec)	23	25	25	25	25
Average rotational delay (msec)	8.6	8.5	8.5	8.5	8.5
Average access time (msec)	31.6	33.5	33.5	33.5	33.5
Data transfer rate (KBytes/sec)	1209	904	904	1209	1209
FIRST CUSTOMER SHIPMENT	3/85	10/80	3/82	7/83	7/83
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	--
COMMENTS	*2,7 RLL Code			*2,7 RLL Code	*2,7 RLL Code

MANUFACTURER	HITACHI, LTD.	HITACHI, LTD.	HITACHI, LTD.	HITACHI, LTD.	HITACHI, LTD.
DRIVE	DK512-12	DK512-17	DK812S-12	DK812S-17	DK814S-17
DISK/TREND GROUP	7	7	7	7	7
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	130 mm OD 40 mm ID	130 mm OD 40 mm ID	210 mm OD 100 mm ID	210 mm OD 100 mm ID	210 mm OD 100 mm ID
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	3370 (Ferrite)	3370 (Ferrite)	Modified 3350	Modified 3350	3370 (Ferrite)
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	ESDI, SMD	ESDI, SMD	SMD	SMD	Modified SMD
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 120.6	U: 172.3	U: 119	U: 170.1	U: 170
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 20,944	U: 20,944	U: 20,672	U: 20,672	U: 32,768
Data surfaces per spindle	7	10	7	10	5
Heads per data surface	1	1	1	1	1
Tracks per surface	823	823	823	823	823
Track density (TPI)	925	925	760	760	800
Maximum linear density (BPI)	18500*	18500*	9650 BPI* 6433 FCI	9650 BPI* 6433 FCI	18500*
Rotational speed (RPM)	3482	3482	3510	3510	2632
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Average positioning time (msec)	23	23	25	25	20
Average rotational delay (msec)	8.6	8.6	8.5	8.5	11.4
Average access time (msec)	31.6	31.6	33.5	33.5	31.4
Data transfer rate (KBytes/sec)	1209	1209	1209	1209	1815
FIRST CUSTOMER SHIPMENT	3/85	3/85	6/83	6/83	12/84
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	--
COMMENTS	*2,7 RLL Code	*2,7 RLL Code	*2,7 RLL Code	*2,7 RLL Code	*2,7 RLL Code

MANUFACTURER	HITACHI, LTD.	HITACHI, LTD.	HITACHI, LTD.	HITACHI, LTD.	HITACHI, LTD.
DRIVE	DK814S-24	DK814S-34	DKU-80	DK815-5	DK815-10
DISK/TREND GROUP	7	8	8	9	9
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	210 mm OD 100 mm ID	210 mm OD 100 mm ID	210 mm OD	224 mm OD 100 mm ID	224 mm OD 100 mm ID
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Hi Dens-Oxide	Oxide Coated
DRIVE: Technology type	3370 (Ferrite)	3370 (Ferrite)		3370 (Ferrite)	3380
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Thin Film
Interface	Modified SMD	Modified SMD	IBM, SMD	Mod. SMD	Mod SMD, IPI-II
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 238	U: 340	U: 427.7	U: 525.38	U: 1050
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 32,768	U: 32,768	U: 26,880	U: 30,240	U: 40,320
Data surfaces per spindle	7	10	13	14	15
Heads per data surface	1	1	2	1	1
Tracks per surface	823	823	1224	1241	1737
Track density (TPI)	800	800		860	1160
Maximum linear density (BPI)	18500*	18500*		14585*	20000*
Rotational speed (RPM)	2632	2632	3000	3600	3600
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Linear, Voice Coil
Average positioning time (msec)	20	20	18	18	15
Average rotational delay (msec)	11.4	11.4	10.0	8.3	8.3
Average access time (msec)	31.4	31.4	28.0	26.3	23.3
Data transfer rate (KBytes/sec)	1815	1815	1344	1815	2420
FIRST CUSTOMER SHIPMENT	12/84	12/84	11/83	11/84	1Q87
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	--
COMMENTS	*2,7 RLL Code	*2,7 RLL Code		*2,7 RLL Code	*1,7 RLL Code

MANUFACTURER	HITACHI, LTD.	HITACHI, LTD.	HITACHI, LTD.	HITACHI, LTD.	HITACHI, LTD.
DRIVE	DKU-85I-D14 DKU-85I-D24	DKU-85I-E14 DKU-85I-E24 H-6585-14 H-6585-24	DKU-97I	DKU-97S	DKU-98I H-8598-12 H-8598-22
DISK/TREND GROUP	9	9	9	9	9
MARKET	Captive	Captive	OEM	OEM	Captive, OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	14"	14"	14"	14"	14"
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	3380 (Ferrite)	3380 (Ferrite)	Modified 3350	Modified 3350	3380
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	IBM	IBM	IBM	SMD	IBM
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	F: 630	F: 1260	F: 635.0	U: 697.059	F: 1260
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 47,476	F: 47,476	F: 19,069	U: 20,672	F: 47,476
Data surfaces per spindle	**	**	20	20	20
Heads per data surface	2	2	2	2	2
Tracks per surface	**	**	1666	1682	1328 (Physical)
Track density (TPI)	**	**	720	720	600
Maximum linear density (BPI)	**	**	6425	6425	15240*
Rotational speed (RPM)	3600	3600	3600	3600	3600
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Dual Rotary, Voice Coil	Dual Rotary, Voice Coil	Dual Rotary, Voice Coil
Average positioning time (msec)	15	17	20/18	20	16
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	23.3	25.3	28.3/26.3	28.3	24.3
Data transfer rate (KBytes/sec)	3000	3000	1198	1240	3000
FIRST CUSTOMER SHIPMENT	4/86	12/85	1/81	9/83	4Q82
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	--
COMMENTS	Drive has four spindles ** not announced	Drive has four spindles ** not announced	Drive has two spindles		*2,7 RLL Code Drive has two spindles 2 actuators per spindle

MANUFACTURER	HITACHI, LTD.	HITACHI, LTD.	IBIS	IBM	IBM
DRIVE	H-6555	H-8576-12 H-8576-22	1400	5160-088 5160-089 5162-286	5170-099 5170-599 5170-899
DISK/TREND GROUP	9	9	9	5	5
MARKET	Captive	Captive	OEM	Captive	Captive
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	224 mm OD 100 mm ID	14"	14"	130 mm OD 40 mm ID	130 mm OD 40 mm ID
Recording medium	Hi Dens Oxide	Oxide Coated	Thin Film	Oxide Coated	Oxide Coated
DRIVE: Technology type	3370 (Ferrite)	Modified 3350	Special	Modified 3350	Modified 3350
Heads	Ferrite	Ferrite	Thin Film	Ferrite	Ferrite
Interface	Hitachi	IBM	Custom,ISI,VME	ST412	IBM, ST412
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	F: 500	F: 635.0	U: 1,409.0	F: 31.9	F: 21.4
REMOVABLE	--	--	--		--
Capacity per track (Bytes)	U: 28,884	F: 19,069	U: 49,728	F: 8,704	F: 8,704
Data surfaces per spindle	14	20	16	8	4
Heads per data surface	1	2	2	1	1
Tracks per surface	1237	1666	1776	306	615
Track density (TPI)	860	720	769	350	815
Maximum linear density (BPI)	14585*	6425	15294	9150	9398
Rotational speed (RPM)	3600	3600	3600	3600	3573
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Dual Rotary, Voice Coil	Linear, Voice Coil	Rotary, Band, Stepping Motor	Rotary, Voice Coil
Average positioning time (msec)	18	20	16	85 (including settling)	40
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.4
Average access time (msec)	26.3	28.3	24.3	93.3	48.4
Data transfer rate (KBytes/sec)	1815	1198	12000	625	625
FIRST CUSTOMER SHIPMENT	1Q85	4Q80	4Q83	4/86	4/85
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	--
COMMENTS	*2,7 RLL Code Drive has 1 to 4 spindles	Drive has two spindles	Drive has one spindle, with two actuators. Up to 4 track parallel data transfer.	System unit for PC XT	System Unit for PC AT

MANUFACTURER	IBM	IBM	IBM	IBM	IBM
DRIVE	5525-021 5525-031	8101-A11	8130-A21 8140-A31 A41, A51 A61, A71	WD-325	3310-A1 3310-A2 3310-B1 3310-B2
DISK/TREND GROUP	5	5	5	5	6
MARKET	Captive	Captive	Captive	OEM	Captive
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	210 mm OD 100 mm ID	210 mm OD 100 mm ID	210 mm OD 100 mm ID	95 mm OD 25 mm ID	210 mm OD 100 mm ID
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	Piccolo	Piccolo	Piccolo	Modified 3350	Piccolo
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	IBM	IBM	IBM	ST412	IBM
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	F: 29.327360	F: 29.327360	F: 29.327360	U: 25.5	F: 64.520192
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 16,384	F: 16,384	F: 16,384	U: 10,416	F: 16,384
Data surfaces per spindle	5	5	5	4	11
Heads per data surface	1	1	1	1	1
Tracks per surface	359	359	359	612	359
Track density (TPI)	450	450	450	850	450
Maximum linear density (BPI)	8530	8530	8530	13400	8530
Rotational speed (RPM)	3125	3125	3125	3600	3125
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Stepping Motor	Rotary, Voice Coil
Average positioning time (msec)	27	27	27	80	27
Average rotational delay (msec)	9.6	9.6	9.6	8.3	9.6
Average access time (msec)	36.6	36.6	36.6	88.3	36.6
Data transfer rate (KBytes/sec)	1031	1031	1031	625	1031
FIRST CUSTOMER SHIPMENT	2/80	3Q79	3Q79	5/86	3/79
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	--
COMMENTS	5520 Admin. System	8100 System	8100 System	41 mm High	4331

MANUFACTURER	IBM	IBM	IBM	IBM	IBM
DRIVE	4956-G10 H10	4963-58A	4963-64A 4963-64B	5170-319 5170-339 5170-839 5170-849	5364
DISK/TREND GROUP	6	6	6	6	6
MARKET	Captive	Captive	Captive	Captive	Captive
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	130 mm OD 40 mm ID	210 mm OD 100 mm ID	210 mm OD 100 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	Modified 3350	Piccolo	Piccolo	Modified 3350	Modified 3350
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	ST412	IBM	IBM	ST412	IBM, ST412
CAPACITY/RECORDING DENSITY		0.131 MB Fixed Heads			
Total capacity (MBytes) FIXED	F: 40	F: 58.654720	F: 64.520192	F: 31.9	F: 41.92
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 8,704	F: 16,384	F: 16,384	F: 8,704	F: 8,192
Data surfaces per spindle	7	11	11	5	7
Heads per data surface	1	1	1	1	1
Tracks per surface	733	359	359	733	733
Track density (TPI)	815	450	450	815	815
Maximum linear density (BPI)	9398	8530	8530	9398	9398
Rotational speed (RPM)	3600	3125	3125	3600	3600
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Average positioning time (msec)	40	27	27	40	40
Average rotational delay (msec)	8.3	9.6	9.6	8.3	8.3
Average access time (msec)	48.3	36.6	36.6	48.3	48.3
Data transfer rate (KBytes/sec)	625	1031	1031	625	625
FIRST CUSTOMER SHIPMENT	9/86	2/79	2/79	10/85	6/85
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	--
COMMENTS	Series/1	Series/1	Series/1	System unit for PC AT	System Unit for System/36 PC

MANUFACTURER	IBM	IBM	IBM	IBM	IBM
DRIVE	5381- All Models	5525-032 5525-051	6150-4735	6150-6941	667-85
DISK/TREND GROUP	6	6	6	6	6
MARKET	Captive	Captive	Captive	Captive	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	210 mm OD 100 mm ID	210 mm OD 100 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	Piccolo	Piccolo	Modified 3350	Modified 3350	Modified 3350
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	IBM	IBM	ST412	ESDI	ESDI
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	F: 64.520192	F: 64.520192	F: 44.6	F: 73.0	U: 85.0
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 16,384	F: 16,384	F: 8,704	F: 17,920	U: 20,833
Data surfaces per spindle	11	11	7	7	7
Heads per data surface	1	1	1	1	1
Tracks per surface	359	359	733	582	582
Track density (TPI)	450	450	815	648	648
Maximum linear density (BPI)	8530	8530	9398	18942*	18942*
Rotational speed (RPM)	3125	3125	3600	3600	3600
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Average positioning time (msec)	27	27	40	30	30
Average rotational delay (msec)	9.6	9.6	8.3	8.3	8.3
Average access time (msec)	36.6	36.6	48.3	38.3	38.3
Data transfer rate (KBytes/sec)	1031	1031	625	1250	1250
FIRST CUSTOMER SHIPMENT	8/79	11/80	3/86	9/86	9/86
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	--
COMMENTS	System/38 5381 Processor available with up to six disk spindles	5520 Admin. System -051 Model is Dual Spindle	RT PC	RT PC *2,7 RLL Code	*2,7 RLL Code

MANUFACTURER	IBM	IBM	IBM	IBM	IBM
DRIVE	680	8101-A23	8130-A23 8130-B23 8140-A33 A43, A53 A63, A73	4967-2CA 4967-2CB	5360-BXX
DISK/TREND GROUP	6	6	6	7	7
MARKET	OEM	Captive	Captive	Captive	Captive
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	210 mm OD 100 mm ID	210 mm OD 100 mm ID	210 mm OD 100 mm ID	14"	14"
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	Piccolo	Piccolo	Piccolo	Modified 3350	Modified 3350
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	IBM	IBM	IBM	IBM	IBM
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	F: 64.5	F: 64.520	F: 64.520192	F: 200.202	F: 200.202
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 16,384	F: 16,384	F: 16,384	F: 25,088	F: 25,088
Data surfaces per spindle	11	11	11	7	7
Heads per data surface	1	1	1	2	2
Tracks per surface	358	359	359	1140	1140
Track density (TPI)	450	450	450	485	485
Maximum linear density (BPI)	8530	8530	8530	9751	9751
Rotational speed (RPM)	3125	3125	3125	2964	2964
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Linear, Voice Coil	Linear, Voice Coil
Average positioning time (msec)	27	27	27	25	25
Average rotational delay (msec)	9.6	9.6	9.6	10.1	10.1
Average access time (msec)	36.6	36.6	36.6	35.1	35.1
Data transfer rate (KBytes/sec)	1031	1031	1031	1500	1500
FIRST CUSTOMER SHIPMENT	1/82	8/79	3Q79	7/83	7/83
U.S. OEM PRICE FOR 100 UNITS	$4,375	--	--	--	--
COMMENTS	Embedded Servo	8100 System -A25 model is two spindles	8100 System	Series/1 384 KB Cache	System/36 5360-BX4 uses 2 spindles,with total 400.4 MB

MANUFACTURER	IBM	IBM	IBM	IBM	IBM
DRIVE	678-200	8102-A15	9332-240 9332-250	9332-A11	4967-3CA 3CB
DISK/TREND GROUP	7	7	7	7	8
MARKET	OEM	Captive	Captive	Captive	Captive
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	210 mm OD 100 mm ID	210 mm OD 100 mm ID	210 mm OD 100 mm ID	210 mm OD 100 mm ID	14"
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	Modified 3350	Piccolo	Modified 3350	Modified 3350	Modified 3350
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	IPI-3, SCSI	IBM	SCSI	IPI-3	IBM
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 238.3 F: 200.3	F: 129.761	F: 200.3	F: 200.3	F: 358
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 44,252 F: 37,376*	F: 16,384	F: 37,376	F: 37,376	F: 25,088
Data surfaces per spindle	4	11	4	4	7
Heads per data surface	1	1	1	1	1
Tracks per surface	1346	720	1346	1346	2048
Track density (TPI)	1096	850	1096	1096	869
Maximum linear density (BPI)	23110**	8770	23100 *	23100*	9751
Rotational speed (RPM)	3119	3125	3119	3119	2964
PERFORMANCE					
Actuator type	Linear, Voice Coil	Rotary, Voice Coil	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil
Average positioning time (msec)	19.5	27	19.5	19.5	25
Average rotational delay (msec)	9.62	9.6	9.62	9.62	10.1
Average access time (msec)	29.12	36.6	29.12	29.12	35.1
Data transfer rate (KBytes/sec)	2500	1031	2500	2500	1500
FIRST CUSTOMER SHIPMENT	6/86	4/84	2Q87	8/86	9/86
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	--
COMMENTS	*Outer 893 Tr. **1,7 RLL Code Embedded Servo	8100 System -A17 model is two spindles	RT PC *1,7 RLL Code Embedded Servo	System/36 System/38 *1,7 RLL Code Embedded Servo	Series/1

MANUFACTURER	IBM	IBM	IBM	IBM	IBM
DRIVE	5360-BXA BXB C2X	678-400	9332-440 9332-450	9332-A12	3370-A02 3370-A12 3370-B02 3370-B12
DISK/TREND GROUP	8	8	8	8	9
MARKET	Captive	OEM	Captive	Captive	Captive
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	14"	210 mm OD 100 mm ID	210 mm OD 100 mm ID	210 mm OD 100 mm ID	14"
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	Modified 3350	Modified 3350	Modified 3350	Modified 3350	3370
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Thin Film
Interface	IBM	IPI-3, SCSI	SCSI	IPI-3	IBM
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	F: 359.661	U: 476.5 F: 400.6	F: 400.6	F: 400.6	F: 729.858
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 25,088	U: 44,252 F: 37,376*	F: 37,376	F: 37,376	F: 31,744
Data surfaces per spindle	7	8	8	8	12
Heads per data surface	2	1	1	1	2
Tracks per surface	2048	1346	1346	1346	1916
Track density (TPI)	869	1096	1096	1096	800
Maximum linear density (BPI)	9751	23110**	23100 *	23100*	12134 BPI* 8128 FCI
Rotational speed (RPM)	2964	3119	3119	3119	2964
PERFORMANCE					
Actuator type	Linear, Voice Coil	Dual, Linear, Voice Coil	Dual, Linear, Voice Coil	Dual, Linear, Voice Coil	Dual, Linear, Voice Coil
Average positioning time (msec)	25	19.5	19.5	19.5	19
Average rotational delay (msec)	10.1	9.62	9.62	9.62	10.1
Average access time (msec)	35.1	29.12	29.12	29.12	29.1
Data transfer rate (KBytes/sec)	1500	2500	2500	2500	1859
FIRST CUSTOMER SHIPMENT	2/86	6/86	2Q87	8/86	2Q84
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	--
COMMENTS	System/36 System uses multiple spindles	*Outer 893 Tr. **1,7 RLL Code Embedded Servo	RT PC *1,7 RLL Code Embedded Servo	System/36 System/38 *1,7 RLL Code Embedded Servo	*2,7 RLL Code 4341 4361 4381 System/38

MANUFACTURER	IBM	IBM	IBM	IBM	IBM
DRIVE	3375-A1 3375-B1 3375-D1	3380-AD4 3380-BD4	3380-AE4 3380-BE4	685-B01	9335-B01
DISK/TREND GROUP	9	9	9	9	9
MARKET	Captive	Captive	Captive	OEM	Captive
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	14"	14"	14"	14"	14"
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	3370	3380	3380 x 2	3380	3380
Heads	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
Interface	IBM	IBM	IBM	IBM	IBM
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	F: 819.7	F: 1,260.4878	F: 2,520.9756	U: 1043.1 F: 855.9	F: 855.9
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 35,616	F: 47,476	F: 47,476	U: 44,280 F: 36,352	F: 36,352
Data surfaces per spindle	12	15	15	6	6
Heads per data surface	2	2	2	2	2
Tracks per surface	1918	1770	3540	3926	3924
Track density (TPI)	800	*	1386	1600	1600
Maximum linear density (BPI)	12134 BPI* 8128 FCI	*	16200	16200*	16200*
Rotational speed (RPM)	2964	3620	3620	3623	3623
PERFORMANCE					
Actuator type	Dual, Linear, Voice Coil	Dual, Linear Voice Coil	Dual, Linear Voice Coil	Dual, Rotary, Voice Coil	Dual, Rotary, Voice Coil
Average positioning time (msec)	19	15	17	18	18
Average rotational delay (msec)	10.1	8.3	8.3	8.28	8.28
Average access time (msec)	29.1	23.3	25.3	26.28	26.28
Data transfer rate (KBytes/sec)	1859	3000	3000	3000	3000
FIRST CUSTOMER SHIPMENT	3Q81	2/85	7/85	6/86	8/86
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	--
COMMENTS	*2,7 RLL Code 4331 4341 303X Series	*not announced Drive has two spindles	Drive has two spindles	*2,7 RLL Code	System/38 *2,7 RLL Code Embedded Servo

MANUFACTURER	ISOT	ISOT	ISOT	ISOT	ISOT
DRIVE	CM 5400-00 CM 5400-01	CM 5410	CM 5412	ES 5066 ES 5067.01 ES 5067.02	ES 5067
DISK/TREND GROUP	1	1	3	4	4
MARKET	OEM	Captive OEM	OEM	OEM	OEM
MEDIA: Generic type	5440	5440	SMD	3336-1	3336-11
Nominal disk diameter	14"	14"	14"	14"	14"
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	2314	2314	3330-11	3330-1	3330-11
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	Various Options	Various Options	SMD		
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 3.125	U: 5.75	--	--	--
REMOVABLE	U: 3.125	U: 5.75	U: 80	F: 100	F: 200
Capacity per track (Bytes)	U: 7,812	U: 7,812	U: 20,160	F: 13,030	F: 13,030
Data surfaces per spindle	4	4	5	19	19
Heads per data surface	1	1	1	1	1
Tracks per surface	204	406	823	411	815
Track density (TPI)	100	200	400	192	370
Maximum linear density (BPI)	2200	2200	6060	4040	4040
Rotational speed (RPM)	2400/1500	2400/1500	2400/3600	3600	3600
PERFORMANCE					
Actuator type	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil
Average positioning time (msec)	50	50	45	30	30
Average rotational delay (msec)	12.5/20	12.5	12.5/8.3	8.3	8.3
Average access time (msec)	62.5/70	62.5	57.5/53.3	38.3	38.3
Data transfer rate (KBytes/sec)	312/195	312/195	806/1209	806	806
FIRST CUSTOMER SHIPMENT	1979	1982	1983	1980	1981
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	--
COMMENTS					

MANUFACTURER	JOSEPHINE COUNTY TECHNOLOGY	JOSEPHINE COUNTY TECHNOLOGY	JOSEPHINE COUNTY TECHNOLOGY	KOVO (ARITMA)	KOVO (ARITMA)
DRIVE	JCT-100	JCT-105	JCT-110	Aritma 4080	Aritma 5080
DISK/TREND GROUP	5	5	5	4	4
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	3336-1	3336-11
Nominal disk diameter	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	14"	14"
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	Modified 3350	Modified 3350	Modified 3350	3330-1	3330-11
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	ST412	ST412	ST412	IBM	IBM
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 5.2	U: 7.0	U: 14.0	--	--
REMOVABLE	--	--	--	F: 100.0	F: 200.0
Capacity per track (Bytes)	U: 11,504	U: 11,504	U: 11,504	F: 13,030	F: 13,030
Data surfaces per spindle	2	2	4	19	19
Heads per data surface	1	1	1	1	1
Tracks per surface	226	306	306	411	815
Track density (TPI)	200	270	270	192	370
Maximum linear density (BPI)	7690	7690	7690	4040	4040
Rotational speed (RPM)	3600	3600	3600	3600	3600
PERFORMANCE					
Actuator type	Linear, Band, Stepping Motor	Linear, Band, Stepping Motor	Linear, Band, Stepping Motor	Linear, Voice Coil	Linear, Voice Coil
Average positioning time (msec)	110 (including settling)	150 (including settling)	150 (including settling)	30	30
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	118.3	158.3	158.3	38.3	38.3
Data transfer rate (KBytes/sec)	625	625	625	806	806
FIRST CUSTOMER SHIPMENT	6/84	9/84	6/85	1985	1986
U.S. OEM PRICE FOR 100 UNITS	$230	$265	$295	--	--
COMMENTS	41 mm High	41 mm High	41 mm High		

MANUFACTURER	KOVO (ZBROJOVKA BRNO)	LAPINE TECHNOLOGY	LAPINE TECHNOLOGY	MATSUSHITA COMMUNICATION INDUSTRIAL	MATSUSHITA COMMUNICATION INDUSTRIAL
DRIVE	KDP 724	LT200 Titan	LT300 Titan	JU-114	JU-116
DISK/TREND GROUP	1	5	5	5	5
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	2315	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	14"	95 mm OD 25 mm ID	96 mm OD 40 mm ID	95 mm OD 25 mm ID	95 mm OD 25 mm ID
Recording medium	Oxide Coated	Thin Film	Thin Film	Thin Film	Thin Film
DRIVE: Technology type	2314	3370 (Ferrite)	Modified 3350	3370 (Ferrite)	3370 (Ferrite)
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface		ST412	ST412	ST412	ST412
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 3.125	U: 25.5	U: 38.4*	U: 13.3	U: 26.6
REMOVABLE	U: 3.125	--	--	--	--
Capacity per track (Bytes)	U: 7,812	U: 10,416	U: 15,624*	U: 10,416	U: 10,416
Data surfaces per spindle	4	4	4	2	4
Heads per data surface	1	1	1	1	1
Tracks per surface	204	612	616	640	640
Track density (TPI)	100	835	835	800	800
Maximum linear density (BPI)	2200	12268	12268 FCI	14423	14423
Rotational speed (RPM)	2400	3600	3600	3536	3536
PERFORMANCE					
Actuator type	Linear, Voice Coil	Rotary, Band, Stepping Motor	Rotary, Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor
Average positioning time (msec)	45	65 (including settling)	65 (including settling)	85 (including settling)	85 (including settling)
Average rotational delay (msec)	12.5	8.3	8.3	8.48	8.48
Average access time (msec)	57.5	73.3	73.3	93.48	93.48
Data transfer rate (KBytes/sec)	312.5	625	938*	625	625
FIRST CUSTOMER SHIPMENT	1976	8/85	3Q86	3Q86	3Q86
U.S. OEM PRICE FOR 100 UNITS	--	$320 (1000)	$340 (1000)	--	--
COMMENTS		3265 is ruggedized model	*with 2,7 RLL controller		

MANUFACTURER	MATSUSHITA COMMUNICATION INDUSTRIAL	MATSUSHITA COMMUNICATION INDUSTRIAL	MATSUSHITA COMMUNICATION INDUSTRIAL	MATSUSHITA COMMUNICATION INDUSTRIAL	MATSUSHITA COMMUNICATION INDUSTRIAL
DRIVE	JU-614	JU-615	JU-616	JU-662	JU-664
DISK/TREND GROUP	5	5	5	5	5
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	Modified 3350	Modified 3350	Modified 3350	Modified 3350	Modified 3350
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	ST412	ST412	ST412	ST412	ST412
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 13.3	U: 20.0	U: 26.6	U: 6.7	U: 13.3
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 10,416	U: 10,416	U: 10,416	U: 10,416	U: 10,416
Data surfaces per spindle	4	6	8	2	4
Heads per data surface	1	1	1	1	1
Tracks per surface	320	320	320	320	320
Track density (TPI)	360	360	360	320	320
Maximum linear density (BPI)	9100	9100	9100	9280	9280
Rotational speed (RPM)	3600	3600	3600	3600	3600
PERFORMANCE					
Actuator type	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor
Average positioning time (msec)	85 (including settling)	85 (including settling)	85 (including settling)	95 (including settling)	95 (including settling)
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	93.3	93.3	93.3	103.3	103.3
Data transfer rate (KBytes/sec)	625	625	625	625	625
FIRST CUSTOMER SHIPMENT	1Q84	1Q84	1Q84	3Q84	3Q84
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	--
COMMENTS				41 mm High	41 mm High

MANUFACTURER	MAXTOR	MAXTOR	MAXTOR	MAXTOR	MAXTOR
DRIVE	XT-1085	XT-2085	XT-1105	XT-1140	XT-2140
DISK/TREND GROUP	6	6	7	7	7
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID
Recording medium	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
DRIVE: Technology type	3370 (Ferrite)	3370 (Ferrite)	3370 (Ferrite)	3370 (Ferrite)	3370 (Ferrite)
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	ST412	ST412	ST412	ST412	ST412
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 85.32	U: 89.24	U: 105.27	U: 143.55	U: 140.24
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 10,416	U: 10,416	U: 10,416	U: 10,416	U: 10,416
Data surfaces per spindle	8	7	11	15	11
Heads per data surface	1	1	1	1	1
Tracks per surface	1024	1224	918	918	1224
Track density (TPI)	1070	1070	1070	1070	1070
Maximum linear density (BPI)	9934	11155	9280	9280	11155
Rotational speed (RPM)	3600	3600	3600	3600	3600
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Average positioning time (msec)	28	30	27	27	30
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	36.3	38.3	35.3	35.3	38.3
Data transfer rate (KBytes/sec)	625	625	625	625	625
FIRST CUSTOMER SHIPMENT	2Q83	3Q84	2Q83	2Q83	3Q84
U.S. OEM PRICE FOR 100 UNITS	$1,230	$1,230	$2,000	$2,350	$2,180
COMMENTS					

MANUFACTURER	MAXTOR	MAXTOR	MAXTOR	MAXTOR	MAXTOR
DRIVE	XT-2190	XT-3170	XT-3280	EXT-4175	EXT-4280
DISK/TREND GROUP	7	7	7	7	7
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID
Recording medium	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
DRIVE: Technology type	3370 (Ferrite)	3370 (Ferrite)	3370 (Ferrite)	3370	3370
Heads	Ferrite	Ferrite	Ferrite	Thin Film	Thin Film
Interface	ST412	SCSI	SCSI	ESDI	ESDI
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 191.24	F: 146.64	F: 244.41	U: 178.28	U: 280.16
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 10,416	F: 13,312	F: 13,312	U: 20,808	U: 20,808
Data surfaces per spindle	15	9	15	7	11
Heads per data surface	1	1	1	1	1
Tracks per surface	1224	1224	1224	1224	1224
Track density (TPI)	1070	1070	1070	1070	1070
Maximum linear density (BPI)	11155	16732 BPI* 11155 FCI	16732 BPI* 11155 FCI	20952 BPI* 13968 FCI	20952 BPI* 13968 FCI
Rotational speed (RPM)	3600	3600	3600	3600	3600
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Average positioning time (msec)	30	30	30	27	27
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	38.3	38.3	38.3	35.3	35.3
Data transfer rate (KBytes/sec)	625	937.5	937.5	1250	1250
FIRST CUSTOMER SHIPMENT	3Q84	2/86	2/86	4Q84	4Q84
U.S. OEM PRICE FOR 100 UNITS	$2,580	$2,065	$3,040	$1,850	$2,880
COMMENTS		*2,7 RLL Code	*2,7 RLL Code	*2,7 RLL Code	*2,7 RLL Code

MANUFACTURER	MAXTOR	MAXTOR	MAXTOR	MAXTOR	MEMOREX
DRIVE	EXT-4380	XT-3380	XT-8380E	XT-8760E	3680
DISK/TREND GROUP	8	8	8	9	9
MARKET	OEM	OEM	OEM	OEM	PCM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	14"
Recording medium	Thin Film	Thin Film	Thin Film	Thin Film	Oxide Coated
DRIVE: Technology type	3370	3370 (Ferrite)	3370	3370	3380
Heads	Thin Film	Ferrite	Thin Film	Thin Film	Thin Film
Interface	ESDI	SCSI	ESDI	ESDI	IBM
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 382.03	F: 319.61	U: 408	U: 765	F: 1260
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 20,808	F: 17,408	U: 31,250	U: 31,250	F: 47,476
Data surfaces per spindle	15	15	8	15	15
Heads per data surface	1	1	1	1	2
Tracks per surface	1224	1224	1632	1632	1,768
Track density (TPI)	1070	1070	1376	1376	806
Maximum linear density (BPI)	20952 BPI* 13968 FCI	20970 BPI* 13980 FCI	31429 BPI* 20953 FCI	31429 BPI* 20953 FCI	15240*
Rotational speed (RPM)	3600	3600	3600	3600	3600
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Dual Linear, Voice Coil
Average positioning time (msec)	27	27	16	18	16
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	35.3	35.3	24.3	26.3	24.3
Data transfer rate (KBytes/sec)	1250	1250	1875	1875	3000
FIRST CUSTOMER SHIPMENT	4Q84	4Q86	1Q87	1Q87	8/83
U.S. OEM PRICE FOR 100 UNITS	$3,850	$3,950	$2,700	$4,760	--
COMMENTS	*2,7 RLL Code	*2,7 RLL Code	*2,7 RLL Code	*2,7 RLL Code	PCM 3380 Drive has one spindle *2,7 RLL Code

MANUFACTURER	MEMOREX	MEMORY SYSTEMS, INC.	MEMORY SYSTEMS, INC.	MEMORY SYSTEMS, INC.	MICRO STORAGE
DRIVE	3680 HDP	MS840-S	MS860-S	MS880-S	MS 212
DISK/TREND GROUP	9	6	6	6	2
MARKET	PCM	OEM	OEM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	5.25" Cartridge
Nominal disk diameter	14"	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID
Recording medium	Oxide Coated	Thin Film	Thin Film	Thin Film	Thin Film
DRIVE: Technology type	3380	3350	3350	3350	3370 (Ferrite)
Heads	Thin Film	Ferrite	Ferrite	Ferrite	Ferrite
Interface	IBM	ST412	ST412	ST412	ST412
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	F: 1260	U: 40	U: 60	U: 80	--
REMOVABLE	--	--	--	--	U: 12.9
Capacity per track (Bytes)	F: 47,476	U: 10,416	U: 10,416	U: 10,416	U: 10,416
Data surfaces per spindle	15	4	6	8	2
Heads per data surface	2	1	1	1	1
Tracks per surface	1768	960	960	960	620
Track density (TPI)	806	1000	1000	1000	556
Maximum linear density (BPI)	15240*	8842	8842	8842	10900
Rotational speed (RPM)	3600	3600	3600	3600	3524
PERFORMANCE					
Actuator type	Dual, Linear, Voice Coil	Band, Encoder Motor	Band, Encoder Motor	Band, Encoder Motor	Band, Stepping Motor
Average positioning time (msec)	16	40	40	40	95 (including settling)
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.51
Average access time (msec)	24.3	48.3	48.3	48.3	103.51
Data transfer rate (KBytes/sec)	3000	625	625	625	625
FIRST CUSTOMER SHIPMENT	3Q85	2Q86	2Q86	2Q86	6/85
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	$695
COMMENTS	PCM 3380 *2,7 RLL Code Drive has eight spindles				Embedded Servo

MANUFACTURER	MICROPOLIS	MICROPOLIS	MICROPOLIS	MICROPOLIS	MICROPOLIS
DRIVE	1323	1323A	1324	1324A	1325
DISK/TREND GROUP	6	6	6	6	6
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	3370 (Ferrite)	3370 (Ferrite)	3370 (Ferrite)	3370 (Ferrite)	3370 (Ferrite)
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	ST412	ST412	ST412	ST412	ST412
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 42.7	U: 53.3	U: 64.0	U: 74.7	U: 85.3
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 10,416	U: 10,416	U: 10,416	U: 10,416	U: 10,416
Data surfaces per spindle	4	5	6	7	8
Heads per data surface	1	1	1	1	1
Tracks per surface	1024	1024	1024	1024	1024
Track density (TPI)	1000	1000	1000	1000	1000
Maximum linear density (BPI)	9824	9824	9824	9824	9824
Rotational speed (RPM)	3600	3600	3600	3600	3600
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Average positioning time (msec)	28	28	28	28	28
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	36.3	36.3	36.3	36.3	36.3
Data transfer rate (KBytes/sec)	625	625	625	625	625
FIRST CUSTOMER SHIPMENT	2Q84	2Q84	2Q84	2Q84	2Q84
U.S. OEM PRICE FOR 100 UNITS	$650 (1000)	$695 (1000)	$850 (1000)	$875 (1000)	$895 (1000)
COMMENTS					

MANUFACTURER	MICROPOLIS	MICROPOLIS	MICROPOLIS	MICROPOLIS	MICROPOLIS
DRIVE	1353	1373	1373A	1353A	1354
DISK/TREND GROUP	6	6	6	7	7
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID
Recording medium	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
DRIVE: Technology type	3370 (Ferrite)	3370 (Ferrite)	3370 (Ferrite)	3370 (Ferrite)	3370 (Ferrite)
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	ESDI	SCSI	SCSI	ESDI	ESDI
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 85.3	F: 77.0	F: 96.3	U: 106.7	U: 128.0
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 20,832	F: 19,456	F: 19,456	U: 20,832	U: 20,832
Data surfaces per spindle	4	4	5	5	6
Heads per data surface	1	1	1	1	1
Tracks per surface	1024	1016	1024	1024	1024
Track density (TPI)	1000	1000	*	1000	1000
Maximum linear density (BPI)	19794*	19794*	*	19794*	19794*
Rotational speed (RPM)	3600	3600	3600	3600	3600
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Average positioning time (msec)	23	23	23	23	23
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	31.3	31.3	31.3	31.3	31.3
Data transfer rate (KBytes/sec)	1250	1250	1250	1250	1250
FIRST CUSTOMER SHIPMENT	3Q85	1Q86	2/86	3Q85	3Q85
U.S. OEM PRICE FOR 100 UNITS	$995 (1000)	$1,095 (1000)	$1,395 (1000)	$1,295 (1000)	$1,350 (1000)
COMMENTS	*2,7 RLL Code	*2,7 RLL Code	*not announced	*2,7 RLL Code	*2,7 RLL Code

MANUFACTURER	MICROPOLIS	MICROPOLIS	MICROPOLIS	MICROPOLIS	MICROPOLIS
DRIVE	1354A	1355	1374	1374A	1375
DISK/TREND GROUP	7	7	7	7	7
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID
Recording medium	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
DRIVE: Technology type	3370 (Ferrite)	3370 (Ferrite)	3370 (Ferrite)	3370 (Ferrite)	3370 (Ferrite)
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	ESDI	ESDI	SCSI	SCSI	SCSI
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 149.3	U: 170.6	F: 115.5	F: 134.8	F: 154.0
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 20,832	U: 20,832	F: 19,456	F: 19,456	F: 19,456
Data surfaces per spindle	7	8	6	7	8
Heads per data surface	1	1	1	1	1
Tracks per surface	1024	1024	1016	1024	1016
Track density (TPI)	1000	1000	1000	*	1000
Maximum linear density (BPI)	19794*	19794*	19794*	*	19794*
Rotational speed (RPM)	3600	3600	3600	3600	3600
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Average positioning time (msec)	23	23	23	23	23
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	31.3	31.3	31.3	31.3	31.3
Data transfer rate (KBytes/sec)	1250	1250	1250	1250	1250
FIRST CUSTOMER SHIPMENT	3Q85	3Q85	1Q86	2/86	1Q86
U.S. OEM PRICE FOR 100 UNITS	$1,375 (1000)	$1,395 (1000)	$1,450 (1000)	$1,475 (1000)	$1,495 (1000)
COMMENTS	*2,7 RLL Code	*2,7 RLL Code	*2,7 RLL Code	*not announced	*2,7 RLL Code

MANUFACTURER	MICROPOLIS	MICROPOLIS	MICROPOLIS	MICROPOLIS	MICROPOLIS
DRIVE	1554	1555	1556	1557	1558
DISK/TREND GROUP	7	8	8	8	8
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID
Recording medium	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
DRIVE: Technology type	3370 (Ferrite)	3370 (Ferrite)	3370 (Ferrite)	3370 (Ferrite)	3370 (Ferrite)
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	ESDI	ESDI	ESDI	ESDI	ESDI
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 280	U: 305	U: 331	U: 356	U: 382
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 20,832	U: 20,832	U: 20,832	U: 20,832	U: 20,832
Data surfaces per spindle	11	12	13	14	15
Heads per data surface	1	1	1	1	1
Tracks per surface	1224	1224	1224	1224	1224
Track density (TPI)	*	*	*	*	*
Maximum linear density (BPI)	*	*	*	*	*
Rotational speed (RPM)	3600	3600	3600	3600	3600
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Average positioning time (msec)	18	18	18	18	18
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	26.3	26.3	26.3	26.3	26.3
Data transfer rate (KBytes/sec)	1250	1250	1250	1250	1250
FIRST CUSTOMER SHIPMENT	11/86	11/86	11/86	11/86	11/86
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	$2,195 (1000)
COMMENTS	SCSI version is Model 1574 *not announced	SCSI version is Model 1575 *not announced	SCSI version is Model 1576 *not announced	SCSI version is Model 1577 *not announced	SCSI version is Model 1578 *not announced

MANUFACTURER	MICROSCIENCE INTERNATIONAL	MICROSCIENCE INTERNATIONAL	MICROSCIENCE INTERNATIONAL	MICROSCIENCE INTERNATIONAL	MICROSCIENCE INTERNATIONAL
DRIVE	Easycard	HH-312	HH-325	HH-612	HH-725
DISK/TREND GROUP	5	5	5	5	5
MARKET	OEM, PCM	OEM	OEM	OEM	OEM
MEDIA: Generic type	Drive On Card	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	95 mm OD 25 mm ID	95 mm OD 25 mm ID	95 mm OD 25 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID
Recording medium	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
DRIVE: Technology type	3370 (Ferrite)	Modified 3370	3370 (Ferrite)	Modified 3350	Modified 3350
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	IBM PC	ST412	ST412	ST412	ST412
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	F: 20.0	U: 12.76	U: 25.52	U: 12.76	U: 25.52
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 8,192	U: 10,416	U: 10,416	U: 10,416	U: 10,416
Data surfaces per spindle	4	4	4	2	4
Heads per data surface	1	1	1	2	2
Tracks per surface	612	306	612	612	612
Track density (TPI)	855	648	855	648	648
Maximum linear density (BPI)	13014	11000	13014	9680	9680
Rotational speed (RPM)	3550	3550	3550	3550	3550
PERFORMANCE					
Actuator type	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor
Average positioning time (msec)	80 (including settling)	70 (including settling)	80 (including settling)	70 (including settling)	80 (including settling)
Average rotational delay (msec)	8.45	8.45	8.45	8.45	8.45
Average access time (msec)	88.45	78.45	88.45	78.45	88.45
Data transfer rate (KBytes/sec)	625	625	625	625	625
FIRST CUSTOMER SHIPMENT	12/85	4Q84	3/85	9/83	6/84
U.S. OEM PRICE FOR 100 UNITS	$445 (2500)	$260 (2500)	$275 (2500)	$220 (2500)	$245 (2500)
COMMENTS	Embedded Servo	41 mm High Embedded Servo	41 mm High Embedded Servo	41 mm High Embedded Servo	41 mm High Embedded Servo

MANUFACTURER	MICROSCIENCE INTERNATIONAL	MILTOPE	MILTOPE	MILTOPE	MILTOPE
DRIVE	HH-1050	RDS-1500	RDS-8600	RDS-4000	RDS-5000
DISK/TREND GROUP	6	2	2	6	6
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	Fixed	Special	Special	Special	Special
Nominal disk diameter	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	95 mm OD 25 mm ID	130 mm OD 40 mm ID
Recording medium	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
DRIVE: Technology type	3370 (Ferrite)	Modified 3350	3370 (Ferrite)	3370 (Ferrite)	3370 (Ferrite)
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	ST412	ST412/SCSI	ST412/SCSI	ST412, SCSI	SCSI
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 51.04	--	--	--	--
REMOVABLE	--	F: 18.5	F: 76.0	F: 38.2	F: 47.0
Capacity per track (Bytes)	U: 10,416	F: 9,216	F: 9,216	F: 9,216	F: 9,216
Data surfaces per spindle	5	3	8	5	5
Heads per data surface	1	1	1	1	1
Tracks per surface	1024	670	1031	829	1024
Track density (TPI)	960	680	1000	1186	1000
Maximum linear density (BPI)	10020	9890	9824	11240	9824
Rotational speed (RPM)	3600	3600	3600	3600	3600
PERFORMANCE					
Actuator type	Linear, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Average positioning time (msec)	28	40	40	35	40
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	36.3	48.3	48.3	43.3	48.3
Data transfer rate (KBytes/sec)	625	625	625	625	625
FIRST CUSTOMER SHIPMENT	1/86	5/84	2Q86	1986	2Q86
U.S. OEM PRICE FOR 100 UNITS	$675 (2500)	--	--	--	--
COMMENTS	41 mm High Embedded Servo	Sold as militarized subsystem	Sold as militarized subsystem	Sold as militarized subsystem	Sold as militarized subsystem

MANUFACTURER	MILTOPE	MINISCRIBE	MINISCRIBE	MINISCRIBE	MINISCRIBE
DRIVE	RDS-1720	3212	3425	8212	8425
DISK/TREND GROUP	7	5	5	5	5
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	Special	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	95 mm OD 25 mm ID	95 mm OD 25 mm ID
Recording medium	Thin Film	High Dens.Oxide	High Dens.Oxide	Thin Film	Thin Film
DRIVE: Technology type	3370 (Ferrite)	Modified 3350	Modified 3350	3370 (Ferrite)	3370 (Ferrite)
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	ESDI	ST412	ST412	ST412	ST412
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	--	U: 12.75	U: 25.6	U: 12.8	U: 25.6
REMOVABLE	F: 160.8	--	--	--	--
Capacity per track (Bytes)	F: 19,456	U: 10,416	U: 10,416	U: 10,416	U: 10,416
Data surfaces per spindle	8	2	4	2	4
Heads per data surface	1	1	1	1	1
Tracks per surface	1033	612	615	615	615
Track density (TPI)	1000	588	588	804	804
Maximum linear density (BPI)	20000*	10030	10030	13412	13412
Rotational speed (RPM)	3600	3600	3600	3600	3600
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rack & Pinion, Stepping Motor	Rack & Pinion, Stepping Motor	Rack & Pinion Stepping Motor	Rack & Pinion Stepping Motor
Average positioning time (msec)	40	85 (including settling)	85 (including settling)	68 (including settling)	68 (including settling)
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	48.3	93.3	93.3	76.3	76.3
Data transfer rate (KBytes/sec)	1250	625	625	625	625
FIRST CUSTOMER SHIPMENT	3Q86	1Q84	8/84	3Q84	3Q84
U.S. OEM PRICE FOR 100 UNITS	--	$225 (2500)	$275 (2500)	$240 (2500)	$300 (2500)
COMMENTS	Sold as militarized subsystem *2,7 RLL Code	41 mm High	41 mm High	41 mm High	41 mm High SCSI version is Model 8425S

MANUFACTURER	MINISCRIBE	MINISCRIBE	MINISCRIBE	MINISCRIBE	MINISCRIBE
DRIVE	8425S	6032	6053	6085	6085E
DISK/TREND GROUP	5	6	6	6	6
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	95 mm OD 25 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID
Recording medium	Hi Dens Oxide	Hi Dens Oxide	Hi Dens Oxide	Hi Dens Oxide	Thin Film
DRIVE: Technology type	3370 (Ferrite)	3370 (Ferrite)	3370 (Ferrite)	3370 (Ferrite)	3370 (Ferrite)
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	SCSI	ST412	ST412	ST412	ESDI
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	F: 21.3	U: 32.0	U: 53.3	U: 85.3	U: 85.3
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 8,704	U: 10,416	U: 10,416	U: 10,416	U: 20,832
Data surfaces per spindle	4	3	5	8	4
Heads per data surface	1	1	1	1	1
Tracks per surface	612	1024	1024	1024	1024
Track density (TPI)	804	1000	1000	1000	1040
Maximum linear density (BPI)	13412	9950	9950	9950	20066*
Rotational speed (RPM)	3600	3600	3600	3600	3600
PERFORMANCE					
Actuator type	Rack & Pinion Stepping Motor	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil
Average positioning time (msec)	68 (including settling)	28	28	28	23
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	76.3	36.3	36.3	36.3	31.3
Data transfer rate (KBytes/sec)	625	625	625	625	1250
FIRST CUSTOMER SHIPMENT	3Q86	4Q84	4Q84	4Q84	3Q86
U.S. OEM PRICE FOR 100 UNITS	$375 (2500)	$600 (1000)	$700 (1000)	$900 (1000)	$1,000 (1000)
COMMENTS	41 mm High				*2,7 RLL Code

MANUFACTURER	MINISCRIBE	MINISCRIBE	MITSUBISHI ELECTRIC CORPORATION	MITSUBISHI ELECTRIC CORPORATION	MITSUBISHI ELECTRIC CORPORATION
DRIVE	6128E	6170E	MR321	MR322	MR521
DISK/TREND GROUP	7	7	5	5	5
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	130 mm OD 40 mm ID	130 mm OD 40 mm ID	95 mm OD 25 mm ID	95 mm OD 25 mm ID	130 mm OD 40 mm ID
Recording medium	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film/Oxide
DRIVE: Technology type	3370 (Ferrite)	3370 (Ferrite)	3370 (Ferrite)	3370 (Ferrite)	Modified 3350
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	ESDI	ESDI	ST412	ST412	ST412
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 128.0	U: 170.6	U: 12.75	U: 25.5	U: 12.75
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 20,832	U: 20,832	U: 10,416	U: 10,416	U: 10,416
Data surfaces per spindle	6	8	2	4	2
Heads per data surface	1	1	1	1	1
Tracks per surface	1024	1024	615	615	612
Track density (TPI)	1040	1040	821	821	690
Maximum linear density (BPI)	20066*	20066*	13840	13840	9201
Rotational speed (RPM)	3600	3600	3600	3600	3536
PERFORMANCE					
Actuator type	Linear, Voice Coil	Linear, Voice Coil	Rotary, Band, Stepping Motor	Rotary, Band, Stepping Motor	Band, Stepping Motor
Average positioning time (msec)	23	23	70 (including settling)	70 (including settling)	85 (including settling)
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.48
Average access time (msec)	31.3	31.3	78.3	78.3	93.48
Data transfer rate (KBytes/sec)	1250	1250	625	625	625
FIRST CUSTOMER SHIPMENT	3Q86	3Q86	2Q86	2Q86	4/84
U.S. OEM PRICE FOR 100 UNITS	$1,150 (1000)	$1,300 (1000)	--	--	--
COMMENTS	*2,7 RLL Code	*2,7 RLL Code	41 mm High	41 mm High	41 mm High

MANUFACTURER	MITSUBISHI ELECTRIC CORPORATION	MITSUBISHI ELECTRIC CORPORATION	MITSUBISHI ELECTRIC CORPORATION	MITSUBISHI ELECTRIC CORPORATION	MITSUBISHI ELECTRIC CORPORATION
DRIVE	MR522	MR533	MR535	M4870F	MR5310
DISK/TREND GROUP	5	6	6	7	7
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	210 mm OD 100 mm ID	130 mm OD 40 mm ID
Recording medium	Thin Film/Oxide	Oxide Coated	Oxide Coated	Oxide Coated	Thin Film
DRIVE: Technology type	Modified 3350	3370 (Ferrite)	3370 (Ferrite)	Modified 3350	3370 (Ferrite)
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	ST412	ST412	ST412, SCSI	SMD	SCSI/EDSI
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 25.5	U: 30.33	U: 50.55	U: 251.4	U: 101.1
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 10,416	U: 10,416	U: 10,416	U: 20,480	U: 20,832
Data surfaces per spindle	4	3	5	12	5
Heads per data surface	1	1	1	1	1
Tracks per surface	612	971	971	1023	971
Track density (TPI)	690	1028	1028	1000	1028
Maximum linear density (BPI)	9201	9358	9358	10000	18716*
Rotational speed (RPM)	3536	3600	3600	3544	3600
PERFORMANCE					
Actuator type	Band, Stepping Motor	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Average positioning time (msec)	85 (including settling)	30	30	20	30
Average rotational delay (msec)	8.48	8.3	8.3	8.47	8.3
Average access time (msec)	93.48	38.3	38.3	28.47	38.3
Data transfer rate (KBytes/sec)	625	625	625	1209	1250
FIRST CUSTOMER SHIPMENT	6/84	3Q86	3Q86	4/84	4Q86
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	--
COMMENTS	41 mm High	41 mm High	41 mm High		53 mm High *2,7 RLL Code

MANUFACTURER	MITSUBISHI ELECTRIC CORPORATION	NEC	NEC	NEC	NEC
DRIVE	MR4875	N7745	D3126	D5124	D5126
DISK/TREND GROUP	8	4	5	5	5
MARKET	OEM	Captive	OEM, Captive	OEM, Captive	OEM
MEDIA: Generic type	Fixed	3336-11	Fixed	Fixed	Fixed
Nominal disk diameter	210 mm OD 100 mm ID	14"	95 mm OD 25 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID
Recording medium	Oxide Coated	Oxide Coated	Thin Film	Oxide Coated	Oxide Coated
DRIVE: Technology type	3370	3330-11	Modified 3350	Modified 3350	Modified 3350
Heads	Thin Film	Ferrite	Ferrite	Ferrite	Ferrite
Interface	Modified SMD	NEC	ST412	ST412	ST412
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 408.5	--	U: 25.62	U: 12.91	U: 25.49
REMOVABLE	--	F: 200	--	--	--
Capacity per track (Bytes)	U: 30,720	F: 13,030	U: 10,416	U: 10,416	U: 10,416
Data surfaces per spindle	13	19	4	4	4
Heads per data surface	1	1	1	1	1
Tracks per surface	1023	815	615	310	615
Track density (TPI)	1000	370	750	350	700
Maximum linear density (BPI)	14100	4040	15000	9000	9000
Rotational speed (RPM)	3544	3600	3564	3600	3600
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Linear, Voice Coil	Linear, Band, Stepping Motor	Band, Stepping Motor	Linear, Band, Stepping Motor
Average positioning time (msec)	20	30	85 (including settling)	85 (including settling)	85 (including settling)
Average rotational delay (msec)	8.47	8.3	8.4	8.3	8.3
Average access time (msec)	28.47	38.3	93.4	93.3	93.3
Data transfer rate (KBytes/sec)	1814	806	625	625	625
FIRST CUSTOMER SHIPMENT	3Q85	11/75	7/85	3/84	10/84
U.S. OEM PRICE FOR 100 UNITS	--	--	$387 (1000)	$350 (1000)	$430 (1000)
COMMENTS				41 mm High	41 mm High

MANUFACTURER	NEC	NEC	NEC	NEC	NEC
DRIVE	D5126H	D2246 N7726	D2247	D5146	D5146H
DISK/TREND GROUP	5	6	6	6	6
MARKET	OEM	OEM, Captive	OEM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	130 mm OD 40 mm ID	210 mm OD 100 mm ID	210 mm OD 100 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	Modified 3350	Modified 3350	Modified 3350	Modified 3350	Modified 3350
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	ST412	SMD	SMD	ST412	ST412
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 25.49	U: 85.0	U: 82.9	U: 51.24	U: 51.24
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 10,416	U: 20,480	U: 20,160	U: 10,416	U: 10,416
Data surfaces per spindle	4	6	5	8	8
Heads per data surface	1	1	1	1	1
Tracks per surface	615	692	823	615	615
Track density (TPI)	700	720	960	700	700
Maximum linear density (BPI)	9000	9040	8670	9000	9000
Rotational speed (RPM)	3600	3510	3600	3600	3600
PERFORMANCE					
Actuator type	Linear, Band, Stepping Motor	Rotary, Voice Coil	Rotary, Voice Coil	Linear, Band, Stepping Motor	Linear, Band, Stepping Motor
Average positioning time (msec)	40	25	18.5	85 (including settling)	40
Average rotational delay (msec)	8.3	8.55	8.3	8.3	8.3
Average access time (msec)	48.3	33.55	26.8	93.3	48.3
Data transfer rate (KBytes/sec)	625	1198	1209	625	625
FIRST CUSTOMER SHIPMENT	4/86	5/82	5/83	6/85	4/86
U.S. OEM PRICE FOR 100 UNITS	--	$2,510	$2,730	--	$717 (1000)
COMMENTS	41 mm High			41 mm High	41 mm High

MANUFACTURER	NEC	NEC	NEC	NEC	NEC
DRIVE	D5452	D2257 N7729	D5652	D2268	D2268H
DISK/TREND GROUP	6	7	7	8	8
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	130 mm OD 40 mm ID	210 mm OD 100 mm ID	130 mm OD 40 mm ID	210 mm OD 100 mm ID	210 mm OD 100 mm ID
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	Modified 3350	Modified 3350	Modified 3350	Modified 3350	Modified 3350
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	ST412	SMD	ESDI	SMD	Modified SMD
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 85.72	U: 167.7	U: 172.76	U: 337.1	U: 337.1
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 10,416	U: 20,480	U: 20,992	U: 40,960	U: 40,960
Data surfaces per spindle	10	8	10	10	10
Heads per data surface	1	1	1	1	1
Tracks per surface	823	1024	823	823	823
Track density (TPI)	926	720	926	780	780
Maximum linear density (BPI)	9307	9420	18758*	18900*	18900*
Rotational speed (RPM)	3600	3510	3573	2720	3600
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Average positioning time (msec)	28	20	28	20	20
Average rotational delay (msec)	8.3	8.55	8.4	11	8.3
Average access time (msec)	36.3	28.55	36.4	31	28.3
Data transfer rate (KBytes/sec)	625	1198	1250	1859	2460
FIRST CUSTOMER SHIPMENT	4/86	5/83	2/86	6/85	11/85
U.S. OEM PRICE FOR 100 UNITS	--	$3,087	$1,825 (1000)	$4,326	$4,405
COMMENTS		N7729 has two spindles per drive	*2,7 RLL Code	*2,7 RLL Code	*2,7 RLL Code

MANUFACTURER	NEC	NEC	NEC	NEC	NEC
DRIVE	D2332 N7737	D2352 N7738	D2352H	D2362	N7755
DISK/TREND GROUP	8	9	9	9	9
MARKET	OEM	OEM	OEM	OEM	Captive
MEDIA: Generic type	Fixed	Captive, OEM	Fixed	Fixed	Fixed
Nominal disk diameter	230 mm OD 100 mm ID	230 mm OD 100 mm ID	230 mm OD 100 mm ID	230 mm OD 100 mm ID	14"
Recording medium	Thin Film	Thin Film	Thin Film	Thin Film	Oxide Coated
DRIVE: Technology type	Modified 3350	Modified 3350	Modified 3350	Modified 3350	Modified 3350
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	SMD	Modified SMD	Mod.SMD, IPI-2	Mod.SMD, IPI-2	NEC
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 337.1	U: 520	U: 520	U: 800	F: 635.0
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 20,480	U: 36,288	U: 36,288	U: 40,960	F: 19,069
Data surfaces per spindle	10	9.5	9.5	11.5	15
Heads per data surface	2	2/1	2/1	2/1	2
Tracks per surface	1646	1520	1520	1700	2244
Track density (TPI)	1080	1020	1020	1070	960
Maximum linear density (BPI)	10500	18600*	18600*	21400*	6400
Rotational speed (RPM)	3544	3070	3600	3600	3600
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Linear, Voice Coil
Average positioning time (msec)	15	15	15	15	20
Average rotational delay (msec)	8.47	9.8	8.3	8.3	8.3
Average access time (msec)	23.47	24.8	23.3	23.3	28.3
Data transfer rate (KBytes/sec)	1209	1859	2180	2460	1198
FIRST CUSTOMER SHIPMENT	6/85	1/85	11/85	2/86	1979
U.S. OEM PRICE FOR 100 UNITS	--	$7,890	$8,058	--	--
COMMENTS		*2,7 RLL Code	*2,7 RLL Code	*2,7 RLL Code	Drive has two spindles

MANUFACTURER	NEC	NEC	NEC	NEWBURY DATA	NEWBURY DATA
DRIVE	N7756	N7761	N7765	NDR 505	NDR 340 Penny
DISK/TREND GROUP	9	9	9	1	6
MARKET	Captive	Captive	Captive	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	5.25" Cartridge	Fixed
Nominal disk diameter	230 mm OD 100 mm ID	14"	14"	130 mm OD 40 mm ID	95 mm OD 25 mm ID
Recording medium	Thin Film	Oxide Coated	Oxide Coated	Oxide Coated	Thin Film
DRIVE: Technology type	Modified 3350	3380	3380	Modified 3350	3370 (Ferrite)
Heads	Ferrite	Thin Film	Thin Film	Ferrite	Ferrite
Interface	NEC	NEC	NEC	Modified SA 1000	ST412
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	F: 486.2	F: 672.2	F: 1344.9	U: 6.4	U: 51.2
REMOVABLE	--	--	--	U: 6.4	--
Capacity per track (Bytes)	F: 32,288	F: 47,476	F: 47,476	U: 10,032	U: 10,416
Data surfaces per spindle	9.5	5	6	4	8
Heads per data surface	2/1	2	2	1	1
Tracks per surface	1520	1770	2982	320	615
Track density (TPI)	1000	800	1200	454	980
Maximum linear density (BPI)	18600*	15300*	16100*	8738	12673
Rotational speed (RPM)	3070	3620	3620	3443	3600
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil
Average positioning time (msec)	15	16	17	40	40
Average rotational delay (msec)	9.8	8.3	8.3	8.7	8.3
Average access time (msec)	24.8	24.3	25.3	48.7	48.3
Data transfer rate (KBytes/sec)	1860	3000	3000	625	625
FIRST CUSTOMER SHIPMENT	3Q84	1983	9/86	3Q83	1Q86
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	--
COMMENTS	*2,7 RLL Code Drive has two spindles	*2,7 RLL Code 4 spindles per drive	*2,7 RLL Code 4 spindles per drive	Embedded servo Licensed from DMA Systems	41 mm High

MANUFACTURER	NEWBURY DATA	NEWBURY DATA	NEWBURY DATA	NEWBURY DATA	NEWBURY DATA
DRIVE	NDR 1065	NDR 1085	NDR 1105	NDR 1140	NDR 2190
DISK/TREND GROUP	6	6	7	7	7
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	130 mm OD	130 mm OD	130 mm OD	130 mm OD	130 mm OD
Recording medium	40 mm ID Thin Film	40 mm ID Thin Film	40 mm ID Thin Film	40 mm ID Thin Film	40 mm ID Thin Film
DRIVE: Technology type	3370 (Ferrite)	3370 (Ferrite)	3370 (Ferrite)	3370 (Ferrite)	3370 (Ferrite)
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	ST412	ST412	ST412	ST412	ST412
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 66.93	U: 85.33	U: 105.18	U: 143.43	U: 191.24
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 10,416	U: 10,416	U: 10,416	U: 10,416	U: 10,416
Data surfaces per spindle	7	8	11	15	15
Heads per data surface	1	1	1	1	1
Tracks per surface	918	1024	918	918	1224
Track density (TPI)	995	980	995	995	1070
Maximum linear density (BPI)	9280	9934	9280	9280	11155
Rotational speed (RPM)	3600	3600	3600	3600	3600
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Average positioning time (msec)	25	26	25	25	28
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	33.3	34.3	33.3	33.3	36.3
Data transfer rate (KBytes/sec)	625	625	625	625	625
FIRST CUSTOMER SHIPMENT	4Q84	1Q86	4Q84	4Q84	4Q85
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	--
COMMENTS	Licensed from Maxtor	Licensed from Maxtor	Licensed from Maxtor	Licensed from Maxtor	Licensed from Maxtor

MANUFACTURER	NEWBURY DATA	NEWBURY DATA	NIPPON ELECTRIC INDUSTRY	NIPPON ELECTRIC INDUSTRY	NIPPON ELECTRIC INDUSTRY
DRIVE	NDR 4175	NDR 4380	RD-3127	RD-3255	RD-4127
DISK/TREND GROUP	7	8	5	5	5
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID
Recording medium	Thin Film	Thin Film	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	3370	3370	3370 (Ferrite)	3370 (Ferrite)	Modified 3350
Heads	Thin Film	Thin Film	Ferrite	Ferrite	Ferrite
Interface	ESDI	ESDI	ST 412	ST 412	ST 412
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 178.28	U: 382.03	U: 12.7	U: 25.5	U: 12.7
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 20,832	U: 20,832	U: 10,416	U: 10,416	U: 10,416
Data surfaces per spindle	7	15	2	4	4
Heads per data surface	1	1	1	1	1
Tracks per surface	1224	1224	612	612	306
Track density (TPI)	1070	1070	706	706	400
Maximum linear density (BPI)	22310 BPI* 14873 FCI	22310 BPI* 14873 FCI	9000	9000	8500
Rotational speed (RPM)	3600	3600	3545	3545	3600
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor
Average positioning time (msec)	28	28	85 (including settling)	85 (including settling)	85 (including settling)
Average rotational delay (msec)	8.3	8.3	8.46	8.46	8.3
Average access time (msec)	36.3	36.3	93.46	93.46	93.3
Data transfer rate (KBytes/sec)	1250	1250	625	625	625
FIRST CUSTOMER SHIPMENT	4Q86	4Q86	1Q85	1Q85	7/83
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	--
COMMENTS	*2,7 RLL Code	*2,7 RLL Code	41 mm High	41 mm High	

MANUFACTURER	NIPPON ELECTRIC INDUSTRY	NIPPON ELECTRIC INDUSTRY	NIPPON PERIPHERALS LTD	NIPPON PERIPHERALS LTD	NIPPON PERIPHERALS LTD
DRIVE	RD-4191	RD-4255	NP02-13	NP02-26A	NP02-26S
DISK/TREND GROUP	5	5	5	5	5
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	Modified 3350	Modified 3350	Modified 3350	3370 (Ferrite)	Modified 3350
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	ST412	ST 412	ST412	ST412	ST412
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 19.1	U: 25.5	U: 13.33	U: 26.66	U: 26.6
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 10,416	U: 10,416	U: 10,416	U: 10,416	U: 10,416
Data surfaces per spindle	6	8	4	4	4
Heads per data surface	1	1	1	1	1
Tracks per surface	306	306	320	640	640
Track density (TPI)	400	400	298	617	596
Maximum linear density (BPI)	8500	8500	10200	10200	10200
Rotational speed (RPM)	3600	3600	3600	3600	3543
PERFORMANCE					
Actuator type	Band, Stepping Motor	Band, Stepping Motor	Rotary, Stepping Motor	Rotary, Torque Motor	Rotary, Stepping Motor
Average positioning time (msec)	85 (including settling)	85 (including settling)	95 (including settling)	40	95 (including settling)
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.5
Average access time (msec)	93.3	93.3	103.3	48.3	103.5
Data transfer rate (KBytes/sec)	625	625	625	625	625
FIRST CUSTOMER SHIPMENT	7/83	7/83	8/83	4Q86	2/85
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	--
COMMENTS			41 mm High	41 mm High	41 mm High

MANUFACTURER	NIPPON PERIPHERALS LTD	NIPPON PERIPHERALS LTD	NIPPON PERIPHERALS LTD	NIPPON PERIPHERALS LTD	NIPPON PERIPHERALS LTD
DRIVE	NP03-13	NP03-20	NP04-26F	NP02-52A	NP03-38
DISK/TREND GROUP	5	5	5	6	6
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	95 mm OD 25 mm ID	95 mm OD 25 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	95 mm OD 25 mm ID
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	Modified 3350	Modified 3350	Modified 3350	3370 (Ferrite)	3370 (Ferrite)
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	ST412	ST412	ST412	ST412	ST412/SASI
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 12.7	U: 19.1	U: 26.66	U: 53.22	U: 38.25
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 10,416	U: 10,416	U: 10,416	U: 10,416	U: 10,416
Data surfaces per spindle	4	6	8	8	6
Heads per data surface	1	1	1	1	1
Tracks per surface	306	306	320	640	612
Track density (TPI)	450	450	298	617	900
Maximum linear density (BPI)	12500	12500	10200	10200	12500
Rotational speed (RPM)	3600	3600	3600	3600	3600
PERFORMANCE					
Actuator type	Band, Stepping Motor	Band, Stepping Motor	Rotary, Stepping Motor	Rotary, Torque Motor	Band, Stepping Motor
Average positioning time (msec)	85 (including settling)	85 (including settling)	95 (including settling)	40	85
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	93.3	93.3	103.3	48.3	93.3
Data transfer rate (KBytes/sec)	625	625	625	625	625
FIRST CUSTOMER SHIPMENT	2/85	2/85	5/83	4Q86	3Q86
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	--
COMMENTS				41 mm High	41 mm High

MANUFACTURER	NIPPON PERIPHERALS LTD	NIPPON PERIPHERALS LTD	NIPPON PERIPHERALS LTD	NIPPON PERIPHERALS LTD	NIPPON PERIPHERALS LTD
DRIVE	NP04-36	NP04-50	NP04-85	NP37-A02 NP37-B02 NP37-C02	NP75-A01 NP75-B01 NP75-C01
DISK/TREND GROUP	6	6	6	9	9
MARKET	OEM	OEM	OEM	OEM, PCM	PCM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	14"	14"
Recording medium	Thin Film	Thin Film	Thin Film	Oxide Coated	Oxide Coated
DRIVE: Technology type	Modified 3350	Modified 3350	Modified 3350	3370 (Ferrite)	3370 (Ferrite)
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	ST412	ST412	ST412	IBM	IBM
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 36.4	U: 50.9	U: 86.3	F: 729.858	F: 819.7
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 10,416	U: 10,416	U: 10,416	F: 31,744	F: 35,616
Data surfaces per spindle	5	7	11	12	12
Heads per data surface	1	1	1	2	2
Tracks per surface	699	699	754	1916	1918
Track density (TPI)	754	793	831	810	810
Maximum linear density (BPI)	9375	9600	9600	12128*	12128*
Rotational speed (RPM)	3600	3600	3600	2964	2964
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Dual, Linear, Voice Coil	Dual, Linear Voice Coil
Average positioning time (msec)	45	45	35	19	19
Average rotational delay (msec)	8.3	8.3	8.3	10.12	10.12
Average access time (msec)	53.3	53.3	43.3	29.12	29.12
Data transfer rate (KBytes/sec)	625	625	625	1859	1859
FIRST CUSTOMER SHIPMENT	11/83	11/83	4/85	8/84	9/84
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	--
COMMENTS				*2,7 RLL Code	*2,7 RLL Code PCM 3375

MANUFACTURER	NIPPON SYSTEMHOUSE	NIPPON SYSTEMHOUSE	NIPPON SYSTEMHOUSE	NORTHERN TELECOM	NORTHERN TELECOM
DRIVE	SQ306RD	SQ325F	SQ338F	8204X	8208X
DISK/TREND GROUP	1	5	6	6	7
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	3.9" Cartridge	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	100 mm OD 40 mm ID	100 mm OD 40 mm ID	100 mm OD 40 mm ID	200 mm OD 63.5 mm ID	200 mm OD 63.5 mm ID
Recording medium	Thin Film	Thin Film	Thin Film	Oxide Coated	Oxide Coated
DRIVE: Technology type	Modified 3350	Modified 3350	Modified 3350	3370 (Ferrite)	3370 (Ferrite)
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	ST 412	ST 412	ST 412	SMD, SCSI	SMD, SCSI
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	--	U: 25.5	U: 38.2	U: 93.7	SCSI: 142.0 U: 187.3
REMOVABLE	U: 6.38	--	--	-	--
Capacity per track (Bytes)	U: 10,416	U: 10,416	U: 10,416	U: 21,912	U: 21,912
Data surfaces per spindle	2	4	6	4	8
Heads per data surface	1	1	1	1	1
Tracks per surface	306	612	612	1069	1069
Track density (TPI)	435	764	764	1039	1039
Maximum linear density (BPI)	12186	12223	12223	10238	10238
Rotational speed (RPM)	3547	3547	3547	3313.5	3313.5
PERFORMANCE					
Actuator type	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Rotary, Torque Motor	Rotary, Torque Motor
Average positioning time (msec)	90 (including settling)	90 (including settling)	90 (including settling)	19.5 (256 Byte sector)	19.5(256 Byte sector)
Average rotational delay (msec)	8.46	8.46	8.46	9.0	9.0
Average access time (msec)	98.46	98.46	98.46	28.5	28.5
Data transfer rate (KBytes/sec)	625	625	625	1209	1209
FIRST CUSTOMER SHIPMENT	10/84	5/85	5/85	9/83	9/83
U.S. OEM PRICE FOR 100 UNITS	--	--	--	$2,000	$3,280
COMMENTS	41 mm High 4.8" Wide Licensed by Syquest Technology. Embedded Servo	41 mm High 4.8" Wide Licensed by Syquest Technology. Embedded Servo	41 mm High 4.8" Wide Licensed by Syquest Technology. Embedded Servo	Embedded Servo	Embedded Servo

MANUFACTURER	NORTHERN TELECOM	NORTHERN TELECOM	NORTHERN TELECOM	NORTHERN TELECOM	OLIVETTI PERIPHERAL EQUIPMENT
DRIVE	8210X	8212X	8310	8312	HD 352
DISK/TREND GROUP	7	8	8	9	5
MARKET	OEM	OEM	OEM	OEM	Captive, OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	200 mm OD 63.5 mm ID	200 mm OD 63.5 mm ID	200 mm OD 63.5 mm ID	200 mm OD 63.5 mm ID	95 mm OD 25 mm ID
Recording medium	Oxide Coated	Oxide Coated	Thin Film	Thin Film	Oxide Coated
DRIVE: Technology type	3370 (Ferrite)	3370 (Ferrite)	3370	3370	3370 (Ferrite)
Heads	Ferrite	Ferrite	Thin Film	Thin Film	Ferrite
Interface	SMD, SCSI	SMD, SCSI	H/P-SMD	H/P-SMD, SCSI	ST412
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	SCSI: 177.5 U: 234.2	SCSI: 265.6 U: 350.2	U: 378.6	SCSI: 503.5 U: 563.0	U: 25.5
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 21,912	U: 21,912	U: 34,300	U: 34,300	U: 10,417
Data surfaces per spindle	10	12	10	12	4
Heads per data surface	1	1	1	1	1
Tracks per surface	1069	1332	1104	1368	612
Track density (TPI)	1039	1203	1069	1236	800
Maximum linear density (BPI)	10238	10238	16200 BPI* 10800 FCI	16200 BPI* 10800 FCI	13370
Rotational speed (RPM)	3313.5	3313.5	3313.5	3313.5	3573
PERFORMANCE					
Actuator type	Rotary, Torque Motor	Rotary, Torque Motor	Rotary, Torque Motor	Rotary, Torque Motor	Rotary, Stepping Motor
Average positioning time (msec)	19.5(256 Byte sector)	21 (256 Byte sector)	20 (256 Byte sector)	21	85
Average rotational delay (msec)	9.0	9.0	9.0	9	8.39
Average access time (msec)	28.5	30.0	29.0	30	93.39
Data transfer rate (KBytes/sec)	1209	1209	1895	1895	625
FIRST CUSTOMER SHIPMENT	9/83	6/85	6/85	12/85	2/86
U.S. OEM PRICE FOR 100 UNITS	$3,450	$3,950	$4,100	$5,895	--
COMMENTS	Embedded Servo	Embedded Servo	*2,7 RLL Code Embedded Servo	*2,7 RLL Code Embedded Servo	41 mm High

MANUFACTURER	OLIVETTI PERIPHERAL EQUIPMENT	OLIVETTI PERIPHERAL EQUIPMENT	OLIVETTI PERIPHERAL EQUIPMENT	OLIVETTI PERIPHERAL EQUIPMENT	OLIVETTI PERIPHERAL EQUIPMENT
DRIVE	HD 362	HD 661/12	HD 662/11	HD 662/12	HD 670/12
DISK/TREND GROUP	5	5	5	5	5
MARKET	Captive, OEM	OEM, Captive	OEM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	95 mm OD 25 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	3370 (Ferrite)	3350	Modified 3350	Modified 3350	Modified 3350
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	IBM PC	ST412	ST412	ST412	ST412
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	F: 21.3	U: 12.75	U: 12.75	U: 25.52	U: 25.52
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 8,704	U: 10,417	U: 10,417	U: 10,417	U: 10,417
Data surfaces per spindle	4	4	2	4	4
Heads per data surface	1	1	1	1	1
Tracks per surface	612	306	612	612	612
Track density (TPI)	800	345	690	690	690
Maximum linear density (BPI)	13370	8952	8952	8952	8952
Rotational speed (RPM)	3573	3600	3573	3573	3573
PERFORMANCE					
Actuator type	Rotary, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor
Average positioning time (msec)	85	85 (including settling)	85 (including settling)	85 (including settling)	40 (including settling)
Average rotational delay (msec)	8.39	8.3	8.39	8.39	8.39
Average access time (msec)	93.39	93.3	93.39	93.39	48.39
Data transfer rate (KBytes/sec)	625	625	625	625	625
FIRST CUSTOMER SHIPMENT	4/86	2Q84	2Q85	2Q85	3Q85
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	--
COMMENTS	41 mm High	41 mm High	41 mm High	41 mm High	41 mm High

MANUFACTURER	OLIVETTI PERIPHERAL EQUIPMENT	OLIVETTI PERIPHERAL EQUIPMENT	OTARI ELECTRIC CO., LTD.	OTARI ELECTRIC CO., LTD.	OTARI ELECTRIC CO., LTD.
DRIVE	HDC 372	HD 674	C-214	C-226	C-507
DISK/TREND GROUP	5	6	5	5	5
MARKET	PCM, OEM	Captive, OEM	OEM	OEM	OEM
MEDIA: Generic type	Drive On Card	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	95 mm OD 25 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID
Recording medium	Oxide Coated	Oxide Coated	Thin Film	Thin Film	Oxide Coated
DRIVE: Technology type	3370 (Ferrite)	3370 (Ferrite)	Modified 3350	Modified 3350	Modified 3350
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	IBM PC	ST412	ST412	ST412	ST412
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	F: 21.3	U: 51.25	U: 12.75	U: 25.5	U: 6.38
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 8,704	U: 10,417	U: 10,416	U: 10,416	U: 10,417
Data surfaces per spindle	4	6	2	4	2
Heads per data surface	1	1	1	1	1
Tracks per surface	612	820	612	612	306
Track density (TPI)	800	765	650	650	383
Maximum linear density (BPI)	13370	9940	10300	10300	8944
Rotational speed (RPM)	3573	3518	3600	3600	3600
PERFORMANCE					
Actuator type	Rotary, Stepping Motor	Band, Linear Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Rotary, Band Stepping Motor
Average positioning time (msec)	85	40	85 (including settling)	85 (including settling)	90 (including settling)
Average rotational delay (msec)	8.39	8.53	8.3	8.3	8.3
Average access time (msec)	93.39	48.53	93.3	93.3	98.3
Data transfer rate (KBytes/sec)	625	625	625	625	625
FIRST CUSTOMER SHIPMENT	5/86	8/86	9/85	9/85	1/83
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	--
COMMENTS	41 mm Thick	41 mm High	41 mm High	41 mm High	Licensed By Disctron

MANUFACTURER	OTARI ELECTRIC CO., LTD.	OTARI ELECTRIC CO., LTD.	OTARI ELECTRIC CO., LTD.	PERIPHERAL TECHNOLOGY	PERIPHERAL TECHNOLOGY
DRIVE	C-514	C-519	C-526	PT-225	PT-238R
DISK/TREND GROUP	5	5	5	5	6
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	130 mm OD	130 mm OD	130 mm OD	95 mm OD	95 mm OD
	40 mm ID	40 mm ID	40 mm ID	25 mm ID	25 mm ID
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Thin Film	Thin Film
DRIVE: Technology type	Modified 3350	Modified 3350	Modified 3350	3370 (Ferrite)	3370 (Ferrite)
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	ST412	ST412	ST412	ST412	ST412
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 12.75	U: 19.13	U: 25.5	U: 25.6	U: 38.4
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 10,417	U: 10,417	U: 10,417	U: 10,404	U: 15,624
Data surfaces per spindle	4	6	8	4	4
Heads per data surface	1	1	1	1	1
Tracks per surface	306	306	306	615	615
Track density (TPI)	383	383	383	983	983
Maximum linear density (BPI)	8944	8944	8944	12218	18327 BPI*
Rotational speed (RPM)	3600	3600	3600	3517	12218 FCI 3517
PERFORMANCE					
Actuator type	Rotary, Band	Rotary, Band	Rotary, Band	Linear,	Linear,
Average positioning time (msec)	Stepping Motor 90 (including settling)	Stepping Motor 90 (including settling)	Stepping Motor 90 (including settling)	DC Motor 40 (including settling)	DC Motor 40 (including settling)
Average rotational delay (msec)	8.3	8.3	8.3	8.5	8.5
Average access time (msec)	98.3	98.3	98.3	48.5	48.5
Data transfer rate (KBytes/sec)	625	625	625	625	937.5
FIRST CUSTOMER SHIPMENT	1/83	1/83	1/83	3Q86	3Q86
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	--
COMMENTS	Licensed By Disctron	Licensed By Disctron	Licensed By Disctron	41 mm High Embedded Servo	41 mm High Embedded Servo *2,7 RLL Code

MANUFACTURER	PERIPHERAL TECHNOLOGY	PERIPHERAL TECHNOLOGY	PERTEC	PERTEC	PERTEC
DRIVE	PT-338	PT-357R	DX199	DX265	DX332
DISK/TREND GROUP	6	6	7	7	8
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	95 mm OD 25 mm ID	95 mm OD 25 mm ID	200 mm OD 63.5 mm ID	200 mm OD 63.5 mm ID	200 mm OD 63.5 mm ID
Recording medium	Thin Film	Thin Film	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	3370 (Ferrite)	3370 (Ferrite)	3370 (Ferrite)	3370 (Ferrite)	3370 (Ferrite)
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	ST412	ST412	SMD,SCSI,ESDI	SMD,SCSI,ESDI	SMD,SCSI,ESDI
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 38.4	U: 57.6	U: 199	U: 265	U: 332
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 10,404	U: 15,624	U: 20,160	U: 20,160	U: 20,160
Data surfaces per spindle	6	6	6	8	10
Heads per data surface	1	1	1	1	1
Tracks per surface	615	615	1649	1649	1649
Track density (TPI)	983	983	1083	1083	1083
Maximum linear density (BPI)	12218	18327 BPI* 12218 FCI	12022*	12022*	12022*
Rotational speed (RPM)	3517	3517	3600	3600	3600
PERFORMANCE					
Actuator type	Linear, DC Motor	Linear, DC Motor	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Average positioning time (msec)	40 (including settling)	40 (including settling)	22	22	22
Average rotational delay (msec)	8.5	8.5	8.3	8.3	8.3
Average access time (msec)	48.5	48.5	30.3	30.3	30.3
Data transfer rate (KBytes/sec)	625	937.5	1208	1208	1208
FIRST CUSTOMER SHIPMENT	3Q86	3Q86	4/85	4/85	4/85
U.S. OEM PRICE FOR 100 UNITS	--	--	$3,900	$4,200	$4,500
COMMENTS	41 mm High Embedded Servo	41 mm High Embedded Servo *2,7 RLL Code	*2,7 RLL Code	*2,7 RLL Code	*2,7 RLL Code

MANUFACTURER	PERTEC	PERTEC	PLUS DEVELOPMENT CORP.	PLUS DEVELOPMENT CORP.	PRIAM
DRIVE	DX368	DX548	Hardcard	Hardcard 20	803
DISK/TREND GROUP	8	9	5	5	6
MARKET	OEM	OEM	PCM, OEM	PCM, OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Drive On Card	Drive On Card	Fixed
Nominal disk diameter	200 mm OD 63.5 mm ID	200 mm OD 63.5 mm ID	95 mm OD 25 mm ID	95 mm OD 25 mm ID	200 mm OD 63.5 mm ID
Recording medium	Oxide Coated	Oxide Coated	Hi Dens Oxide	Hi Dens Oxide	Oxide Coated
DRIVE: Technology type	3370 (Ferrite)	3370 (Ferrite)	3370 (Ferrite)	3370 (Ferrite)	Modified 3350
Heads	Ferrite	Thin Film	Ferrite	Ferrite	Ferrite
Interface	SMD	SMD	IBM PC	IBM PC	Priam, SMD
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 368	U: 548.5	F: 10.5	F: 21.2	U: 85.68
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 30,240	U: 30,240	F: 8,704	F: 8,704	U: 20,160
Data surfaces per spindle	10	11	2	4	5
Heads per data surface	1	1	1	1	1
Tracks per surface	1217	1649	612	615	850
Track density (TPI)	1083	1083	812	812	960
Maximum linear density (BPI)	16000*	18000*	13917 BPI* 9278 FCI	13917 BPI* 9278 FCI	9167
Rotational speed (RPM)	3600	3600	3600	3600	3600
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Torque Motor	Rotary, Torque Motor	Linear, Voice Coil
Average positioning time (msec)	18	20	65 (including settling)	49 (including settling)	35
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	26.3	28.3	73.3	57.3	43.3
Data transfer rate (KBytes/sec)	1815	1815	625	625	1209
FIRST CUSTOMER SHIPMENT	1Q86	2Q86	10/85	6/86	9/83
U.S. OEM PRICE FOR 100 UNITS	$4,850	$6,025	--	--	$2,950
COMMENTS	*2,7 RLL Code	*2,7 RLL Code	*2,7 RLL Code	*2,7 RLL Code	

MANUFACTURER	PRIAM	PRIAM	PRIAM	PRIAM	PRIAM
DRIVE	6650	7050	V130	V150	V170
DISK/TREND GROUP	6	6	6	6	6
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	14"	200 mm OD 63.5 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID,
Recording medium	Oxide Coated	Oxide Coated	Thin Film	Thin Film	Thin Film
DRIVE: Technology type	Modified 3350	Modified 3350	3370 (Ferrite)	3370 (Ferrite)	3370 (Ferrite)
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	Priam, SMD	Priam, SMD	ST412	ST412	ST412
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 67.9	U: 70.49	U: 30.8	U: 51.4	U: 72.0
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 20,160	U: 13,400	U: 10,416	U: 10,416	U: 10,416
Data surfaces per spindle	1.5	5	3	5	7
Heads per data surface	2/1	1	1	1	1
Tracks per surface	2242	1049	987	987	987
Track density (TPI)	960	960	960	960	960
Maximum linear density (BPI)	6430	6597	9897	9897	9897
Rotational speed (RPM)	3100	3600	3600	3600	3600
PERFORMANCE					
Actuator type	Linear, Voice Coil	Linear, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Average positioning time (msec)	46	42	30	30	30
Average rotational delay (msec)	9.7	8.3	8.3	8.3	8.3
Average access time (msec)	55.7	50.3	38.3	38.3	38.3
Data transfer rate (KBytes/sec)	1040	806	625	625	625
FIRST CUSTOMER SHIPMENT	3Q80	4Q81	4Q83	4Q83	4Q83
U.S. OEM PRICE FOR 100 UNITS	$2,660	$2,850	$1,120	$1,255	$1,410
COMMENTS					

MANUFACTURER	PRIAM	PRIAM	PRIAM	PRIAM	PRIAM
DRIVE	V185	15450	514	519	617
DISK/TREND GROUP	6	7	7	7	7
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	130 mm OD 40 mm ID	14"	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID
Recording medium	Thin Film	Oxide Coated	Thin Film	Thin Film	Thin Film
DRIVE: Technology type	3370 (Ferrite)	Modified 3350	3370 (Ferrite)	3370 (Ferrite)	3370 (Ferrite)
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	ST412	Priam, SMD	ST412	ST412	ESDI
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 85.0	U: 158.5	U: 140.2	U: 191.2	U: 178.4
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 10,416	U: 20,160	U: 10,416	U: 10,416	U: 20,832
Data surfaces per spindle	7	3.5	11	15	7
Heads per data surface	1	2/1	1	1	1
Tracks per surface	1166	2242	1224	1224	1224
Track density (TPI)	1047	960	1070	1070	1070
Maximum linear density (BPI)	10526	6430	10924	10924	21848 BPI* 14565 FCI
Rotational speed (RPM)	3600	3100	3600	3600	3600
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil
Average positioning time (msec)	30	46	20	20	20
Average rotational delay (msec)	8.3	9.7	8.3	8.3	8.3
Average access time (msec)	38.3	55.7	28.3	28.3	28.3
Data transfer rate (KBytes/sec)	625	1040	625	625	1250
FIRST CUSTOMER SHIPMENT	3Q84	3Q81	1Q86	1Q86	4Q86
U.S. OEM PRICE FOR 100 UNITS	$1,475	$3,895	$2,270	$2,475	--
COMMENTS					*2,7 RLL Code

MANUFACTURER		PRIAM	PRIAM	PRIAM	PRIAM	PRIAM
DRIVE		628	717	725	728	806
DISK/TREND GROUP		7	7	7	7	7
MARKET		OEM	OEM	OEM	OEM	OEM
MEDIA:	Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
	Nominal disk diameter	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	200 mm OD 63.5 mm ID
	Recording medium	Thin Film	Thin Film	Thin Film	Thin Film	Oxide Coated
DRIVE:	Technology type	3370 (Ferrite)	3370 (Ferrite)	3370 (Ferrite)	3370 (Ferrite)	Modified 3350
	Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
	Interface	ESDI	SCSI	SCSI	SCSI	Priam,SMD,SCSI
CAPACITY/RECORDING DENSITY						
Total capacity (MBytes)	FIXED	U: 280.4	F: 157.6	F: 225.2	F: 247.7	U: 22.7
	REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)		U: 20,832	F: 18,432	F: 12,288	F: 18,432	U: 20,160
Data surfaces per spindle		11	7	15	11	11
Heads per data surface		1	1	1	1	1
Tracks per surface		1224	1225	1225	1225	1023
Track density (TPI)		1070	1070	1070	1070	1040
Maximum linear density (BPI)		21848 BPI* 14565 FCI	21848 BPI* 14565 FCI	14565	21848 BPI* 14565 FCI	9167
Rotational speed (RPM)		3600	3600	3600	3600	3600
PERFORMANCE						
Actuator type		Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil
Average positioning time (msec)		20	20	20	20	20
Average rotational delay (msec)		8.3	8.3	8.3	8.3	8.3
Average access time (msec)		28.3	28.3	28.3	28.3	28.3
Data transfer rate (KBytes/sec)		1250	1250	833	1250	1210
FIRST CUSTOMER SHIPMENT		4Q86	1Q87	2Q86	4Q86	5/84
U.S. OEM PRICE FOR 100 UNITS		--	--	$2,830	--	$3,280
COMMENTS		*2,7 RLL Code	*2,7 RLL Code		*2,7 RLL Code	

MANUFACTURER	PRIAM	PRIAM	PRIAM	QUANTUM	QUANTUM
DRIVE	638	738	807	Q520	Q2010
DISK/TREND GROUP	8	8	8	5	5
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	130 mm OD 40 mm ID	130 mm OD 40 mm ID	200 mm OD 63.5 mm ID	130 mm OD 40 mm ID	200 mm OD 63.5 mm ID
Recording medium	Thin Film	Thin Film	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	3370 (Ferrite)	3370 (Ferrite)	Modified 3350	3350	3350
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	ESDI	SCSI	Priam,SMD,SCSI	ST412	SA1000
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 382.4	F: 337.8	U: 344	U: 21.33	U: 10.66
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 20,832	F: 18,432	U: 20,160	U: 10,416	U: 10,400
Data surfaces per spindle	15	15	11	4	2
Heads per data surface	1	1	1	1	1
Tracks per surface	1224	1225	1552	512	512
Track density (TPI)	1070	1070	1040	591	345
Maximum linear density (BPI)	21848 BPI* 14565 FCI	21848 BPI* 14565 FCI	12096	9200	6600
Rotational speed (RPM)	3600	3600	3600	3529	3000
PERFORMANCE					
Actuator type	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil	Rotary, Torque Motor	Rotary, Torque Motor
Average positioning time (msec)	20	20	25	45	50
Average rotational delay (msec)	8.3	8.3	8.3	8.5	10
Average access time (msec)	28.3	28.3	33.3	53.5	60
Data transfer rate (KBytes/sec)	1250	1250	1210	625	543
FIRST CUSTOMER SHIPMENT	3Q86	4Q86	6/84	4/83	1Q81
U.S. OEM PRICE FOR 100 UNITS	--	--	$4,105	$895 (1000)	$1,150 (1000)
COMMENTS	*2,7 RLL Code	*2,7 RLL Code			

MANUFACTURER	QUANTUM	QUANTUM	QUANTUM	QUANTUM	QUANTUM
DRIVE	Q2020	Q530	Q540	Q2030	Q2040
DISK/TREND GROUP	5	6	6	6	6
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	200 mm OD 63.5 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	200 mm OD 63.5 mm ID	200 mm OD 63.5 mm ID
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	3350	3350	3350	3350	3350
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	SA1000	ST412	ST412	SA1000	SA1000
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 21.33	U: 31.99	U: 42.66	U: 32.0	U: 42.66
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 10,400	U: 10,416	U: 10,416	U: 10,400	U: 10,400
Data surfaces per spindle	4	6	8	6	8
Heads per data surface	1	1	1	1	1
Tracks per surface	512	512	512	512	512
Track density (TPI)	345	591	591	345	345
Maximum linear density (BPI)	6600	9200	9200	6600	6600
Rotational speed (RPM)	3000	3529	3529	3000	3000
PERFORMANCE					
Actuator type	Rotary, Torque Motor	Rotary, Torque Motor	Rotary, Torque Motor	Rotary, Torque Motor	Rotary, Torque Motor
Average positioning time (msec)	55	45	45	60	65
Average rotational delay (msec)	10	8.5	8.5	10	10
Average access time (msec)	65	53.5	53.5	70	75
Data transfer rate (KBytes/sec)	543	625	625	543	543
FIRST CUSTOMER SHIPMENT	1Q81	4/83	4/83	1Q81	1Q81
U.S. OEM PRICE FOR 100 UNITS	$1,440 (1000)	$995 (1000)	$1,095 (1000)	$1,700 (1000)	$1,960 (1000)
COMMENTS					

MANUFACTURER	QUANTUM	QUANTUM	QUANTUM	RICOH	RODIME
DRIVE	Q250	Q280	Q160	RH5130	201
DISK/TREND GROUP	6	6	7	2	5
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	5.25" Cartridge	Fixed
Nominal disk diameter	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID
Recording medium	Thin Film	Thin Film	Thin Film	Oxide Coated	Oxide Coated
DRIVE: Technology type	3370 (Ferrite)	3370 (Ferrite)	3370 (Ferrite)	Modified 3350	Modified 3350
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	SCSI	SCSI	SCSI	ST412	ST412
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	F: 53.4	F: 80.1	F: 160	U: 12.75	U: 6.67
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 16,384	F: 16,384	F: 16,384	U: 10,416	U: 10,416
Data surfaces per spindle	4	6	12	2	2
Heads per data surface	1	1	1	1	1
Tracks per surface	815	815	815	612	320
Track density (TPI)	876	876	876	612	356
Maximum linear density (BPI)	20000 BPI* 15000 FCI	20000 BPI* 15000 FCI	20000 BPI* 15000 FCI	10894	8720
Rotational speed (RPM)	3600	3600	3600	3473	3600
PERFORMANCE					
Actuator type	Rotary, Torque Motor	Rotary, Torque Motor	Rotary, Torque Motor	Rack & Pinion, Stepping Motor	Rotary, Band, Stepping Motor
Average positioning time (msec)	26	26	26	98 (including settling)	90 (including settling)
Average rotational delay (msec)	8.3	8.3	8.3	8.6	8.3
Average access time (msec)	34.3	34.3	34.3	106.6	98.3
Data transfer rate (KBytes/sec)	1250	1250	1250	625	625
FIRST CUSTOMER SHIPMENT	4/86	4/86	4Q86	3Q85	6/82
U.S. OEM PRICE FOR 100 UNITS	$850 (1000)	$950 (1000)	$1,395 (1000)	--	--
COMMENTS	41 mm High *1,7 RLL Code Embedded Servo	41 mm High *1,7 RLL Code Embedded Servo	*1,7 RLL Code Embedded Servo	41 mm High Embedded Servo DMA License	

MANUFACTURER	RODIME	RODIME	RODIME	RODIME	RODIME
DRIVE	201E	202	202E	203	204
DISK/TREND GROUP	5	5	5	5	5
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	Modified 3350	Modified 3350	Modified 3350	Modified 3350	Modified 3350
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	ST412	ST412	ST412	ST412	ST412
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 13.33	U: 13.33	U: 26.67	U: 20.0	U: 26.67
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 10,416	U: 10,416	U: 10,416	U: 10,416	U: 10,416
Data surfaces per spindle	2	4	4	6	8
Heads per data surface	1	1	1	1	1
Tracks per surface	640	320	640	320	320
Track density (TPI)	600	356	600	356	356
Maximum linear density (BPI)	10300	8720	10300	8720	8720
Rotational speed (RPM)	3600	3600	3600	3600	3600
PERFORMANCE					
Actuator type	Rotary, Band, Stepping Motor	Rotary, Band, Stepping Motor	Rotary, Band, Stepping Motor	Rotary, Band, Stepping Motor	Rotary, Band, Stepping Motor
Average positioning time (msec)	55 (including settling)	90 (including settling)	55 (including settling)	90 (including settling)	90 (including settling)
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	63.3	98.3	63.3	98.3	98.3
Data transfer rate (KBytes/sec)	625	625	625	625	625
FIRST CUSTOMER SHIPMENT	4/84	6/82	4/84	6/82	6/82
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	--
COMMENTS					

MANUFACTURER	RODIME	RODIME	RODIME	RODIME	RODIME
DRIVE	251 351	252 352	651 751	652 752	203E
DISK/TREND GROUP	5	5	5	5	6
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	96 mm OD 40 mm ID	96 mm OD 40 mm ID	96 mm OD 40 mm ID	96 mm OD 40 mm ID	130 mm OD 40 mm ID
Recording medium	Thin Film	Thin Film	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	Modified 3350	Modified 3350	3370	3370	Modified 3350
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	ST412	ST412	SCSI	SCSI	ST412
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 6.38	U: 12.75	F: 10.65	F: 21.3	U: 40.0
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 10,416	U: 10,416	F: 17,408	F: 17,408	U: 10,416
Data surfaces per spindle	2	4	2	4	6
Heads per data surface	1	1	1	1	1
Tracks per surface	306	306	306	306	640
Track density (TPI)	600	600	600	600	600
Maximum linear density (BPI)	11200	11200	22100 BPI 14700 FCI	22100 BPI 14700 FCI	10300
Rotational speed (RPM)	3600	3600	2750	2750	3600
PERFORMANCE					
Actuator type	Rotary, Band, Stepping Motor	Rotary, Band, Stepping Motor	Rotary, Band, Stepping Motor	Rotary, Band, Stepping Motor	Rotary, Band, Stepping Motor
Average positioning time (msec)	85 (including settling)	85 (including settling)	85 (including settling)	85 (including settling)	55 (including settling)
Average rotational delay (msec)	8.3	8.3	10.9	10.9	8.3
Average access time (msec)	93.3	93.3	95.9	95.9	63.3
Data transfer rate (KBytes/sec)	625	625	937	937	625
FIRST CUSTOMER SHIPMENT	9/83	9/83	4Q85	4Q85	4/83
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	--
COMMENTS	250 Series uses frame to match half high 5.25" form factor	250 series uses frame to match half high 5.25" form factor	41 mm High 750 series uses frame to match half high 5.25" form factor	41 mm High 750 series uses frame to match half high 5.25" form factor	

MANUFACTURER	RODIME	RODIME	RODIME	RODIME	RODIME
DRIVE	204E	412	413	414	432
DISK/TREND GROUP	6	6	6	6	6
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID
Recording medium	Oxide Coated	Thin Film	Thin Film	Thin Film	Thin Film
DRIVE: Technology type	Modified 3350	3370 (Ferrite)	3370 (Ferrite)	3370 (Ferrite)	3370 (Ferrite)
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	ST412	ST412	ST412	ST412	SCSI
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 53.34	U: 42.7	U: 64.0	U: 85.3	F: 71.3
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 10,416	U: 10,416	U: 10,416	U: 10,416	F: 17,408
Data surfaces per spindle	8	4	6	8	4
Heads per data surface	1	1	1	1	1
Tracks per surface	640	1024	1024	1024	1024
Track density (TPI)	600	925	925	925	925
Maximum linear density (BPI)	10300	10500	10500	10500	21000 BPI* 14000 FCI
Rotational speed (RPM)	3600	3571	3571	3571	3571
PERFORMANCE					
Actuator type	Rotary, Band, Stepping Motor	Rotary Voice Coil	Rotary Voice Coil	Rotary Voice Coil	Rotary, Voice Coil
Average positioning time (msec)	55 (including settling)	30	30	30	30
Average rotational delay (msec)	8.3	8.4	8.4	8.4	8.4
Average access time (msec)	63.3	38.4	38.4	38.4	38.4
Data transfer rate (KBytes/sec)	625	625	625	625	1250
FIRST CUSTOMER SHIPMENT	4/83	3Q86	3Q86	3Q86	4Q86
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	--
COMMENTS		41 mm High	41 mm High	41 mm High	*2,7 RLL Code 41 mm High

MANUFACTURER	RODIME	RODIME	SAGEM	SAGEM	SAGEM
DRIVE	433	434	MSA 250-50	MSA 250-100	MSA 240-25
DISK/TREND GROUP	7	7	--	--	5
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Special	Special	Fixed
Nominal disk diameter	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID
Recording medium	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
DRIVE: Technology type	3370 (Ferrite)	3370 (Ferrite)	3370 (Ferrite)	3370 (Ferrite)	3370 (Ferrite)
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	SCSI	SCSI	SCSI	SCSI	SCSI
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	F: 107.0	F: 142.6	--	--	F: 25
REMOVABLE	--	--	F: 50	F: 100	--
Capacity per track (Bytes)	F: 17,408	F: 17,408	F: 14,848	F: 14,848	F: 14,848
Data surfaces per spindle	6	8	8	16	4
Heads per data surface	1	1	8	8	8
Tracks per surface	1024	1024	464	464	464
Track density (TPI)	925	925	600	600	600
Maximum linear density (BPI)	21000 BPI* 14000 FCI	21000 BPI* 14000 FCI	13000	13000	13000
Rotational speed (RPM)	3571	3571	3600	3600	3600
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Average positioning time (msec)	30	30	10	10	10
Average rotational delay (msec)	8.4	8.4	8.3	8.3	8.3
Average access time (msec)	38.4	38.4	18.3	18.3	18.3
Data transfer rate (KBytes/sec)	1250	1250	1500	1500	1500
FIRST CUSTOMER SHIPMENT	4Q86	4Q86	1Q87	1Q87	3Q87
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	--
COMMENTS	*2,7 RLL Code 41 mm High	*2,7 RLL Code 41 mm High	Militarized Subsystem Removable Head/Disk Module	Militarized Subsystem Removable Head/Disk Module	Militarized Subsystem

MANUFACTURER	SAGEM	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY
DRIVE	MSA 240-50	ST213	ST225	ST225N	ST4026
DISK/TREND GROUP	6	5	5	5	5
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID
Recording medium	Thin Film	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	3370 (Ferrite)	3370 (Ferrite)	3370 (Ferrite)	3370 (Ferrite)	3370 (Ferrite)
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	SCSI	ST412	ST412	SCSI	ST412
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	F: 50	U: 12.81	U: 25.62	F: 21.36*	U: 25.62
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 14,848	U: 10,416	U: 10,416	F: 8,704*	U: 10,416
Data surfaces per spindle	8	2	4	4	4
Heads per data surface	8	1	1	1	1
Tracks per surface	464	615	615	615	615
Track density (TPI)	600	588	588	588	625
Maximum linear density (BPI)	13000	9827	9827	9827	9617
Rotational speed (RPM)	3600	3600	3600	3600	3600
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Band, Stepping Motor	Rotary, Band, Stepping Motor	Rotary, Band, Stepping Motor	Linear, Voice Coil
Average positioning time (msec)	10	65 (including settling)	65 (including settling)	65 (including settling)	40
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	18.3	73.3	73.3	73.3	48.3
Data transfer rate (KBytes/sec)	1500	625	625	Up To 1250	625
FIRST CUSTOMER SHIPMENT	3Q87	4Q85	10/84	4Q85	11/84
U.S. OEM PRICE FOR 100 UNITS	--	$285 (500)	$347 (500)	$450 (500)	$575 (500)
COMMENTS	Militarized Subsystem	41 mm High	41 mm High	41 mm High *512 Byte Sectors	

MANUFACTURER	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY
DRIVE	ST238N	ST238R	ST251	ST251N	ST277N
DISK/TREND GROUP	6	6	6	6	6
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID
Recording medium	Oxide Coated	Oxide Coated	Thin Film	Oxide Coated	Thin Film
DRIVE: Technology type	3370 (Ferrite)	3370 (Ferrite)	3370 (Ferrite)	3370 (Ferrite)	3370 (Ferrite)
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	SCSI	ST412	ST412	SCSI	SCSI
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	F: 31.4	U: 38.44	U: 51.25	F: 41.9	F: 62.8
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 12,800	U: 15,624*	U: 10,416	F: 12,800	F: 12,800
Data surfaces per spindle	4	4	6	4	6
Heads per data surface	1	1	1	1	1
Tracks per surface	615	615	820	820	820
Track density (TPI)	588	588	777	777	777
Maximum linear density (BPI)	14740 BPI* 9827 FCI	14740 BPI* 9827 FCI	9935	14902 BPI* 9935 FCI	14902 BPI* 9935 FCI
Rotational speed (RPM)	3600	3600	3600	3600	3600
PERFORMANCE					
Actuator type	Rotary, Band, Stepping Motor	Rotary, Band, Stepping Motor	Rotary, Band, Stepping Motor	Rotary, Band, Stepping Motor	Rotary, Band, Stepping Motor
Average positioning time (msec)	65 (including settling)	65 (including settling)	40 (including settling)	40 (including settling)	40 (including settling)
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	73.3	73.3	48.3	48.3	48.3
Data transfer rate (KBytes/sec)	937.5	937.5*	625	937.5	937.5*
FIRST CUSTOMER SHIPMENT	4Q86	1Q86	2Q86	4Q86	4Q86
U.S. OEM PRICE FOR 100 UNITS	--	$360 (500)	$750 (500)	--	--
COMMENTS	*2,7 RLL Code 41 mm High	41 mm High *With 2,7 RLL Controller	41 mm High	*2,7 RLL Code 41 mm High	41 mm High *2,7 RLL Code

MANUFACTURER	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY
DRIVE	ST277R	ST4038	ST4051	ST4080R	ST4096
DISK/TREND GROUP	6	6	6	6	6
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID
Recording medium	Thin Film	Oxide Coated	Thin Film	Thin Film	Thin Film
DRIVE: Technology type	3370 (Ferrite)	3370 (Ferrite)	3370 (Ferrite)	3370 (Ferrite)	3370 (Ferrite)
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	ST412	ST412	ST412	ST412	ST412
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 76.9	U: 38.17	U: 50.88	U: 79.9	U: 95.99
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 15,624*	U: 10,416	U: 10,416	U: 15,624*	U: 10,416
Data surfaces per spindle	6	5	5	5	9
Heads per data surface	1	1	1	1	1
Tracks per surface	820	733	977	1024	1024
Track density (TPI)	777	750	960	1031	1031
Maximum linear density (BPI)	14902 BPI* 9935 FCI	9617	9720	14688 BPI* 9935 FCI	9792
Rotational speed (RPM)	3600	3600	3600	3600	3600
PERFORMANCE					
Actuator type	Rotary, Band, Stepping Motor	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil
Average positioning time (msec)	40 (including settling)	40	40	28	28
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	48.3	48.3	48.3	36.3	36.3
Data transfer rate (KBytes/sec)	937.5*	625	625	937.5*	625
FIRST CUSTOMER SHIPMENT	3Q86	1/85	1/85	4Q86	1Q86
U.S. OEM PRICE FOR 100 UNITS	--	$645 (500)	$765 (500)	--	$1,285 (500)
COMMENTS	41 mm High *with RLL controller			*With RLL controller	

MANUFACTURER	SEAGATE TECHNOLOGY	SIEMENS	SIEMENS	SIEMENS	STORAGE TECHNOLOGY CORPORATION
DRIVE	ST4144R	1100	1200	1300	8380-A4 8380-AA4 8380-B4
DISK/TREND GROUP	7	7	7	8	9
MARKET	OEM	OEM	OEM	OEM	PCM, OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	14"
Recording medium	Thin Film	Thin Film	Thin Film	Thin Film	Oxide Coated
DRIVE: Technology type	3370 (Ferrite)	3370	3370	3370	3380
Heads	Ferrite	Thin Film	Thin Film	Thin Film	Thin Film
Interface	ST412	ANSI, ESDI	ANSI, ESDI	ANSI, ESDI	IBM
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 79.9	U: 103	U: 207	U: 310	F: 1,260
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 15,624*	U: 21,280	U: 21,280	U: 21,280	F: 47,476
Data surfaces per spindle	9	4	8	12	15
Heads per data surface	1	1	1	1	2
Tracks per surface	1024	1216	1216	1216	1770
Track density (TPI)	1031	1207	1207	1207	800
Maximum linear density (BPI)	14688 BPI* 9935 FCI	19077 BPI* 12718 FCI	19077 BPI* 12718 FCI	19077 BPI* 12718 FCI	15240 BPI* 10160 FCI
Rotational speed (RPM)	3600	3571	3571	3571	3620
PERFORMANCE					
Actuator type	Linear, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Dual, Linear, Voice Coil
Average positioning time (msec)	28	25	25	25	16
Average rotational delay (msec)	8.3	8.4	8.4	8.4	8.3
Average access time (msec)	36.3	33.4	33.4	33.4	24.3
Data transfer rate (KBytes/sec)	937.5*	1250	1250	1250	3000
FIRST CUSTOMER SHIPMENT	4Q86	1Q86	1Q86	1Q86	1983
U.S. OEM PRICE FOR 100 UNITS	--	$2,425	$3,427	$3,825	--
COMMENTS	*With RLL controller	*2,7 RLL Code	*2,7 RLL Code	*2,7 RLL Code	*2,7 RLL Code PCM 3380 Drive has two spindles

MANUFACTURER	STORAGE TECHNOLOGY CORPORATION	SYQUEST TECHNOLOGY	SYQUEST TECHNOLOGY	SYQUEST TECHNOLOGY	SYQUEST TECHNOLOGY
DRIVE	8380-BE4	SQ306RD	SQ312RD	SQ319	SQ325F
DISK/TREND GROUP	9	1	2	2	5
MARKET	PCM, OEM	OEM	OEM	OEM, PCM	OEM
MEDIA: Generic type	Fixed	3.9" Cartridge	3.9" Cartridge	3.9" Cartridge	Fixed
Nominal disk diameter	14"	100 mm OD 40 mm ID	100 mm OD 40 mm ID	100 mm OD 40 mm ID	100 mm OD 40 mm ID
Recording medium	Oxide Coated	Thin Film	Thin Film	Thin Film	Thin Film
DRIVE: Technology type	3380 x 2	Modified 3350	Modified 3350	Modified 3350	Modified 3350
Heads	Thin Film	Ferrite	Ferrite	Ferrite	Ferrite
Interface	IBM	ST412	ST412	IBM PC	ST412
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	F: 2520.97	--	--	--	U: 25.5
REMOVABLE	--	U: 6.38	U: 12.75	U: 19.1	--
Capacity per track (Bytes)	F: 47,476	U: 10,416	U: 10,416	U: 15,048	U: 10,416
Data surfaces per spindle	15	2	2	2	4
Heads per data surface	2	1	1	1	1
Tracks per surface	3540	306	615	615	612
Track density (TPI)	*	435	741	741	764
Maximum linear density (BPI)	*	12186	12608	18912	12223
Rotational speed (RPM)	3620	3547	3545	3545	3547
PERFORMANCE					
Actuator type	Dual, Linear, Voice Coil	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor
Average positioning time (msec)	17	90 (including settling)	85 (including settling)	85 (including settling)	95 (including settling)
Average rotational delay (msec)	8.3	8.46	8.46	8.46	8.46
Average access time (msec)	25.3	98.46	93.46	93.46	103.46
Data transfer rate (KBytes/sec)	3000	625	625	937.5	625
FIRST CUSTOMER SHIPMENT	6/86	9/82	7/84	7/86	6/84
U.S. OEM PRICE FOR 100 UNITS	--	$550 (1000)	$550 (1000)	$770	$850
COMMENTS	PCM 3380-BE4 *not announced Drive has two spindles	41 mm High 4.8" Wide Embedded Servo	41 mm High 4.8" Wide Embedded Servo	Includes controller, software, and mounting hardware	41 mm High 4.8" Wide Embedded Servo

MANUFACTURER	SYQUEST TECHNOLOGY	TANDON	TANDON	TANDON	TANDON
DRIVE	SQ338F	Businesscard 21	TM252	TM261	TM262
DISK/TREND GROUP	6	5	5	5	5
MARKET	OEM	PCM, OEM	OEM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed-Card	Fixed	Fixed	Fixed
Nominal disk diameter	100 mm OD	95 mm OD	130 mm OD	95 mm OD	95 mm OD
Recording medium	40 mm ID Thin Film	25 mm ID Thin Film	40 mm ID Thin Film	25 mm ID Thin Film	25 mm ID Thin Film
DRIVE: Technology type	Modified 3350	3370 (Ferrite)	Modified 3350	3370 (Ferrite)	3370 (Ferrite)
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	ST412	IBM PC	ST412	ST412	ST412
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 38.2	F: 21.3	U: 12.75	U: 12.79	U: 25.58
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 10,416	F: 8,704	U: 10,416	U: 10,416	U: 10,416
Data surfaces per spindle	6	4	4	2	4
Heads per data surface	1	1	1	1	1
Tracks per surface	612	612	306	615	615
Track density (TPI)	764	804	345	804	804
Maximum linear density (BPI)	12223	13739	9074	13739	13739
Rotational speed (RPM)	3547	3568	3600	3568	3568
PERFORMANCE					
Actuator type	Band, Stepping Motor	Rack & Pinion, Stepping Motor	Rotary, Band Stepping Motor	Rack & Pinion, Stepping Motor	Rack & Pinion, Stepping Motor
Average positioning time (msec)	95 (including settling)	80 (including settling)	100 (including settling)	80 (including settling)	80 (including settling)
Average rotational delay (msec)	8.46	8.4	8.3	8.4	8.4
Average access time (msec)	103.46	88.4	108.3	88.4	88.4
Data transfer rate (KBytes/sec)	625	625	625	625	625
FIRST CUSTOMER SHIPMENT	5/84	1/86	7/83	4/85	4/85
U.S. OEM PRICE FOR 100 UNITS	$375 (1000)	$425 (2500)	$250 (2500)	--	--
COMMENTS	41 mm High 4.8" Wide Embedded Servo		41 mm High	41 mm High TM261 in half high 5.25" package	41 mm High TM362 in half high 5.25" package

MANUFACTURER	TANDON	TANDON	TANDON	TANDON	TANDON
DRIVE	TM361	TM362	TM703	TM703AT	TM755
DISK/TREND GROUP	5	5	6	6	6
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	95 mm OD	95 mm OD	130 mm OD	130 mm OD	130 mm OD
Recording medium	25 mm ID Thin Film	25 mm ID Thin Film	40 mm ID Thin Film	40 mm ID Thin Film	40 mm ID Thin Film
DRIVE: Technology type	3370 (Ferrite)	3370 (Ferrite)	Modified 3350	Modified 3350	3370 (Ferrite)
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	ST412	ST412	ST412	IBM PC	ST412
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 12.79	U: 25.58	U: 36.2	F: 30	U: 51.04
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 10,416	U: 10,416	U: 10,416	F: 8,704	U: 10,416
Data surfaces per spindle	2	4	5	5	5
Heads per data surface	1	1	1	1	1
Tracks per surface	615	615	695	733	981
Track density (TPI)	804	804	700	700	960
Maximum linear density (BPI)	13739	13739	10,000	10000	9528
Rotational speed (RPM)	3568	3568	3600	3600	3600
PERFORMANCE					
Actuator type	Rack & Pinion, Stepping Motor	Rack & Pinion, Stepping Motor	Rotary, Voice Coil	Rotary, Voice Coil	Linear, Voice Coil
Average positioning time (msec)	80 (including settling)	80 (including settling)	45 (including settling)	40	35
Average rotational delay (msec)	8.4	8.4	8.3	8.3	8.3
Average access time (msec)	88.4	88.4	53.3	48.3	43.3
Data transfer rate (KBytes/sec)	625	625	625	625	625
FIRST CUSTOMER SHIPMENT	4/85	4/85	1/83	1986	4/85
U.S. OEM PRICE FOR 100 UNITS	$265 (2500)	$290 (2500)	$550 (2500)	$550 (2500)	$690 (2500)
COMMENTS	41 mm High	41 mm High			41 mm High

MANUFACTURER	TEAC	TEAC	TEAC	TECSTOR	TECSTOR
DRIVE	SD-510	SD-520	SD-540	3005	3010
DISK/TREND GROUP	5	5	6	8	8
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	14"	14"
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	Modified 3350	3370 (Ferrite)	3370 (Ferrite)	Modified 3350	Modified 3350
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	ST412	ST412	ST412	Modified SMD	Modified SMD
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 12.76	U: 25.52	U: 51.25	U: 331.8	U: 331.8
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 10,416	U: 10,416	U: 10,416	U: 20,160	U: 20,160
Data surfaces per spindle	4	4	8	10	10
Heads per data surface	1	1	1	2	2
Tracks per surface	306	612	615	1646	1646
Track density (TPI)	345	690	690	680	680
Maximum linear density (BPI)	9074	9074	8940	6450	6450
Rotational speed (RPM)	3600	3600	3600	3600	3600
PERFORMANCE					
Actuator type	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Rotary, Voice Coil	Rotary, Voice Coil
Average positioning time (msec)	85 (including settling)	85 (including settling)	40 (including settling)	29	29
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	93.3	93.3	48.3	37.3	37.3
Data transfer rate (KBytes/sec)	625	625	625	6050	12100
FIRST CUSTOMER SHIPMENT	4/84	5/85	1986	1Q85	1Q85
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	--
COMMENTS	41 mm High	41 mm High	41 mm High	5 track parallel data transfer	10 track parallel data transfer

MANUFACTURER	TECSTOR	TOKICO	TOKICO	TOKICO	TOKICO
DRIVE	3020	DK502-3	DK503-2 TD5013	DK505-2 TD5025	DK506 TD5046
DISK/TREND GROUP	8	5	5	5	6
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	14"	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	Modified 3350	Modified 3350	Modified 3350	Modified 3350	3370 (Ferrite)
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	Modified SMD	ST412	ST412	ST412	ST506/412
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 331.8	U: 26.6	U: 13.33	U: 25.5	U: 51.24
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 20,160	U: 10,416	U: 10,416	U: 10,416	U: 10,416
Data surfaces per spindle	10	8	4	4	8
Heads per data surface	2	1	1	1	1
Tracks per surface	1646	320	320	612	615
Track density (TPI)	680	360	360	670	650
Maximum linear density (BPI)	6450	9260	9260	9490	9500
Rotational speed (RPM)	3600	3600	3600	3550	3550
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Linear, Band Torque Motor
Average positioning time (msec)	29	85 (including settling)	85 (including settling)	85 (including settling)	31.5
Average rotational delay (msec)	8.3	8.3	8.6	8.45	8.5
Average access time (msec)	37.3	93.3	93.6	93.45	40.0
Data transfer rate (KBytes/sec)	24190	625	625	625	625
FIRST CUSTOMER SHIPMENT	1Q85	10/83	10/83	3/85	4/86
U.S. OEM PRICE FOR 100 UNITS	$22,500	--	--	--	--
COMMENTS	20 track parallel data transfer		41 mm High	41 mm High	41 mm High

MANUFACTURER	TOKYO ELECTRIC COMPANY	TOSHIBA CORPORATION	TOSHIBA CORPORATION	TOSHIBA CORPORATION	TOSHIBA CORPORATION
DRIVE	TD-5526	MK-53FB	MK-54FB	MK-56FB	MK-153FA
DISK/TREND GROUP	5	6	6	6	6
MARKET	OEM	OEM	OEM	OEM	Captive, OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Thin Film
DRIVE: Technology type	Modified 3350	3370 (Ferrite)	3370 (Ferrite)	3370 (Ferrite)	3370 (Ferrite)
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	ST412	ST412	ST412	ST412	ESDI
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 25.5	U: 43.2	U: 60.5	U: 86.5	U: 86.5
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 10,416	U: 10,416	U: 10,416	U: 10,416	U: 20,832
Data surfaces per spindle	4	5	7	10	5
Heads per data surface	1	1	1	1	1
Tracks per surface	612	830	830	830	830
Track density (TPI)	550	900	900	900	900
Maximum linear density (BPI)	10568	9383	9383	9383	18766 BPI* 12510 FCI
Rotational speed (RPM)	3573	3600	3600	3600	3600
PERFORMANCE					
Actuator type	Band, Stepping Motor	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Average positioning time (msec)	65 (including settling)	25	25	25	25
Average rotational delay (msec)	8.4	8.3	8.3	8.3	8.3
Average access time (msec)	73.4	33.3	33.3	33.3	33.3
Data transfer rate (KBytes/sec)	625	625	625	625	1250
FIRST CUSTOMER SHIPMENT	3Q85	3/85	3/85	3/85	4/86
U.S. OEM PRICE FOR 100 UNITS	--	$1,170	$1,255	$1,370	$1,695
COMMENTS	41 mm High				*2,7 RLL Code

MANUFACTURER	TOSHIBA CORPORATION	TOSHIBA CORPORATION	TOSHIBA CORPORATION	TOSHIBA CORPORATION	TOSHIBA CORPORATION
DRIVE	MK-153FB	MK-182FB	MK-154FA	MK-154FB	MK-156FA
DISK/TREND GROUP	6	6	7	7	7
MARKET	Captive, OEM	Captive, OEM	Captive, OEM	Captive, OEM	Captive, OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	130 mm OD 40 mm ID	210 mm OD 100 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID
Recording medium	Thin Film	Oxide Coated	Thin Film	Thin Film	Thin Film
DRIVE: Technology type	3370 (Ferrite)	Modified 3350	3370 (Ferrite)	3370 (Ferrite)	3370 (Ferrite)
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	SCSI	SMD	ESDI	SCSI	ESDI
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	F: 74.8	U: 83.0	U: 121.0	F: 105.2	U: 172.9
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 18,432	U: 20,160	U: 20,832	F: 18,432	U: 20,832
Data surfaces per spindle	5	5	7	7	10
Heads per data surface	1	1	1	1	1
Tracks per surface	830	823	830	830	830
Track density (TPI)	900	900	900	900	900
Maximum linear density (BPI)	18766 BPI* 12510 FCI	9,000 BPI* 6,000 FCI	18766 BPI* 12510 FCI	18766 BPI* 12510 FCI	18766 BPI* 12510 FCI
Rotational speed (RPM)	3600	3600	3600	3600	3600
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Average positioning time (msec)	25	18	25	25	25
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	33.3	26.3	33.3	33.3	33.3
Data transfer rate (KBytes/sec)	1250	1210	1250	1250	1250
FIRST CUSTOMER SHIPMENT	9/86	2Q83	4/86	9/86	4/86
U.S. OEM PRICE FOR 100 UNITS	$1,645	$2,275	$1,795	$1,945	$2,035
COMMENTS	*2,7 RLL Code	*2,7 RLL Code	*2,7 RLL Code	*2,7 RLL Code	*2,7 RLL Code

MANUFACTURER	TOSHIBA CORPORATION	TOSHIBA CORPORATION	TOSHIBA CORPORATION	TOSHIBA CORPORATION	TOSHIBA CORPORATION
DRIVE	MK-156FB	MK-184FB	MK-186FB	MK-283FC	MK-284FC
DISK/TREND GROUP	7	7	7	7	7
MARKET	Captive, OEM	Captive, OEM	Captive, OEM	Captive, OEM	Captive, OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	130 mm OD 40 mm ID	210 mm OD 100 mm ID	210 mm OD 100 mm ID	210 mm OD 100 mm ID	210 mm OD 100 mm ID
Recording medium	Thin Film	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	3370 (Ferrite)	Modified 3350	Modified 3350	Modified 3350	Modified 3350
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	SCSI	SMD	SMD	Modified SMD	Modified SMD
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	F: 150.8	U: 116.1	U: 165.9	U: 170.1	U: 238.2
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 18,432	U: 20,160	U: 20,160	U: 41,340	U: 41,340
Data surfaces per spindle	10	7	10	5	7
Heads per data surface	1	1	1	1	1
Tracks per surface	830	823	823	823	823
Track density (TPI)	900	900	900	765	765
Maximum linear density (BPI)	18766 BPI* 12510 FCI	9,000 BPI* 6,000 FCI	9,000 BPI* 6,000 FCI	19300 BPI* 12867 FCI	19300 BPI* 12867 FCI
Rotational speed (RPM)	3600	3600	3600	3600	3600
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Average positioning time (msec)	25	18	18	18	18
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	33.3	26.3	26.3	26.3	26.3
Data transfer rate (KBytes/sec)	1250	1210	1210	2480	2480
FIRST CUSTOMER SHIPMENT	9/86	2Q83	4Q83	4/86	4/86
U.S. OEM PRICE FOR 100 UNITS	$2,185	$2,395	$2,635	--	--
COMMENTS	*2,7 RLL Code	*2,7 RLL Code	*2,7 RLL Code	*2,7 RLL Code	*2,7 RLL Code

MANUFACTURER	TOSHIBA CORPORATION	TOSHIBA CORPORATION	TOSHIBA CORPORATION	TOYO SODA	TOYO SODA
DRIVE	MK-286FC	MK-287FC	MK-288FC	Dart 130	Dart 170
DISK/TREND GROUP	8	8	9	7	7
MARKET	Captive, OEM	Captive, OEM	Captive, OEM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	210 mm OD 100 mm ID	210 mm OD 100 mm ID	210 mm OD 100 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Thin Film	Thin Film
DRIVE: Technology type	Modified 3350	Modified 3350	Modified 3350	3370 (Ferrite)	3370 (Ferrite)
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	Modified SMD	Modified SMD	Modified SMD	ESDI, SCSI	ESDI, SCSI
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U:374.3/340.2**	U: 442.3	U: 510.3	U: 129.3	U: 166.2
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 41,340	U: 41,340	U: 41,340	U: 20,160	U: 20,160
Data surfaces per spindle	11/10*	13	15	7	9
Heads per data surface	1	1	1	1	1
Tracks per surface	823	823	823	916	916
Track density (TPI)	765	765	765	1000	1000
Maximum linear density (BPI)	19300 BPI* 12867 FCI	19300 BPI* 12867 FCI	19300 BPI* 12867 FCI	18534	18534
Rotational speed (RPM)	3600	3600	3600	3600	3600
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Linear, Voice Coil	Linear, Voice Coil
Average positioning time (msec)	18	18	18	18	18
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	26.3	26.3	26.3	26.3	26.3
Data transfer rate (KBytes/sec)	2480	2480	2480	1209	1814
FIRST CUSTOMER SHIPMENT	4/86	4/86	4/86	1Q87	1Q87
U.S. OEM PRICE FOR 100 UNITS	$3,595	--	$4,315	--	--
COMMENTS	*2,7 RLL Code **Switch Selectable	*2,7 RLL Code	*2,7 RLL Code		

MANUFACTURER	TULIN	TULIN	TULIN	TULIN	VICTOR COMPANY OF JAPAN
DRIVE	TL226	TL240	TL326	TL340	JD-3806M
DISK/TREND GROUP	5	5	5	6	5
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	95 mm OD 25 mm ID
Recording medium	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
DRIVE: Technology type	Modified 3350	Modified 3350	3370 (Ferrite)	3370 (Ferrite)	Modified 3350
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	ST412	ST412	ST412	ST412	Modifed ST412
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 26.7	U: 40.0	U: 26.7	U: 40.0	U: 6.33
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 10,416	U: 10,416	U: 10,416	U: 10,416	U: 10,416
Data surfaces per spindle	4	6	4	6	2
Heads per data surface	1	1	1	1	1
Tracks per surface	640	640	640	640	306
Track density (TPI)	656	656	656	656	566
Maximum linear density (BPI)	10000	10000	10000	10000	11439
Rotational speed (RPM)	3600	3600	3600	3600	2322
PERFORMANCE					
Actuator type	Rotary, band stepping motor	Rotary, band, stepping motor	Rotary, Band Stepping Motor	Rotary, Band Stepping Motor	Band, Stepping Motor
Average positioning time (msec)	85 (Including settling)	85 (Including settling)	40 (Including settling)	40 (Including settling)	95 (including settling)
Average rotational delay (msec)	8.3	8.3	8.3	8.3	12.9
Average access time (msec)	93.3	93.3	48.3	48.3	107.9
Data transfer rate (KBytes/sec)	625	625	625	625	400
FIRST CUSTOMER SHIPMENT	3/84	3/84	1986	1986	11/85
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	--
COMMENTS	41 mm High Embedded Servo	41 mm High Embedded Servo	41 mm High Embedded Servo	41 mm High Embedded Servo	28.9 mm High Embedded Servo

MANUFACTURER	VICTOR COMPANY OF JAPAN	VICTOR COMPANY OF JAPAN	VICTOR COMPANY OF JAPAN	WESTERN DYNEX	XEBEC
DRIVE	JD-3812M	JD-S3806M	JD-S3812M	WD-505	Owl I
DISK/TREND GROUP	5	5	5	1	5
MARKET	OEM	OEM, PCM	OEM, PCM	Captive	OEM
MEDIA: Generic type	Fixed	Drive On Card	Drive On Card	5.25" Cartridge	Fixed
Nominal disk diameter	95 mm OD 25 mm ID	95 mm OD 25 mm ID	95 mm OD 25 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID
Recording medium	Thin Film	Thin Film	Thin Film	Oxide Coated	Oxide Coated
DRIVE: Technology type	Modified 3350	Modified 3350	Modified 3350	Modified 3350	Modified 3350
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	Modifed ST412	IBM PC	IBM PC	ST412	SASI
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 12.65	F: 5.32	F: 10.65	--	F: 10.65
REMOVABLE	--	--	--	F: 6.38	--
Capacity per track (Bytes)	U: 10,416	F: 8,704	F: 8,704	U: 10,416	F: 8,704
Data surfaces per spindle	2	2	2	2	4
Heads per data surface	1	1	1	1	1
Tracks per surface	612	306	612	306	306
Track density (TPI)	849	566	849	345	367
Maximum linear density (BPI)	12808	11439	13083	9022	8842
Rotational speed (RPM)	2322	2322	2322	3600	3600
PERFORMANCE					
Actuator type	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor
Average positioning time (msec)	100 (including settling)	95 (including settling)	100 (including settling)	45 (including settling)	85 (including settling)
Average rotational delay (msec)	12.9	12.9	12.9	8.3	8.3
Average access time (msec)	112.9	107.9	112.9	53.3	93.3
Data transfer rate (KBytes/sec)	400	400	400	625	625
FIRST CUSTOMER SHIPMENT	11/85	11/85	11/85	3Q84	4Q84
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	--
COMMENTS	28.9 mm High Embedded Servo	33 mm High Embedded Servo	33 mm High Embedded Servo		41 mm High

MANUFACTURER	XEBEC	YE DATA	YE DATA		
DRIVE	Owl II	3530	3540		
DISK/TREND GROUP	5	6	6		
MARKET	OEM	OEM	OEM		
MEDIA: Generic type	Fixed	Fixed	Fixed		
Nominal disk diameter	130 mm OD 40 mm ID	95 mm OD 25 mm ID	95 mm OD 25 mm ID		
Recording medium	Oxide Coated	Thin Film	Thin Film		
DRIVE: Technology type	3370 (Ferrite)	3370 (Ferrite)	3370 (Ferrite)		
Heads	Ferrite	Ferrite	Ferrite		
Interface	SASI	ST412, SCSI	ST412, SCSI		
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	F: 21.3	U: 38.07	U: 53.3		
REMOVABLE	--	--	--		
Capacity per track (Bytes)	F: 8,704	U: 10,416	U: 10,416		
Data surfaces per spindle	4	5	7		
Heads per data surface	1	1	1		
Tracks per surface	612	731	731		
Track density (TPI)	736	1019	1019		
Maximum linear density (BPI)	8845	13200	13200		
Rotational speed (RPM)	3600	3600	3600		
PERFORMANCE					
Actuator type	Rotary, Band, Stepping Motor	Rotary, DC Motor	Rotary, DC Motor		
Average positioning time (msec)	65 (including settling)	40	40		
Average rotational delay (msec)	8.3	8.3	8.3		
Average access time (msec)	73.3	48.3	48.3		
Data transfer rate (KBytes/sec)	625	625	625		
FIRST CUSTOMER SHIPMENT	4/86	4Q86	4Q86		
U.S. OEM PRICE FOR 100 UNITS	--	--	--		
COMMENTS	41 mm High	41 mm High	41 mm High		

MANUFACTURER PROFILES

1986 DISK/TREND REPORT

MANUFACTURER PROFILES

All manufacturers now producing moving head rigid magnetic disk drives, or which have indicated specific plans to enter the market, are listed in this section. The heading "1985 disk sales" refers to the DISK/TREND estimate of moving head rigid disk drive sales only -- no sales of other drive types are included, nor are sales of parts or other disk drive related products such as controllers. "1985 total net sales" covers the fiscal year ending in 1985 for each firm unless noted otherwise, or for the parent company if the disk drive manufacturer is a subsidiary. The fiscal year of listed firms ends on December 31, 1985, unless otherwise noted. Northern Telecom is listed with U.S. firms for convenience.

Exchange rates

The exchange rates used in converting the financial data of non-U.S. manufacturers to dollars is given below. The average exchange rate for 1985 is used, as reported by the U.S. Federal Reserve Bulletin and rounded to three significant figures.

Country	Currency	Currency units per U.S. dollar
Canada	Dollar	1.37
France	Franc	8.98
Italy	Lira	1909.00
Japan	Yen	238.00
Korea	Won	862.00
Taiwan	Dollar	39.9
United Kingdom	Pound	0.771
West Germany	Deutsch mark	2.942

U.S. Manufacturers

ALPHA DATA, INC.
20750 Marilla Street
Chatsworth, CA 91311

Alpha Data is a privately held manufacturer of head-per-track disk drives. The firm has been trying for several years to develop the market for an unusual 14" moving head drive using plated disks. The current version has 520 megabytes capacity and 18 ms average access time, achieved by using 10 heads per data surface.

AMCODYNE, INC.
1301 South Sunset Street
Longmont, CO 80501

1985 disk sales: $8,900,000

Organized in 1981 by a group of industry veterans with high performance disk drive experience at Storage Technology, Amcodyne started first shipments of its 8" disk cartridge drive (26 MB fixed/26 MB removable) in early 1983. The firm's second product, an 8" fixed disk drive with 224 megabytes capacity, was discontinued in 1985 before deliveries were started, in order to concentrate on the disk cartridge drive market, in which Amcodyne has established a leadership position, with continuing sales to several major system manufacturers. Because the market for Amcodyne's products is relatively small, the company has had difficulty in generating enough revenue to support the development of new products, and in 1986 Amcodyne announced that it was being acquired by Century Data Systems.

AMPEX CORPORATION
Subsidiary of Signal Companies, Inc.
401 Broadway
Redwood City, CA 94063

1985 disk sales: $19,600,000
1985 total net sales: $9,115,000,000 Net income: $(279,000)

After having manufactured OEM disk drives for 15 years, the firm's small remaining market share became unprofitable, and most production has been phased out in 1986. At its peak, the Ampex product line consisted of numerous 14" disk pack and fixed disk drive models, plus several low end 5.25" drives licensed from Rodime. The only product remaining in production is a 14" fixed disk drive with parallel data transfer.

ATASI CORPORATION
2075 Zanker Road
San Jose, CA 95131

1985 disk sales: $21,800,000

Atasi is a privately held firm started in 1981 by disk industry veterans to manufacture high capacity 5.25" Winchester fixed drives. The company was first to establish quantity production of voice coil 5.25" drives and managed to secure an attractive market share. However, the firm's initial design was costly compared to competitive products which followed, and Atasi failed to hold its initial lead. Atasi's agreed upon acquisition by Seagate fell through early in 1984, followed by a management reorganization. As cash problems became severe, the company entered Chapter 11 in August, 1985, but maintained operations with a small staff. Atasi emerged from Chapter 11 in 1986 and has since introduced a 170 megabyte drive.

BRAND TECHNOLOGIES, INC.
6140 Variel Avenue
Woodland Hills, CA

Brand Technologies was formed in 1986 to develop high performance 5.25" Winchester drives by Avi Brand, a veteran of Pertec and Computer Memories. The firm has acquired rights to some of CMI's tooling and equipment to speed up the development process for its own drives, and first shipments are scheduled for early 1987.

BURROUGHS CORPORATION
Burroughs Place
Detroit, MI 48232

1985 disk sales: $184,400,000
1985 total net sales: 5,038,000,000 Net income: $248,000,000

After many years of captive disk drive production, Burroughs acquired Memorex in late 1981. All Burroughs disk drive operations have now been consolidated in the firm's Memorex subsidiary, including production of captive drives. Internally manufactured drives sold with Burroughs systems on a captive basis consist of 3330 and 3380 plug compatible models from the Memorex product line, now equipped with controllers for use with Burroughs systems. The Memorex PCM activities are reviewed under the heading for that organization. The 1986 acquisition of Sperry by Burroughs may lead to changes in the combined company's strategy toward data storage, but it is not yet clear how the new arrangement will affect either Memorex or the Sperry investment in Magnetic Peripherals, Inc.

CENTURY DATA SYSTEMS, INC.
1270 North Kraemer Boulevard
Anaheim, CA 92806

1985 disk sales: $69,300,000

After several years of flat sales, Century was sold in mid-1986 by Xerox to Cybernex Corporation. Cybernex has been restructured after a complex agreement with IBM, which included divestiture of all head manufacturing operations, and is now a holding company for Century Data Systems and Cybernex Advanced Storage Technology. Century's product line has been in transition for several years, as newer fixed disk drives gradually replaced products in production before the acquisition by Xerox in 1979. Disk cartridge drives, inherited from Xerox' Diablo subsidiary, were phased out in 1981. Century is pinning its future hopes on the higher capacity fixed disk drives introduced during the past three years, including 8" fixed disk drives with capacities up to 830 megabytes.

COGITO (See Asian Manufacturers)

COMPUTER MEMORIES, INC.
9233 Eton Avenue
Chatsworth, CA 91311

1985 disk sales: $150,500,000
1985 total net sales: $108,709,000 (FY ending 3/31/85) Net income: $(3,810,000)

CMI started shipments of 5.25" fixed Winchester drives in 1981. IBM became CMI's largest customer in 1984, with major purchases of 20 megabyte drives used in the PC AT. During 1985 and 1986 CMI's IBM business sometimes exceeded 80% of the firm's total. The burden of keeping IBM happy proved to be too much for CMI -- development of future products suffered badly. When IBM stopped buying at the end of 1985, CMI had few products suitable for the 1986 OEM market. The firm also found it necessary to settle an expensive patent infringement lawsuit with Quantum, with the payment of $6 million and an agreement to discontinue certain disk drives. After struggling for several months with the problem, CMI's management announced in June, 1986, that the firm had dropped all disk drive manufacturing.

CONNER PERIPHERALS, INC.
2221 Old Oakland Road
San Jose, CA 95131

Conner Peripherals is pioneering the market for high performance 3.5 inch Winchester disk drives. The firm is headed by Finis Conner, co-founder of Seagate Technology, and the firm's first product was designed by a development company organized by John Squires, until early 1985 a key member of the Miniscribe technical staff. The company has attracted a minority investment by Compaq Computer and has installed a high-volume production facility in San Jose, with first shipments in August, 1986.

CONTROL DATA CORPORATION
8100 - 34th Avenue South
Minneapolis, MN 55440

1985 disk sales: $1,319,200,000
1985 total net sales: $3,679,700,000 Net income: ($567,500)

After six years of watching its role as the leader in OEM disk drives gradually evaporate, Control Data appears to have stabilized its position. The firm's share of worldwide OEM rigid disk drive revenues fell to 16.8% in 1985, after a continuing decline from 1980's peak of 55%. But during the last two years CDC has managed to maintain a flow of major new 14", 9", 8" and 5.25" drives, to replace those which have been declining in shipments. The company became the dominant OEM drive supplier in the 1970's on the strength of successful product lines in 14" disk cartridges, storage module drives, large disk pack drives, plus mid-range and large fixed disk drives. But many of the older OEM drives peaked in shipments years ago, and CDC went through a long dry spell, before management changes refocused resources on new product start up activities. Disk drives sold by Control Data are designed and manufactured by Magnetic Peripherals, Inc., a joint venture with ownership now shared by CDC, Honeywell, Sperry and Bull Peripherals. Control Data manages the joint venture and has exclusive responsibility for sales of its products in the OEM market. Drives made by MPI for sale with any of the parent company's systems are considered captive CDC drives for the purposes of DISK/TREND statistics, and captive drives for parent companies are a significant portion of MPI shipments. Control Data was a participant in the plug compatible disk drive market for several years, but its late start in the 3380 market prompted the firm to phase out of the PCM market in 1985. Until 1986 CDC also was the managing partner in Optical Storage International, an optical disk joint venture with Philips. However, this organization has now been renamed, with majority control in Philips hands.

CYBERNEX ADVANCED STORAGE TECHNOLOGY, INC.
Subsidiary of Cybernex Corporation
6589 Via Del Oro
San Jose, CA 95119

CAST is now affiliated with the Century Data Systems group of companies managed by the reorganized Cybernex, after Cybernex' agreement with IBM to withdraw from thin film head manufacturing, and the sale of Century to Cybernex by Xerox. CAST was originally established by Cybernex in 1983 to develop and manufacture high capacity half high 5.25" drives, and has started limited production of drives with capacities up to 110 megabytes. Much of the funding for CAST was provided by Singapore National Iron & Steel Mills, and the firm plans to establish manufacturing in Singapore.

DATA GENERAL CORPORATION
4400 Computer Drive
Westboro, MA 01581

1985 disk sales: $136,000,000
1985 total net sales: $1,239,000,000 (FY ending 9/30/85) Net income: $24,305,000

Data General manufactured all disk drive requirements internally for years, covering its requirements with several captive disk cartridge, disk pack and 14" Winchester drives. Despite the addition to its product line of several drives purchased from outside disk drive manufacturers, Data General has continued with introduction of internally developed drives, adding low end 8" drives in 1982, plus a 354 megabyte 14" fixed drive in 1983, subsequently extended to 592 megabytes in late 1984. Disk drive manufacturing is being consolidated in a new facility in New Hampshire.

DIGITAL EQUIPMENT CORPORATION
146 Main Street
Maynard, MA 01754

1985 disk sales: $536,400,000
1985 total net sales: $6,686,000,000 (FY ending 6/30/85) Net income: $447,000,000

During the many years that DEC has manufactured disk drives, most of the revenues from the program were derived from disk cartridge drives, notably the high volume RL02 and its predecessors. However, in 1981 a new family of 14" Winchester drives appeared. The RA81, a 14" rack mounted Winchester drive with a formatted capacity of 456 megabytes has been the big revenue producer for DEC in recent years. The other drive in the group is the RA60, a rack mounted disk pack drive with 205 megabytes formatted capacity. These were DEC's first internally designed and produced high end disk drives, and the manufacturing startup for the drives and their controller was painful, but significant to the firm's profitability. The

company has told customers that it expects to deliver the follow-on to the RA81, the RA82, in the near future. In late 1983, DEC started shipping the RC25 "Aztec", a long-delayed 8" disk cartridge drive, superseding the 14" RL02 -- perhaps too late to maintain the company's disk cartridge drive market at its previous size. Although DEC is expected to eventually produce its own high end 5.25" drives, it has become a major customer for 5.25" drives manufactured by both Micropolis and Maxtor.

DISC TECH ONE
849 Ward Drive
Santa Barbara, CA 93111

In 1982 Disc Tech One acquired from M/A-Com the Ohio Scientific disk drive operation (previously owned by Okidata). In 1984 the firm merged with Lifetech Industries Corporation, a San Diego hearing aid manufacturer, but Disc Tech One was later re-established as a separate company. The firm is now devoting most of its resources to development and manufacture of disk subsystems for personal computers, with very limited production of the original 14" drives, and the 8" drives acquired from 3M and the 5.25" drives acquired from CCT.

DISCTRON, INC.
Subsidiary of Computer & Communications
Technology Corporation
1701 McCarthy Boulevard
Milpitas, CA 95035

1985 disk sales: $5,800,000
1985 total net sales: $67,753,000 Net income: ($9,893,000)

CCT established Disctron from the combination of Data Peripherals and Rotating Memory Systems, following the acquisition of RMS in mid-1982. The 8" drives from the Data Peripherals line remained in production until 1985. The RMS 5.25" Winchester product line was sold in 1984 to Disc Tech One.

DMA SYSTEMS
601 Pine Avenue
Goleta, CA 93117

DMA Systems started shipments of its 5.25" 5/5 MB fixed-removable disk cartridge drive in 1982, and established an early leadership position in the 5.25" disk cartridge field, despite relatively high prices compared to fixed disk drives. Later, capacities were doubled on the fixed/removable drives, and an 11 MB half high was introduced. Manufacturing licenses were sold to Memorex, which later discontinued all OEM disk drive operations, and also to Newbury Data, Ricoh, and MFM, all of which are pro-

ducing drives. However, the market was slower to respond to DMA's product and pricing than the firm had anticipated. DMA ran out of funds and was forced to cease operations by its bank, in August, 1985, but re-established production a few months later. By mid-1986, the bank had been paid off and the firm is attempting to reorganize for larger scale operations.

HEWLETT-PACKARD COMPANY
3000 Hanover Street
Palo Alto, CA 94303

1985 disk sales: $259,100,000
1985 total net sales: $6,505,000,000 (FY ending 10/31/85) Net income: $489,000,000

Hewlett-Packard has an extensive manufacturing operation for captive disk drives at Boise, Idaho, established in 1977 and since expanded, supplemented in mid-1983 with a new $50 million facility in Bristol, England, and by production of 3.5" Winchester drives at Greeley, Colorado. H-P makes disk cartridge, disk pack, and fixed Winchester disk drives at Boise, which is also the firm's development facility for advanced head and disk technology development. The sputtered disks used in 3.5" drives are produced at Boise. The industry expects H-P to become a major producer of small fixed disk drives using advanced recording technology.

IBIS SYSTEMS, INC.
5775 North Lindero Canyon Drive
Westlake Village, CA 91360

1985 disk sales: $31,200,000

Ibis was one of the most ambitious of the industry's many start up companies from the early 1980's, with a plan to make OEM and PCM versions of a 3380 equivalent drive using composite manganese zinc heads and plated disks. After finding that the technical complexities of such a project are very real, and having learned the extent of the resources needed to launch an adequate sales and service organization, Ibis changed its strategy to concentrate on a parallel track version of the drive. This plan has paid off, and Ibis is now the leader in drives used with supercomputers and certain high end imaging systems -- all of which can make use of the 12 megabyte/second transfer rate which is unique to the Ibis drive.

INTERNATIONAL BUSINESS MACHINES CORPORATION
Route 22
Armonk, NY 10504

1985 disk sales: $6,416,300,000
1985 total net sales: $50,056,000,000 Net income: $6,555,000,000

IBM is now manufacturing 14", 8", 5.25" and 3.5" fixed disk drives at several factories in the United States, Europe, Japan and Brazil. The revenue leader in all of this activity is clearly the 3380 family, with the double capacity model introduced in 1985 already assuming the majority of shipments. Positioned below the 3380 to serve the low end mainframe market, the 3370 and 3375 are now in decline and will probably be gone in a few years. IBM introduced the 9335, a 14" drive with 855 megabytes, and the 9332, two 8" models with 200 or 400 megabytes, in mid-1986 to replace the older drives and to fill in the gap below. IBM's first significant OEM sales of disk drives were made in early 1984, and involved the 3380 -- both Siemens and Honeywell are buying the drive. For disk drives broadly sold on an OEM basis, it will be more difficult for IBM to establish a significant OEM disk drive business due to tough competition and a rapidly changing market -- but the firm is making a strenuous effort to sell newer models to major system manufacturers and is quoting low prices.

On the other side of the coin, IBM is still a major buyer of OEM disk drives, primarily small diameter drives for the personal computer family. Although the totals are down from the peak of a few years ago, IBM is still buying large quantities to supplement apparent shortfalls in its own production. Internal manufacturing for small diameter disk drives is now going into high gear at IBM: The firm has made a large portion of its current requirements for 5.25" drives for the PC XT and PC AT, and are ramping up production for several new models. 30, 40 and 70 megabyte voice coil 5.25" drives are now in production. The stepping motor 5.25" drives now being phased out will be replaced by sharply increased production of 3.5" drives during the coming year.

JOSEPHINE COUNTY TECHNOLOGY, INC.
1899 N.W. Hawthorne
Grants Pass, OR 97526

Josephine County Technology was started by disk drive industry veterans trying to escape the smog of San Fernando Valley. The firm started production at the close of 1984 with half high 5.25" Winchester drives, designed to be produced at extremely low cost. The company's activities have been on a small scale, so far, limited by a lack of financing.

LAPINE TECHNOLOGY CORPORATION
182 Topaz Avenue
Milpitas, CA 95035

LaPine Technology was formed in July, 1983, to develop and manufacture 3.5" Winchester drives. The founders' experience includes several notable disk drive manufacturers. The company is a case study in creative financing for the disk drive industry, during a period of scarce venture capital funding. The repertoire of financing techniques included limited R&D partnerships, inventory financing (Prudential Bache), and an offshore partner for manufacturing and further equity investment (Kyocera). LaPine's 20 megabyte 3.5" drives are being produced by Kyocera in Japan.

MAXTOR CORPORATION
150 River Oaks Parkway
San Jose, CA 95134

1985 disk sales: $74,900,000
1985 total net sales: $85,155,000 (FY ending 3/31/85) Net income: $10,682,000

Maxtor startled its competitors in 1982 by announcing a family of 5.25" drives with up to 140 megabyte capacity. These drives went into production in mid-1983, later joined by 190 megabyte drives in 1984 and 380 megabyte drives in 1985. Maxtor became the first company to find space in the standard 5.25" form factor for eight disks, and thus was able to achieve up to 190 megabytes while maintaining the standard Seagate transfer rate of five megabits per second -- a strategy which proved successful in making available an immediate market with OEMs wishing to use standard ST412 controllers. In preparation for the ten megabit per second transfer rate required by the 380 megabyte drive, Maxtor became the industry leader in establishing the ESDI de facto interface standard, now widely used for high performance 5.25" drives. Maxtor is now the leader in high end 5.25" Winchesters despite early skepticism by competitors, and has again grabbed the spotlight by announcing a 765 megabyte 5.25" drive, scheduled for delivery in early 1987.

MEGAVAULT
6431 Independence Avenue
Woodland Hills, CA 91367

SLI, a veteran industry supplier of voice coil actuators, changed its name in 1982 to reflect its new emphasis on complete disk drives. Megavault's biggest sale was a kit used by Texas Instruments for a few years in assembling their 8" Winchesters. But that program has been completed, and, lacking other significant customers, Megavault has withdrawn from manufacturing disk drives.

MEMOREX CORPORATION
Subsidiary of Burroughs Corporation
San Tomas and Central Expressways
Santa Clara, CA 95052

1985 disk sales: $62,700,000

Memorex was acquired by Burroughs in late 1981, and Burroughs has placed all disk drive development and manufacturing responsibility for the entire company in the Memorex organization. First deliveries of the firm's 3380 equivalent drive were made in mid-September, 1983, as promised -- but various technical problems kept the production level below plan. However, by early 1986 the problems appear to have been solved, and the company has indicated plans to introduce and ship its first double capacity 3380 equivalent drive by the end of 1986. The Memorex OEM disk drive product line, consisting mostly of 200 megabyte disk pack drives sold to DEC, plus the resale of smaller diameter drives manufactured by others, has been discontinued. One of the first major projects at Memorex under Burroughs management, already satisfactorily completed, was development of controllers to make possible the use of large Memorex disk drives with Burroughs systems -- thus creating another sizeable market for Memorex drives, a captive one. It is not yet clear what effect the Burroughs acquisition of Sperry will have on Memorex disk drive production. Burroughs' captive sales are covered under the Burroughs listing in this section.

MEMORY SYSTEMS, INC.
Subsidiary of Asher Engineering Corporation
15115 Ramona Boulevard
Baldwin Park, CA 91706

Memory Systems was established by Asher Engineering, a specialty motor manufacturer, to develop and market 5.25" Winchester drives in the 40-80 megabyte range, with first shipments in mid-1986. An encoder motor made by Asher is used as the head positioning motor in the drives, which are produced on a contract manufacturing basis for Memory Systems by an outside firm.

MFM, INC.
360 Merrimack Street
Lawrence, MA 01843

MFM started manufacturing 5.25" disk cartridge drives in 1985 under license from DMA Systems. The firm had previously been involved in providing service for DMA drives, and offered controller development services. Increased capacity versions of the original designs are planned.

MICROCOMPUTER MEMORIES, INC.
6855 Vineland Avenue
North Hollywood, CA 91605

1985 disk sales: $18,700,000
1985 total net sales: $1,373,000 (FY ending 3/2/85) Net income: ($5,527,000)

MMI was formed quietly in 1982 to develop a 3.5" Winchester drive, and managed to go public in January, 1984, before the big 1984 decline in technology stocks. The firm started shipping a 10 megabyte drive in 1984 and a 4-platter 20 megabyte version in 1985. After a year of growing shipments, mostly to personal computer subsystem manufacturers, the firm ran out of cash and filed Chapter 11 bankruptcy proceedings in May, 1986. MMI's product line is now limited to a portable disk drive subsystem intended for security applications and other specialized markets.

MICROPOLIS CORPORATION
21123 Nordhoff Street
Chatsworth, CA 91311

1985 disk sales: $93,200,000
1985 total net sales: $94,900,000 Net income: $2,780,000

Known as the originator of high capacity 5.25" flexible disk drives, Micropolis entered the 8" Winchester disk drive market in 1979, and became a factor in the marketplace, after the usual Winchester early production problems. The company has embarked on an ambitious development program for small high performance Winchester disk drives, and has become a market leader in high capacity 5.25" drives -- the first firm to establish volume deliveries of 85 megabyte models. Micropolis has been the 5.25" industry leader at 85 megabytes and is also expected to be in contention for leadership at 170 megabytes. A 380 megabyte model has been scheduled for delivery by the end of 1986.

MICROSCIENCE INTERNATIONAL CORPORATION
575 East Middlefield Road
Mountain View, CA 94043

1985 disk sales: $33,700,000

Microscience International was formed early in 1982 by experienced disk drive engineering managers. The firm started shipments in mid-1983 for its half high 5.25" 10 megabyte drive, and added a 20 megabyte version in mid-1984, both using plated disks, and with several innovative design features intended to improve reliability. 3.5" drives were also added to the line, including both OEM and card-mounted versions. A half high voice coil 5.25" drive with 50 megabytes capacity was added in early 1986. The firm has joined with the Wearnes organization to establish a manufacturing facility in Singapore, now in production.

MICRO STORAGE CORPORATION
2986 Oakmead Village Court
Santa Clara, CA 95051

Micro Storage was formed in 1984 to produce a 5.25" half high disk cartridge drive, with founders from Santa Clara Valley and funding from Omron Tateisi Electronics Company Ltd, Kyoto. First production shipments were made in mid-1985, with manufacturing by Omron. The firm is involved in a lawsuit by SyQuest Technology, which claims that two ex-employees misappropriated trade secrets, but plans to introduce new drives which will avoid the areas of contention.

MILTOPE CORPORATION
1770 Walt Whitman Road
Melville, NY 11747

1985 total net sales: $61,300,000 Net income: $5,430,000

Miltope manufactures both flexible and rigid disk drives for use in its line of militarized peripherals, which includes disk, tape and bubble memory subsystems. Miltope's internally manufactured Winchester drives include 5.25" and 3.5" models incorporating heads and media in removable cartridges.

MINISCRIBE CORPORATION
1871 Lefthand Circle
Longmont, CO 80501

1985 disk sales: $113,400,000
1985 total net sales: $113,951,000 Net income: ($16,773,000)

Production of Miniscribe's 5.25" Winchester drives started in late 1981, stayed at modest levels through most of 1982, then soared in late 1982 as IBM started taking 5.25" Winchester deliveries for the personal computer program. Other major OEM customers were subsequently added, and the company has maintained a strong position in non-captive shipments of 5.25" Winchester drives below 30 megabytes. It's not been an easy life, however, with drastic changes in IBM's procurements in 1984, coupled with the adverse fortunes of some of Miniscribe's customers which lost market share in the personal computer wars to IBM. Miniscribe started shipping half high 5.25" drives in the first half of 1983, and added 20 megabyte 3.5" drives in late 1984 and 85 megabyte 5.25" drives in 1985. But in spite of Miniscribe's success in new product development, business problems caused by loss of IBM's purchases in early 1985 led to the departure of the founding management, to be replaced by a trouble-shooting team installed by Hambrecht & Quist, the investment banking firm which led a rescue financing operation. The new management focused on new products, with a tough cost control program, and recent quarterly results show that Miniscribe has returned to profitability.

NORTHERN TELECOM, INC.
Subsidiary of Northern Telecom, Ltd. (Canada)
259 Cumberland Bend
Nashville, TN 37228

1985 disk sales: $12,900,000
1985 total net sales: $4,160,000,000 Net income: $294,000,000

Northern Telecom's Memory Systems Division in Ann Arbor, Michigan, is shipping a family of high performance 8" Winchester drives, with capacities now up to 563 megabytes. These drives are used for captive applications with Northern Telecom and are supported with an active OEM sales program.

PERIPHERAL TECHNOLOGY, INC.
9170 Independence Avenue
Chatsworth, CA 91311

Peripheral Technology was founded in 1985 to develop and market a high capacity 3.5" Winchester drive first shipped in the second half of 1986, with founders who had worked together at Dataproducts, then acquired various disk drive experience. Financing is from Haitai International, a Korean company.

PLUS DEVELOPMENT CORPORATION
Subsidiary of Quantum Corporation
1778 McCarthy Boulevard
Milpitas, CA 95035

The Plus Hardcard is an innovative plug-in card for the IBM personal computer aftermarket, combining a 3.5" Winchester and all controller electronics on a single add-in card. The original version, first shipped in October, 1985, was 10 megabytes, supplemented in 1986 with a 20 megabyte model. The Hardcard has attracted a flood of competition, both from other disk drive manufacturers and from firms specializing in the personal computer aftermarket. Both types of competitors were able to quickly enter the market, by combining controller boards with 3.5" drives already in production. Quantum set up Plus as a separately operated subsidiary, in order to provide concentration on the special design requirements involved and to establish a specialized marketing and sales organization targeted at the PC market. Manufacturing has been contracted out to Matsushita Kotobuki Electronics.

PER SCI, INC.
Subsidiary of EF Industries
12624 Daphne
Hawthorne, CA 20250

Effective July, 1984, PerSci acquired the 14" disk cartridge drive line from Cipher, which previously had followed an ownership path from Wangco to Perkin Elmer to Cipher. These products thus joined the PerSci floppy drives and the previously acquired Caelus 14" disk cartridge drives (via EMM), in an organization set up by Ed Farris, an ex-EMM executive, to sell and maintain products nearing the end of their production life. The drives acquired from Cipher have been produced at minimal levels.

PRIAM CORPORATION
20 West Montague Expressway
San Jose, CA 95134

1985 disk sales: $104,200,000
1985 total net sales: $105,025,000 (FY ending 6/30/85) Net income: ($20,930,000)

Priam became a significant supplier of OEM Winchester disk drives in 1981, as volume production was achieved for the firm's original line of mid-range 14" drives and shipments of 8" drives got underway. 8" Winchesters with capacities up to 344 megabytes eventually became the firm's leading products. After abortive efforts to enter the high capacity 5.25" market, Priam acquired Vertex Peripherals in early 1985, with its successful 5.25" product line of drives up to 85 megabytes. However, Priam has been slow to penetrate the market for high end 5.25" drives and the firm's management was reorganized in 1986, apparently in an attempt to focus on this area.

QUANTUM CORPORATION
1804 McCarthy Boulevard
Milpitas, CA 95035

1985 disk sales: $119,600,000
1985 total net sales: $121,000,000 (FY ending 3/31/86) Net income: $22,200,000

Quantum's original game plan was to provide a low-cost upgrade to the Shugart Associates 8" Winchester drives. The Quantum plan worked very well, and 5.25" drives with capacities up to 40 megabytes were added in 1983, becoming the company's major product. As the Quantum full size 40 megabyte 5.25" drives peaked, the firm announced half high OEM 5.25" drives with up to 80 megabytes capacity, for delivery before the end of 1985. First shipment of these drives was six months late, however, and Quantum's sales growth has flattened out for the moment. The company also set up Plus Development as a wholly owned subsidiary to pioneer development and marketing of unique 3.5" drives for the personal computer market.

SEAGATE TECHNOLOGY
920 Disc Drive
Scotts Valley, CA 95066

1985 disk sales: $285,500,000
1985 total net sales: $215,000,000 (FY ending 6/30/85) Net income: $1,000,000

The term "Seagate compatible" has become part of the industry's language. In 1981, Seagate shipped two thirds of the 5.25" drives produced worldwide, with 35,000 units -- and another de facto standard was created. In 1982, Seagate's many new competitors nibbled the company's worldwide share of low end 5.25" Winchesters down to 40%, and by 1985 the Seagate market share was down to 24.4%. Seagate has taken the lead in moving production for its high volume drives offshore, to secure lower manufacturing costs. But the world changed for Seagate in mid-1984, with a sharp reduction in sales to its largest customer, IBM -- and an up-and-down buying pattern which continued in 1985. Through tough management, Seagate has stayed profitable and rebuilt its 1986 revenues to the highest level yet attained by the company. Seagate is attempting to diversify into higher capacity 5.25" drives, but during the last year a major part of the firm's growth has come from the personal computer aftermarket: After IBM cut back purchases of Seagate stepping motor drives in favor of internal captive production, Seagate launched a successful campaign to take the business away from IBM at the dealer level. Seagate's phenomenal success in the aftermarket eventually prompted IBM to drastically cut prices on PC XT models shipped with hard disk drives, in an attempt to recover this lost business, but with only partial success. The company is still vulnerable to changes IBM might make in the PC attachment opportunity for disk drives, but has already demonstrated the resiliency likely to be necessary for future survival.

SHUGART CORPORATION
Subsidiary of Xerox Corporation
435 Oakmead Parkway
Sunnyvale, CA 94086

1985 disk sales: $36,300,000
1985 total net sales: $8,732,000,000 Net income: $381,000,000

Shugart Associates took advantage of its early leadership in flexible disk drives with its 1979 introduction of an early low-end 14" Winchester drive, the 14" SA 4000, followed by the 8" SA 1000, which was a winner, until 5.25" drives became the low-end standard. Shugart got a late start with 5.25" Winchesters, and as the company fell behind in floppy drives, lost credibility with OEMs. The rigid disk drive programs were phased out during the past year.

STORAGE TECHNOLOGY CORPORATION
2270 South 88th Street
Louisville, CO 80027

1985 disk sales: $85,200,000
1985 total net sales: $673,000,000 Net income: ($44,000,000)

After great success in the second half of the 1970's as the leader in plug compatible disk drives, STC's shipments dropped in 1982/1983, as IBM 3380 shipments started in earnest. STC's volume shipments of 3380 equivalent drives didn't start until early 1984, too late to save the company from failures in its other new business areas. The firm's management had launched expensive programs to build mainframe computers and optical disk drives -- and had acquired firms in other areas, with extensive bank borrowing. In October, 1984, the bankers wouldn't wait, and the company was thrown into Chapter 11. Disk drive order rates have suffered because of the loss of credibility brought on by bankruptcy, but are improving with the availability of the STC double capacity 3380 equivalent drive in mid-1986. The firm has been carrying out complex negotiations with creditors and hopes to emerge from bankruptcy by the end of 1986.

SYQUEST TECHNOLOGY
47923 Warm Springs Boulevard
Fremont, CA 94538

1985 disk sales: $36,300,000

SyQuest was started in early 1982 to make disk drives using 3.9" (100 mm) plated disks, in both fixed and removable disk configurations. SyQuest's plan was extremely ambitious, but the firm didn't get into volume production with a reliable drive until late 1983. After initial early emphasis on the personal computer aftermarket, SyQuest has established significant OEM sales, with major shipments to the segment of the PC market controlled by governmental security requirements. The firm plans higher capacity follow-on disk drives in this market area. A license has been taken by Nippon Systemhouse for sales in Japan.

TANDON CORPORATION
20320 Prairie Street
Chatsworth, CA 91311

1985 disk sales: $70,500,000
1985 total net sales: $269,000,000 (FY ending 6/30/85) Net income: ($135,000,000)

Tandon's growth rate in flexible disk drives made the company the world's largest manufacturer of floppy drives in the early 1980's, and the firm launched a bid to become a major supplier of 5.25" Winchester drives, eventually supplemented with 3.5" drives. Consistent with the firm's

philosophy of maximum practical vertical integration, Tandon internally manufactures a very high proportion of its drives' content, including plated disks. In contrast to its largest 5.25" Winchester competitors, Seagate and Miniscribe, Tandon was not able to sell these products to IBM, and was late in establishing production for half high models. As a result, the company has never been able to advance beyond 3rd or 4th place in low end 5.25" Winchesters, and dropped to fifth place in 1985. Tandon has undergone a drastic change in company strategy during the last year and is now attempting to establish itself as a major personal computer manufacturer. It is likely that most of the firm's resources will be dedicated to the new program, rather than to disk drives.

TECSTOR, INC.
16161 Gothard Street
Huntington Beach, CA 92647

1985 disk sales: $6,200,000

Tecstor acquired rights in 1981 to a 14" Winchester drive developed by BASF in Europe, but never placed in quantity production. Tecstor's shipments started at the end of 1981, with a family of high performance 14" fixed disk drives offering capacities in the 300 megabyte range. After concluding that the modest production level available for this product line was not adequate to maintain profitability, Tecstor has now concentrated its resources in a line of parallel transfer drives using the same head disk assemblies.

TEXAS INSTRUMENTS INCORPORATED
Terminals and Peripherals Division
P.O. Box 1444
Houston, TX 77040

For several years TI assembled 8" Winchesters for captive use with TI computer systems, under a license from Megavault. The company has now phased out this program, as well as production of 5.25" Winchesters. The 5.25" drives were manufactured for captive use, originally under a Seagate Technology license. TI had planned to use the 5.25" drives as its entry point into the OEM disk drive market, but withdrew that program in 1983 after limited success.

TULIN CORPORATION
2393 Qume Drive
San Jose, CA 95131

1985 disk sales: $16,400,000

Tulin started production shipments of its family of half high 5.25" Winchester disk drives in March, 1984, with capacities up to 40 megabytes. With initial funding from ITT, the parent of neighboring Qume Corporation, and founders with extensive disk drive industry backgrounds, Tulin had

difficulty achieving major market penetration due to the relatively slow 85 millisecond average access time employed in the initial models. The management eventually bought out ITT's interest in the firm, and established a licensing and contract manufacturing arrangement with Oki Electric, in order to step up production for the planned faster drives. This arrangement was the victim of rapid changes in the dollar/yen exchange rate, which made Tulin's landed cost for drives made under the Oki Electric contract prohibitively expensive. Tulin retreated into Chapter 11, and the Oki Electric contracts were abrogated in the bankruptcy proceedings. Tulin is now manufacturing disk drives with a skeleton crew at the original San Jose facility.

VERMONT RESEARCH CORPORATION
Precision Park
North Springfield, VT 05156

1985 total net sales: $7,200,000 (FY ending 9/30/85) Net income: ($990,000)

VRC has been primarily a manufacturer of head-per-track disk drives and magnetic drum memories, with manufacturing both in Vermont and England. Lower demand for these memory devices has caused flat sales and a shrinkage in the company's staff. A 14" high capacity disk cartridge drive with embedded servo was produced for several years for militarized computer systems. In 1983, VRC started shipping fixed/removable and removable-only disk cartridge drives using the Dysan 8" disk cartridge. Because both of these product lines had very small sales, the company has stopped production and is working on a high capacity 8" drive for possible 1987 introduction.

WESTERN DYNEX CORPORATION
3536 West Osborn Road
Phoenix, AZ 85019

Western Dynex managed to stay profitable in the 14" disk cartridge drive business longer than most others, because of its highly efficient, low cost manufacturing operation. But OEM shipments of disk cartridge drives below 12 megabytes capacity are almost only a memory, and Western Dynex has elected to enter the 5.25" disk cartridge race. The drive will use the Dysan 5.25" cartridge, and was originally intended to be Seagate compatible. Rather than emphasize OEM sales, Western Dynex is developing subsystems aimed at specific vertical markets.

XEBEC
3579 Highway 50 East
Carson City, NV 89701

1985 disk sales: $10,000,000
1985 total net sales: $149,000,000 Net income: ($20,800,000)

Xebec's management has been looking for an entry point into the disk drive manufacturing business for years, as an extension of the firm's success in producing high-volume controllers. In 1984, several programs were launched, including purchase of the Datapoint Sunnyvale operations, the Epelo start-up for high performance 5.25" disk drives, and the Owl, an internally manufactured half high 5.25" drive with an embedded SASI interface. However, Xebec ran short on the cash required to fund all of its expansion programs, and only the Owl remains currently active.

Asian Manufacturers

(All fiscal years end in March, 1985 unless otherwise noted. Firms are in Japan unless otherwise noted.)

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

1985 total net sales: $1,321,210,000 Net income $53,265,000

Alps Electric is a high growth manufacturer of electronic components and sub-assemblies for television, audio, instruments and computer applications. The firm builds floppy disk drives on an OEM basis, notably for Apple Computer. Alps shipments of one sided 5.25" drives have topped all other floppy drive manufacturers worldwide since 1981. Alps began shipping 3.5" floppy drives in 1984. In 1985, Alps introduced a line of 5.25" half-high and 3.5" rigid disk drives. In 1986, Alps became the first manufacturer to introduce a 30mm high 3.5" drive.

COGITO SYSTEMS CORPORATION
Subsidiary of Ching Fong Investment Co., Ltd.
180 Chung Hsiao E. Rd., Sec. 4
Taipei, Taiwan

Cogito started operations in 1982 in California with funding from Ching Fong Investments, Ltd., a Taiwan organization which also owns Magnex, a head manufacturer. Cogito's first products have been low end half-high 5.25" Winchester drives. Production started in mid-1983, but shipments remained small, and all operations are now located in Taiwan.

EPSON (See Seiko Epson)

FUJI ELECTRIC CO., LTD.
12-1 Yurakucho 1-Chome
Chiyoda-ku
Tokyo, 100

1985 total net sales: $1,601,718,000 Net income: $28,092,000

Fuji Electric was established in 1923 and is the firm from which Fujitsu was born in 1935. Fuji Electric still owns about 16% of Fujitsu. The firm manufactures power generating equipment, electrical equipment for the transportation sector, vending machines and instrumentation. Data storage products include sputtered media and 3.5" disk drives with capacities up to 25 megabytes. Fuji Electric has provided contract manufacturing services to Fujitsu and Nippon Peripherals for 5.25" and 3.5" drives.

FUJITSU LIMITED
6-1, Marunouchi 2-chome
Chiyoda-ku, Tokyo 100

1985 disk sales: $1,099,400,000
1985 total net sales: $6,564,118,000 Net income: $374,067,000

Fujitsu derives about 70% of its sales from computer systems and is known as the leading manufacturer of computers for the Japanese domestic market. Fujitsu is also a major exporter to the worldwide computer market. Since 1982, the company has been among the leaders in worldwide disk drive revenues, and has skillfully managed a transition from older removable disk drives to a product line consisting mainly of fixed disk drives in all capacity ranges and in several disk diameters. The company's most impressive captive drives are 10.5" models which provide the Fujitsu answer to IBM's 3370 and 3380 drives.

Fujitsu has aggressively marketed most of its captive drives in OEM versions, using industry standard OEM interfaces, and is now a leader in the U.S. market for OEM rigid disk drives. Particularly effective in the OEM market have been the high performance 8" 48/84/168/337 megabyte drives, and the 10.5" "Eagle" series of high performance drives with up to 3.0 MB/sec transfer rate. Higher capacity versions of several existing OEM drives have been announced. Fujitsu is also a major factor in the IBM plug compatible disk drive market with sales of Eagle series drives through Amdahl. Fujitsu has begun manufacturing its high performance drives at a new facility near Portland, OR and is expected to increase the output of this factory at a rapid rate. At the 1986 Japan Business Show, Fujitsu exhibited a new 50 megabyte 3.5" drive.

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

1985 disk sales: $642,300,000
1985 total net sales: $21,064,270,000 Net income: $883,038,000

While Hitachi is Japan's largest manufacturer of electrical and electronic equipment, it is only the third largest Japanese manufacturer of computer systems. The firm currently makes a wide range of Winchester technology fixed disk drives which are sold as captive drives with Hitachi computer systems and, in several cases, as OEM drives. In addition to significant OEM sales of smaller capacity fixed disk drives, Hitachi also sells IBM compatible 3380 equivalent drives to National Advanced Systems for distribution with NAS systems in the U.S., and in 1983 started selling 3380 equivalent drives to BASF for distribution in the European PCM market. Hitachi was the first independent disk drive supplier to ship a double capacity product equivalent to the IBM 3380E. In 1986, Hitachi announced that it would establish a major rigid disk manufacturing facility in Oklahoma city. It will make 8" and 14" rigid drives and a line of optical disk drives.

KYOCERA CORPORATION
2-14-9 Tamagawadai
Setagaya-ku, Tokyo 158

1985 total net sales: $1,1190,273,000 Net income: $132,824,000

Kyocera is the world's largest manufacturer of ceramic packages for integrated circuits, and also makes a variety of electronic and optical components. The firm is currently making 3.5" drives on a contract manufacturing basis for LaPine Technology Corporation. Production began in 1986. Kyocera is considering Asian distribution of a similar product under its own name.

MATSUSHITA COMMUNICATION INDUSTRIAL CO., LTD.
4-3-1 Tsunashima-Higashi
Kohoku-ku, Yokohama 223

1985 disk sales: $7,100,000
1984 total net sales: $1,163,020,000 Net income: $51,704,000
(FY ending 11/30/84)

Matsushita Communication Industrial is a member of the Matsushita Electric industrial group, a worldwide giant in appliances and electronics. MCI was the licensee for Shugart Associates' flexible disk drives in Japan and most of the Shugart floppy models for the Japanese OEM market. In 1981, MCI added several Winchester technology fixed disk drives, including low end 5.25" drives. 3.5" Winchesters were added to the product line in 1985. MCI has also acquired the U.S. distribution rights for the 5.25" half-height floppy disk drive made under the Shugart license.

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

1985 disk sales: $39,000,000
1985 total net sales: $7,807,849,000 Net income: $145,109,000

In addition to being one of Japan's leading electronic and electrical products manufacturers, Mitsubishi Electric is a leader in the domestic small business systems market. The company is ending production of a variety of removable disk types and has begun making small and mid-range Winchester technology drives at a highly automated facility near Osaka. Captive shipments have been the major portion of Mitsubishi's disk drive shipments, but the firm is now emphasizing OEM business in small diameter Winchester drives.

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

1985 disk sales: $689,000,000
1985 total net sales: $9,488,970,000 Net income: $282,088,000

NEC has defined its product area as communications and computers, with computer products currently accounting for about one fourth of the firm's total revenues. Current disk drive production involves fixed disk drives, from large to small configurations, for both captive and OEM markets. Fixed disk drives include 14", 8", 5.25" and 3.5" disk diameters, with large scale production for 8" and 5.25" drives. Sales of the smaller drives have been very strong as a result of success in the OEM market and the strong position of NEC in the Japanese personal computer market.

NIPPON ELECTRIC INDUSTRY CO., LTD.
19-18, Tsutsumi-dori 1-chome
Sumida-ku, Tokyo 131

1985 disk sales: $14,600,000
1985 total net sales: $88,811,000 Net income: ($3,118,000)

Nippon Electric Industry (NEC owns 34.6% of the firm) is known in Japan by its tradename, Densei. The company produces power supplies for communications and computer equipment, automatic control systems and other electronic equipment. It manufactured magnetic drum memories for several years. Densei has entered the OEM disk drive market with 5.25" Winchesters of its own design, and has introduced half high models.

NIPPON PERIPHERALS LIMITED
660 Miyamae, Fujisawa-shi
Kanagawa-ken 251

1985 disk sales: $67,800,000

Fujitsu and Hitachi own NPL equally as a joint venture. NPL's charter was to develop advanced disk drives and other magnetic peripherals, and developed its own versions of most IBM new disk drives introduced since the 3340. In recent years, Fujitsu and Hitachi have de-emphasized the role of NPL, and the firm is scheduled to be shut down in the Spring of 1987. The major portion of NPL's current independent sales are to BASF, which markets PCM drives in Europe, and to Memorex, which markets 3370 equivalent drives in Europe and the U.S. These shipments are treated as PCM shipments by NPL in DISK/TREND statistics to avoid distortion of PCM market totals.

NIPPON SYSTEMHOUSE CO., LTD.
Nakajima Building
1-8-1, Kitashinjuku
Shinjuku-ku, Tokyo

Nippon Systemhouse acquired a license in late 1983 to manufacture the SyQuest line of fixed and removable 3.9" disk drives, and to market them in Japan. The firm is a manufacturer of medical systems, and terminals produced for Burroughs in Japan. The executive staff includes a number of ex-Burroughs managers. Nippon Systemhouse started disk drive production in 1984 and is concentrating on the subsystems market in Japan.

OKI ELECTRIC INDUSTRY CO., LTD.
1-17-12, Toranomon
Minato-ku, Tokyo 105

1985 total net sales: $1,520,445,000 Net income: $46,252,000

Oki is a diversified manufacturer of electronic communications and data processing equipment, and also has a major role in the Japanese market as a terminal producer. For several years, the firm emphasized floppy drives, and made 8" one sided floppy drives for captive use and 5.25" one third high drives for both OEM and captive use. In 1985, Oki obtained rights from Tulin to manufacture and market the Tulin 5.25" half high rigid disk line on a worldwide basis. Production began in early 1986 on a captive basis for Tulin, but as a result of the strong yen, the price to Tulin increased to the point where Tulin was non-competitive and had to file for Chapter 11 protection. A bankruptcy court subsequently terminated the Oki/Tulin supply contract. As a result, Oki is now considering other methods of distributing its rigid disk products.

OMRON TATEISI ELECTRONICS CO.
10, Hanazono-Tsuchidocho
Ukyoku, Kyoto 616

1985 total net sales: $1,1136,408,000 Net income: $38,265,000

Omron is best known as a manufacturer of electronic controls and electronic fund transfer systems. The firm is just beginning to make an entry into the data storage products industry through an investment in Micro Storage Corporation, which has designed a 5.25" cartridge disk drive. The drive will be made in volume by Omron, which began shipments to Micro Storage in mid 1986.

ORIENTAL PRECISION COMPANY LIMITED
11th Floor, Tae Wha Building
194-27 Insa-dong,
Chongno-gu, Seoul, Korea

OPC, founded in 1953, is one of Korea's pioneering firms in the electronics industry. It is a major supplier of telecommunications equipment, video systems, and a volume producer of CRT terminals. OPC is producing a 3.9" cartridge disk drive on a contract manufacturing basis for SyQuest and is actively seeking additional manufacturing business.

OTARI ELECTRIC CO., LTD.
29-18, Minami Ogikubo 4-chome
Suginami-ku, Tokyo 167

Otari is a specialized manufacturer of professional audio tape decks and high speed tape duplicating systems. Shortly before its acquisition by CCT, Rotating Memory Systems (later Disctron) entered into a manufacturing agreement with Otari to produce the 5.25" Winchester drives for sale in Japan. Otari started production of the orginal RMS full size drive in 1983, and has since added half high models on its own.

RICOH CO., LTD
15-5 Minami-Aoyama 1-chome
Minato-ku, Tokyo 107

1985 total net sales: $2,292,151,000 Net income: $70,420,000

Copiers, sensitized papers and photographic equipment provide the major portion of Ricoh's revenues, but the firm has been investing in a growing line of data processing equipment since 1979. Its first products were 8" floppy drives made under a license from Calcomp, but the expanding line now includes several types of printers, plus 5.25" and 3.5" floppy disk drives used in both captive and OEM applications. In 1985, Ricoh obtained a license to make the DMA 5.25" cartridge disk drive design, and production began in 1986. When DMA encountered major financial difficulties, Ricoh became the major source for the drive.

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

1985 disk sales: $9,000,000

Epson is a member of the privately held Suwa Seikosha/Epson group owned by members of the Hattori family, which also control Japan's Seiko companies, known for watches and electronics. Epson is best known for its dot-matrix

printers, but also manufactures a portable computer, displays, line printers, paper tape equipment and floppy disk drives. In 1985, Epson introduced a line of half-high 5.25" rigid disks with capacity to 20 megabytes. Epson has since broadened its product line to include 3.5" drives, plus 40 and 80 megabyte 5.25" drives.

TATUNG CO.
22 Chungshan N. Road, Sec. 3
Taipei, Taiwan

In 1986, Tatung began shipments under its own name of 5.25" half high Winchester disk drives made under license from Xebec. The firm has been making similar drives for Xebec under a contract manufacturing agreement.

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

1985 total net sales: $289,399,000 (FY ending 9/30/85) Net income: ($2,857,000)

TEAC has taken steps in recent years to expand into computer peripherals, in recognition of slow growth in the worldwide market for quality audio tape decks, its major product area. TEAC has shipped 5.25" flexible disk drives since 1978. In 1982, TEAC acquired a manufacturing license from Seagate Technology for its 5.25" Winchester disk drives, with rights to market the drives in Japan and the Far East. The firm added a 12 megabyte half high drive in 1983, followed by a 25 megabyte version in 1985 and 50 megabytes in 1986.

TOKICO, LTD
1-6-3, Fujimi
Kawasakiku, Kawasaki 210

1985 disk sales: $39,000,000
1985 total net sales: $352,504,000 Net income: $6,933,000

Tokico, a member of the Hitachi group, is a manufacturer of automotive equipment, including shock absorbers, brakes and air compressors. The company is manufacturing a 5.25" Winchester fixed disk drive similar to the NPL NP05, with versions of the Tokico drive sold separately by Hitachi and by the Hitachi group trading company, Nissei Sangyo. A half high version went into production in late 1983.

TOKYO ELECTRIC CO., LTD
2-6, Naka-Meguro
Meguro-ku, Tokyo 153

1985 total net sales: $739,155,000 Net income: $22,382,000

Tokyo Electric is a member of the Toshiba group, and manufactures electronic cash registers, POS systems, lighting fixtures, household appliances and a growing family of data processing products. The firm markets 5.25" floppy drives on a worldwide basis and added 3.5" floppy disk drives in 1984. Also available is a small floppy drive using a spiral track. The first rigid disk products, 5.25" Winchesters, were shipped in 1985.

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

1985 disk sales: $100,800,000
1985 total net sales: $14,045,470,000 Net income: $361,845,000

Toshiba is a major factor in consumer electric and electronic products, plus a wide range of industrial electronic products and heavy electric power equipment. The company also has a leading position in the Japanese office computer market. Rigid disk drive production is concentrated in captive products, including disk cartridge and disk pack drives, plus newer Winchester technology fixed disk drives in low and mid-range capacities, in 8" and 5.25" disk diameters. Selected drives are also sold in the Japanese OEM disk drive market. Toshiba's presence in the U.S. OEM rigid disk market was strongly enhanced when it acquired the OEM disk drive operations of Memorex from Burroughs.

TOYO SODA MANUFACTURING CO., LTD.
1-7-7 Akasaka
Minato-ku, Tokyo 107

1985 total net sales: $1,091,282,000 Net income: $48,311,000

Toyo Soda is a manufacturer of materials for use in the electronics industry, including sputtered thin film media for 3.5" and 5.25" rigid disk drives. The firm is also preparing to begin manufacturing in 1987 a drive based upon the designs of now defunct Applied Information Corporation. 130, 170, and 250 megabyte drives have been announced, but production of the 250 megabyte unit has been deferred to a later date.

VICTOR COMPANY OF JAPAN, LTD.
4-1 Nihonbashi-Honcho
Chuo-ku, Tokyo 103

1985 total net sales: $2,731,361,000 Net income $82,761,000

JVC's revenues are generated mostly by consumer electronics products. The firm has been the beneficiary of sharp growth in the home video recorder market and VTRs now account for almost 70% of total revenues. JVC is now expanding into computer peripherals, with 5.25" rigid and floppy disk drives among the first products in the field. Half-high 5.25" floppy drives were shipped in mid-1984, and 3.5" rigid and floppy drives were shipped in 1985. JVC is the only Japanese firm currently producing a 3.5" disk-on-a-card product.

YE DATA, INC.
Subsidiary of Yaskawa Electric Mfg. Co., Ltd.
1-1 Higashi-Ikebukuro 3-chome
Toshima-ku, Tokyo 170

1985 total net sales: $134,437,000 (FY ending 3/31/85) Net income: $3,739,000

Yaskawa Electric produces primarily heavy electrical machinery and automation equipment. YE Data is best known for its line of floppy disk drives, with the firm's biggest success coming in 1984 when it was selected by IBM as supplier for the 1.6 megabyte 5.25" drive used in the PC AT. At the 1986 NCC show, YE Data's 3.5" 50 megabyte drive was introduced by C. Itoh Electronics, a major importer of Japanese electronic industry products for the U.S. market.

European Manufacturers

BASF AG
D-6700 Ludwigshafen
West Germany

1985 disk sales: $23,300,000
1985 total net sales: $16,207,000,000 Net income: $339,225,000

BASF is one of the world's chemical giants, and a pioneer manufacturer of magnetic recording media. Since the early 1970's, BASF has been a disk drive manufacturer, starting with a license from the old Century Data Systems to make 2314 type drives. The company continues to be a significant factor in the European PCM market. Today, BASF's internally manufactured rigid disk drive products consist only of 5.25" Winchester technology drives made in Germany. The firm sold a 14" Winchester product line to Tecstor, and in 1982 sold the product line and facilities for an 8" Winchester drive in Los Gatos, California. BASF resells several Winchester technology drives manufactured in Japan by Nippon Peripherals, Ltd., plus a 3380 equivalent drive made by Hitachi.

BULL PERIPHERALS
Subsidiary of Compagnie des Machines Bull
94, Avenue Gambetta
75960 Paris Cedex 20
France

1985 disk sales: $50,400,000
1985 total net sales: $1,792,873,000 Net income: $12,272,000

In 1982, France's socialist government established control of Cii-Honeywell Bull by taking over Compagnie de Saint-Gobain, which held a majority interest. Honeywell Information Systems' previous 47% share of Cii-HB was reduced to 19.9%, and Compagnie des Machines Bull is now the parent company for several operating units in the Bull Group, including Bull Peripherals. Bull's production of its unusual 10.5" "Cynthia" rigid disk drives is continuing, but 5.25" drives are now being emphasized. Production in France of 5.25" Winchester drives started in 1982, for captive and OEM distribution in Europe. A 5.25" disk cartridge drive was added in 1983. Bull has a cross-licensing arrangement with Vertex (now Priam) under which the organization has been manufacturing high capacity 5.25" drives.

ISOT
51, Chapaev St.
Sofia, Bulgaria

1985 disk sales: $164,500,000

Disk drives manufactured by ISOT, the Bulgarian state computer organization, are exported throughout Eastern Bloc countries by Isotimpex, the foreign trade organization for Bulgarian computer equipment and other electronic products. Isotimpex is currently marketing drives compatible with IBM 2314 and 3330 disk pack drives, plus disk cartridge drives and 14" 80, 100, and 200 megabyte disk pack drives. ISOT, which operates disk drive factories with perhaps the highest level of vertical integration to be found anywhere in the disk drive industry, began production of 14", 8" and 5.25" Winchester drives in late 1985.

KOVO
Jankovcova 2
17088 Praha 7
Czechoslovakia

KOVO is the Czechoslovakian import/export agency with jurisdiction over that country's trade in computers and related products. Included in the current product line are computers and peripheral equipment manufactured by Zbrojovka Brno and Aritma, both diversified manufacturing operations. 14" disk cartridge and disk pack drives are produced in small quantities.

NEWBURY DATA RECORDING, LTD
Subsidiary of Data Recording Instruments Co., Ltd.
Hawthorne Road, Staines
Middlesex TW18 3BJ
England

1985 disk sales: $7,700,000

Newbury Data is the current name for the organization known previously as Data Recording Equipment, or DRE. Disk drives were manufactured for several years by a joint venture company owned by DRI, its parent firm, and Magnetic Peripherals, Inc., the U.S. disk drive development and manufacturing firm managed by Control Data. When the joint venture was dissolved in 1983, DRI regained ownership. Newbury Data is now placing emphasis on newer disk drives, some produced under manufacturing licenses with other U.S. firms. Newbury Data has produced 5.25" disk cartridge drives under a DMA Systems license, and is also in production on Maxtor high capacity 5.25" drives under a license from that firm. New last year were 3.5" 20 and 40 megabyte drives with 40 millisecond average access time.

NIXDORF COMPUTER AG
Furstenallee 7
4790 Paderborn
West Germany

1985 disk sales: $17,100,000
1985 total net sales: $1,334,466,000 Net income: $58,464,000

Nixdorf has maintained average annual growth of almost 25% for over five years, and the firm has undertaken various programs to control costs through internal manufacturing programs. Nixdorf now manufactures storage module drives in Berlin, West Germany, under a license from Control Data, for captive shipment with Nixdorf systems, and is starting production for its own internally developed small Winchester drives.

OLIVETTI PERIPHERAL EQUIPMENT
Subsidiary of Ing. C. Olivetti & C., S.p.A.
via Torina, 603
10090 S. Bernardo d'Ivrea (Torino)
Italy

1985 disk sales: $191,400,000
1985 total net sales: $3,216,605,000 Net income: $263,855,000

Under Olivetti's current management, the firm has undertaken numerous changes to modernize the company's product lines and drop out of older lines. The Olivetti Peripheral Equipment organization represented a consolidation of the firm's printer and disk memory activities in 1980. This organization has established production for 5.25" and 3.5" Winchester disk drives at Ivrea, with both captive and OEM markets in mind. The biggest impact on Olivetti during the past few years was purchase of a 25% share in the company by American Telephone and Telegraph, and adoption of an Olivetti-designed personal computer for distribution by AT&T. Production of small disk drives for this program has been underway at Ivrea, resulting in rapid growth in rigid disk drive production.

PERTEC COMPUTER CORPORATION
Subsidiary of Triumph Werke Nurnberg AG
9600 Irondale Avenue
Chatsworth, CA 91311

1985 disk sales: $7,000,000

Pertec, a pioneer manufacturer of OEM 14" disk cartridge drives, was acquired by Triumph Adler in early 1980. After struggling to bring its disk drive line up to date, the initial 8" Winchester drives announced a few years ago were dropped in favor of a new series of 8" high capacity drives. The disk cartridge line has been phased out. At present, Olivetti is negotiating to purchase Triumph Adler. Olivetti has stated that it intends to sell Pertec upon completion of its purchase of Triumph Adler.

RODIME LIMITED
Nasmyth Road
Southfield Industrial Estates
Glenrothes, Fife KY6 2SD
Scotland

1985 disk sales: $107,500,000
1985 total net sales: $98,453,000 (FY ending 9/30/85) Net income: $11,679,000

Rodime is a rare European phenomenon: A successful 5.25" OEM disk drive start up company, which proceeded to become the first disk drive manufacturer to achieve large volume production of 3.5" Winchester drives. After being formed in late 1980 by key personnel from the Burroughs facility in Glenrothes, Rodime met its schedule for shipments in 1981, and until 1986 continued to achieve a healthy growth rate. Rodime's 5.25" stepping motor models are now declining in shipments. The company has announced 170 megabyte half-high 5.25" drives and is expected to announce high capacity 8" and 3.5" models.

ROM CONTROL DATA S.R.L.
Bucharest
Romania

The Romanian government and Control Data jointly own ROM-CD, with CDC holding 45%. The organization manufactures double density versions of 2314 type drives, using technology provided by CDC. Drives manufactured are marketed in both Eastern Bloc countries and in Western Europe.

SAGEM
(Societe d'Applications Generales d'Electricite et de Mecanique)
6 Avenue d'lena
75783 Paris CEDEX 16
France

SAGEM is active in the fields of military electronics, telecommunications, office systems, industrial and military equipment and computer peripherals. The firm's earliest disk drives were head-per-track designs. In 1986, SAGEM introduced a unique 5.25" Winchester drive with multiple heads per slider, sold as a military subsystem.

SIEMENS AG
Communications Group
St. Martin-strasse 76
D-8000 Munchen 80
West Germany

1985 total net sales: $18,695,000,000 (FY ending 9/30/85) Net income: $543,800,000

After many years of producing rigid disk drives of its own design for captive use with its mainframe systems, Siemens has now closed out its 14" disk drive manufacturing program in Munich. Several disk pack drives and a large fixed disk drive for captive use were phased out in favor of outside purchases of high performance drives, including IBM's 3380. In the meantime, Siemens has developed a 5.25" Winchester disk drive with capacities up to 300 megabytes, and started initial deliveries in early 1986. Siemens is selling the drive in the U.S. and European OEM disk drive markets, and has set up a marketing organization to pioneer the high-end 5.25" disk drive market.