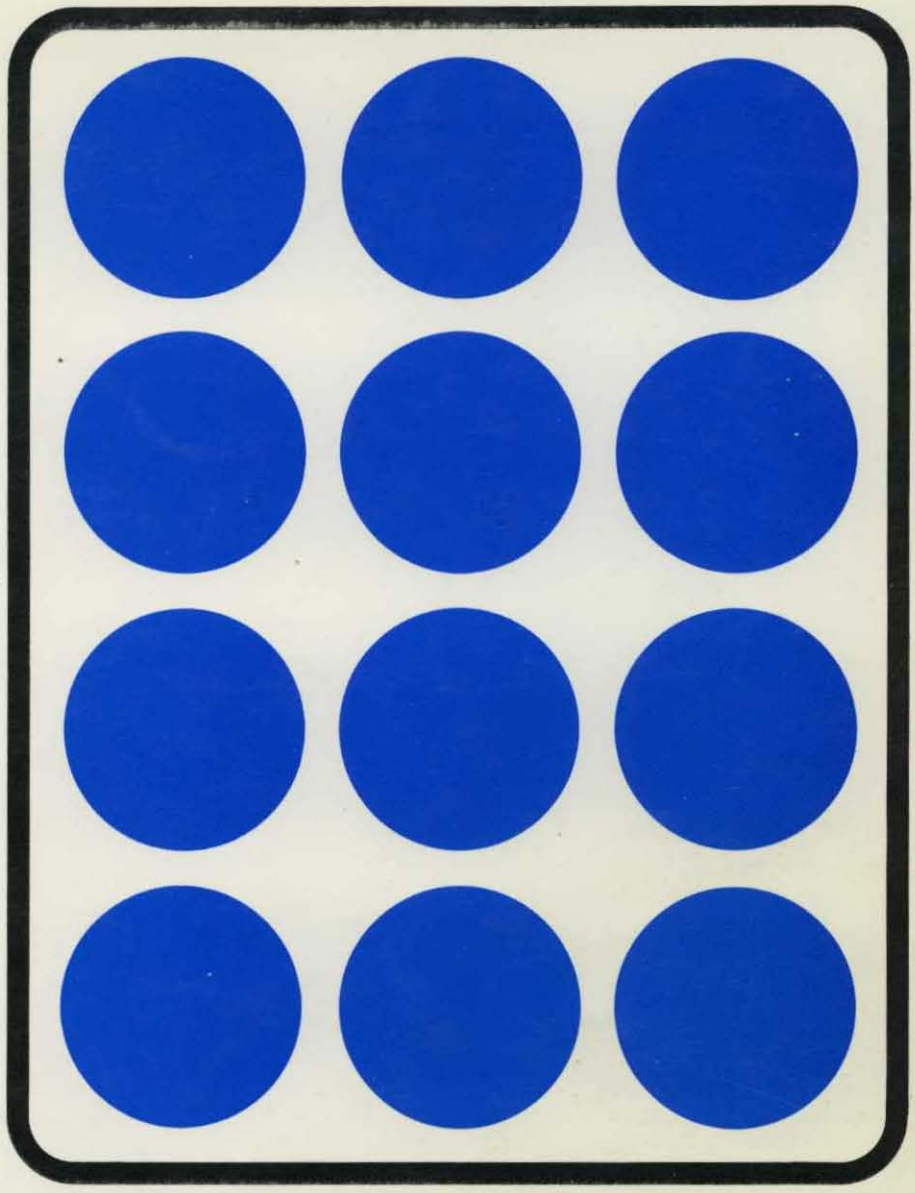
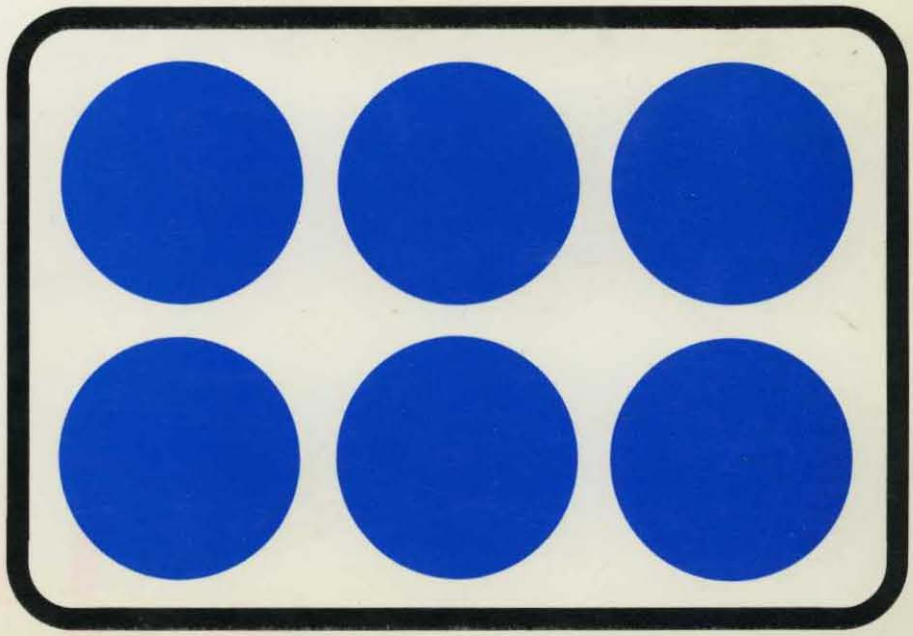


1991 DISK/TREND® REPORT



RIGID DISK DRIVES

1991 DISK/TREND® REPORT

RIGID DISK DRIVES

October, 1991

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FOREWORD

1991 has been an odd year. Despite the pressure on drive manufacturers caused by the economic recession and the resulting slowdown in computer systems markets, this year has seen intense activity on the new product front. Average disk capacities for all types of systems are moving higher, at a faster rate, than almost anyone anticipated.

1991 appears to be year in which the winners will find a way to tolerate lower profits and still find a way to enter the market early with significant new products. The losers will be those which can't keep up with the product development race in a tough year. For them, next year may be even worse.

This is the fifteenth year of the DISK/TREND Report, now published in three volumes. The report on optical disk drives was published in July, and this report on rigid disk drives will be followed, as usual, with a separate report on 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. Your suggestions for improvements in the DISK/TREND report are always welcome and are sincerely appreciated.

James N. Porter

Robert H. Katzive

TABLE OF CONTENTS

LIST OF TABLES

LIST OF TABLES (Continued)

LIST OF TABLES (Continued)

LIST OF TABLES (Continued)

LIST OF TABLES (Continued)

FIGURES

INTRODUCTION

A few DISK/TREND product groups have been changed

As announced last year, the product group for disk pack drives has been dropped from this edition of the DISK/TREND Report. Many industry veterans will be sorry to see them go, since they were the industry's largest revenue producer for a decade. But shipments for disk pack drives are now only a trickle, and it's time to use the space for newer drives. That's why we've split the previous product group for drives over 1 gigabyte into two new groups: 1-2 gigabytes and More than 2 gigabytes. The increased new product activity in both of these groups deserves more attention.

It's becoming more difficult to classify drives into product groups

We assign individual disk drives to DISK/TREND product groups on the basis of unformatted capacities. Until recent years, most OEM drives were specified in unformatted capacities, and our system seemed to be clear to practically everyone. But in the last few years the advent of embedded controllers has meant that a growing majority of drives are now specified in formatted capacities, and our classification system can be confusing to some.

This year we've arbitrarily overridden the system in a few places, for clarity: All 3.5" drives of about 425 formatted megabytes are in the 300-500 megabyte group, even though a few of them specify unformatted capacities slightly above 500 megabytes, and all 2.5" drives in the 80-86 megabyte range have been placed in the 60-100 megabyte group, despite unformatted capacities for a few which exceed 100 megabytes. Frankly, we think its probably about time to change our system, so that all drives are classified by their formatted capacities, and we tentatively plan to do just that in next year's DISK/TREND Report. Please let us know if you disagree for any reason.

We've added new summary information by disk diameter

Additional shipment information broken down by disk diameter has been added to the sections on each product group in recent years, and this year we have added a new table, and corresponding graph, which consolidates all shipments by disk diameter.

Here's some useful information for new readers

*All unit totals are given in spindles in the DISK/TREND Report. A disk drive containing two spindles is counted as two spindles, except for some plug compatible drives for mainframes which are counted in units equivalent of corresponding IBM drive models.

*We report all disk drive revenues at the level of the first public sale, at the estimated transaction price, whether the sale occurs at the captive, PCM/Reseller or OEM/Integrator levels.

SUMMARY: RIGID MAGNETIC DISK DRIVES

Industry size

For the first time in the fifteen year history of the DISK/TREND Report total industry revenues are expected to decline this year. Forecasted 1991 revenues of $24.2 billion are down 5.1% from the previous year. The key reasons behind the decline are an 8.4% drop in captive revenues and an 8.7% reduction in PCM/Reseller revenues for 1991.

OEM/Integrator revenues are continuing to increase despite the current economic recession, up an estimated 6.5% in 1991. Lack of growth in the overall personal computer market has affected the profitability of many manufacturers of OEM drives, but not all product sectors have been adversely affected. Severe price competition and lack of growth have made profits elusive with low-end 3.5" and 5.25" drives, but the notebook computer market, apparently recession-proof, has created a profitable new market for 2.5" drives.

Unit shipments have continued to rise despite the current revenue dip. Total shipments are now projected to rise from 1990's 27.8 million drives to 43.3 million drives in 1994. The increase in unit shipments, combined with the ongoing migration to higher capacities, will produce an average annual increase of 40.4% in terabytes of disk capacity shipped. In general, shipments of drives in the lower capacity ranges are declining, while the higher capacity groups continue to increase.

The disk drive industry's revenue growth is expected to resume next year, and an average annual increase of 5.2% is projected for the 1992-94 period, with OEM/Integrator revenues expected to grow somewhat faster, averaging 6.8%.

TABLE 1

CONSOLIDATED WORLDWIDE REVENUES

RIGID MAGNETIC DISK DRIVES

REVENUE SUMMARY

	DISK DRIVE REVENUES, BY SHIPMENT DESTINATION ($M)									
	1990		Forecast							
	Revenues		1991		1992		1993		1994	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM Captive	7,971.9	11,844.9	7,373.4	10,834.7	9,076.9	12,958.5	9,674.1	14,026.8	9,281.7	13,804.5
Other U.S. Captive	835.2	1,628.8	631.9	1,222.9	562.4	1,171.6	621.7	1,307.5	695.7	1,479.4
TOTAL U.S. CAPTIVE	8,807.1	13,473.7	8,005.3	12,057.6	9,639.3	14,130.1	10,295.8	15,334.3	9,977.4	15,283.9
PCM/Reseller	1,730.0	2,642.0	1,468.5	2,270.1	1,365.5	2,052.6	1,264.0	1,885.1	1,210.9	1,920.2
OEM/Integrator	2,667.2	3,992.9	3,021.4	4,476.4	3,383.6	4,883.2	3,652.8	5,178.8	3,939.8	5,616.5
TOTAL U.S. NON-CAPTIVE	4,397.2	6,634.9	4,489.9	6,746.5	4,749.1	6,935.8	4,916.8	7,063.9	5,150.7	7,536.7
TOTAL U.S. REVENUES	13,204.3	20,108.6	12,495.2	18,804.1	14,388.4	21,065.9	15,212.6	22,398.2	15,128.1	22,820.6
Non-U.S. Manufacturers										
Captive	169.0	2,969.4	120.7	3,011.8	169.8	2,867.4	215.5	2,636.3	274.0	2,484.2
PCM/Reseller	391.2	829.7	419.3	898.0	365.2	819.1	409.4	926.6	514.6	1,154.8
OEM/Integrator	527.3	1,670.3	467.1	1,552.5	424.7	1,323.5	481.2	1,411.7	611.1	1,726.9
TOTAL NON-U.S. REVENUES	1,087.5	5,469.4	1,007.1	5,462.3	959.7	5,010.0	1,106.1	4,974.6	1,399.7	5,365.9
Worldwide Recap										
TOTAL WORLDWIDE REVENUES	14,291.8	25,578.0	13,502.3	24,266.4	15,348.1	26,075.9	16,318.7	27,372.8	16,527.8	28,186.5

Marketing channels

Although not known for its stability, the rigid disk drive industry now has almost the same number of participants as last year -- currently 57 companies, compared to 59 one year ago. Although several companies withdrew from the industry or went out of business, new firms from the United States, Japan, Taiwan, Brazil and Germany started disk drive production.

Noteworthy among the departures was Rodime, now phasing out of production, the first company to produce a 3.5" rigid disk drive. Rodime will now concentrate only on sale of manufacturing licenses under its patents. With the bankruptcy of PrairieTek, the industry lost the first manufacturer of 2.5" drives, which will also attempt to make some money from its patent portfolio. On the other hand, 1991 saw the first announcement of a 1.8" drive from Integral Peripherals, a new firm formed by industry veterans from PrairieTek.

An understanding of the relative price levels of captive, PCM/Reseller and OEM/Integrator 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. 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/Reseller or OEM/Integrator 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.

TABLE 2

CONSOLIDATED WORLDWIDE REVENUES
RIGID MAGNETIC DISK DRIVES
MARKET CLASS REVIEW

REVENUE SUMMARY

WORLDWIDE REVENUES BY MANUFACTURER TYPE	1990 Revenues $M	1990 Revenues %	1991 $M	1991 %	1992 $M	1992 %	1993 $M	1993 %	1994 $M	1994 %
U.S. Manufacturers										
IBM Captive	11,844.9	46.3%	10,834.7	44.6%	12,958.5	49.6%	14,026.8	51.2%	13,804.5	48.9%
	+24.9%		-8.5%		+19.6%		+8.2%		-1.6%	
Other U.S. Captive	1,628.8	6.3%	1,222.9	5.0%	1,171.6	4.4%	1,307.5	4.7%	1,479.4	5.2%
	-21.7%		-24.9%		-4.2%		+11.6%		+13.1%	
PCM/Reseller	2,642.0	10.3%	2,270.1	9.3%	2,052.6	7.8%	1,885.1	6.8%	1,920.2	6.8%
	+25.1%		-14.1%		-9.6%		-8.2%		+1.9%	
OEM/Integrator	3,992.9	15.6%	4,476.4	18.4%	4,883.2	18.7%	5,178.8	18.9%	5,616.5	19.9%
	+16.0%		+12.1%		+9.1%		+6.1%		+8.5%	
Total U.S. Manufacturers	20,108.6	78.5%	18,804.1	77.3%	21,065.9	80.5%	22,398.2	81.6%	22,820.6	80.8%
	+17.5%		-6.5%		+12.0%		+6.3%		+1.9%	
Non-U.S. Manufacturers										
Captive	2,969.4	11.6%	3,011.8	12.4%	2,867.4	10.9%	2,636.3	9.6%	2,484.2	8.8%
	+5.2%		+1.4%		-4.8%		-8.1%		-5.8%	
PCM/Reseller	829.7	3.2%	898.0	3.7%	819.1	3.1%	926.6	3.3%	1,154.8	4.0%
	+16.7%		+8.2%		-8.8%		+13.1%		+24.6%	
OEM/Integrator	1,670.3	6.7%	1,552.5	6.6%	1,323.5	5.5%	1,411.7	5.5%	1,726.9	6.4%
	-12.8%		-7.1%		-14.8%		+6.7%		+22.3%	
Total Non-U.S. Manufacturers	5,469.4	21.5%	5,462.3	22.7%	5,010.0	19.5%	4,974.6	18.4%	5,365.9	19.2%
	+.4%		--		-8.3%		-.7%		+7.9%	
Worldwide Recap										
Captive	16,443.1	64.3%	15,069.4	62.1%	16,997.5	65.2%	17,970.6	65.7%	17,768.1	63.0%
	+14.3%		-8.4%		+12.8%		+5.7%		-1.1%	
PCM/Reseller	3,471.7	13.6%	3,168.1	13.1%	2,871.7	11.0%	2,811.7	10.3%	3,075.0	10.9%
	+23.0%		-8.7%		-9.4%		-2.1%		+9.4%	
OEM/Integrator	5,663.2	22.1%	6,028.9	24.8%	6,206.7	23.8%	6,590.5	24.0%	7,343.4	26.1%
	+5.7%		+6.5%		+2.9%		+6.2%		+11.4%	
Total All Manufacturers	25,578.0	100.0%	24,266.4	100.0%	26,075.9	100.0%	27,372.8	100.0%	28,186.5	100.0%
	+13.3%		-5.1%		+7.5%		+5.0%		+3.0%	

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

Product mix

The rigid disk drive industry is now experiencing a more rapid movement than ever before to higher disk capacities for most applications. The decline in shipments for fixed disk drives with capacities less than 30 megabytes has been under way since 1988, and the 30-60 megabyte range is joining in the decline in 1991. Worldwide shipments of 30-60 megabyte drives peaked in 1990 with 14.1 million drives, 50.7% of the industry's total unit shipments of all drives, but are projected to drop to 6.1 million drives in 1994.

Users' appetite for more disk capacity and the storage demands of new software continue to increase the typical disk capacity used with personal computers, the largest disk application. By 1994, 60-100 megabyte drives are projected to supply the highest shipment volume of any DISK/TREND product group, with 17 million drives, followed by 100-300 megabyte drives, with 12.9 million units.

The fastest growth rate for any product group in the 1992-94 period is the 50.7% annual average projected for drives in the 1-2 gigabyte range. The high growth rate now enjoyed by 5.25" drives in the 1-2 gigabyte product group is destined to be surpassed by new 3.5" drives starting next year.

Boosted initially by the personal computer market and later by workstation and file server requirements, 3.5" drives are expected to provide 76% of 1991's total unit shipments. However, the inevitable movement to smaller disk diameters continues, and worldwide shipments of 3.5" drives are expected to peak in 1992 with 24.9 million units.

The rapid shipment growth for 2.5" drives has been driven entirely by the notebook computer market, so far. 2.5" drives have been an essential

part of the current success story for notebook computers in the four to seven pound range, providing small size, low power requirements and continually increasing storage capacity. 1991 worldwide shipments for 2.5" drives are estimated at 3.9 million units.

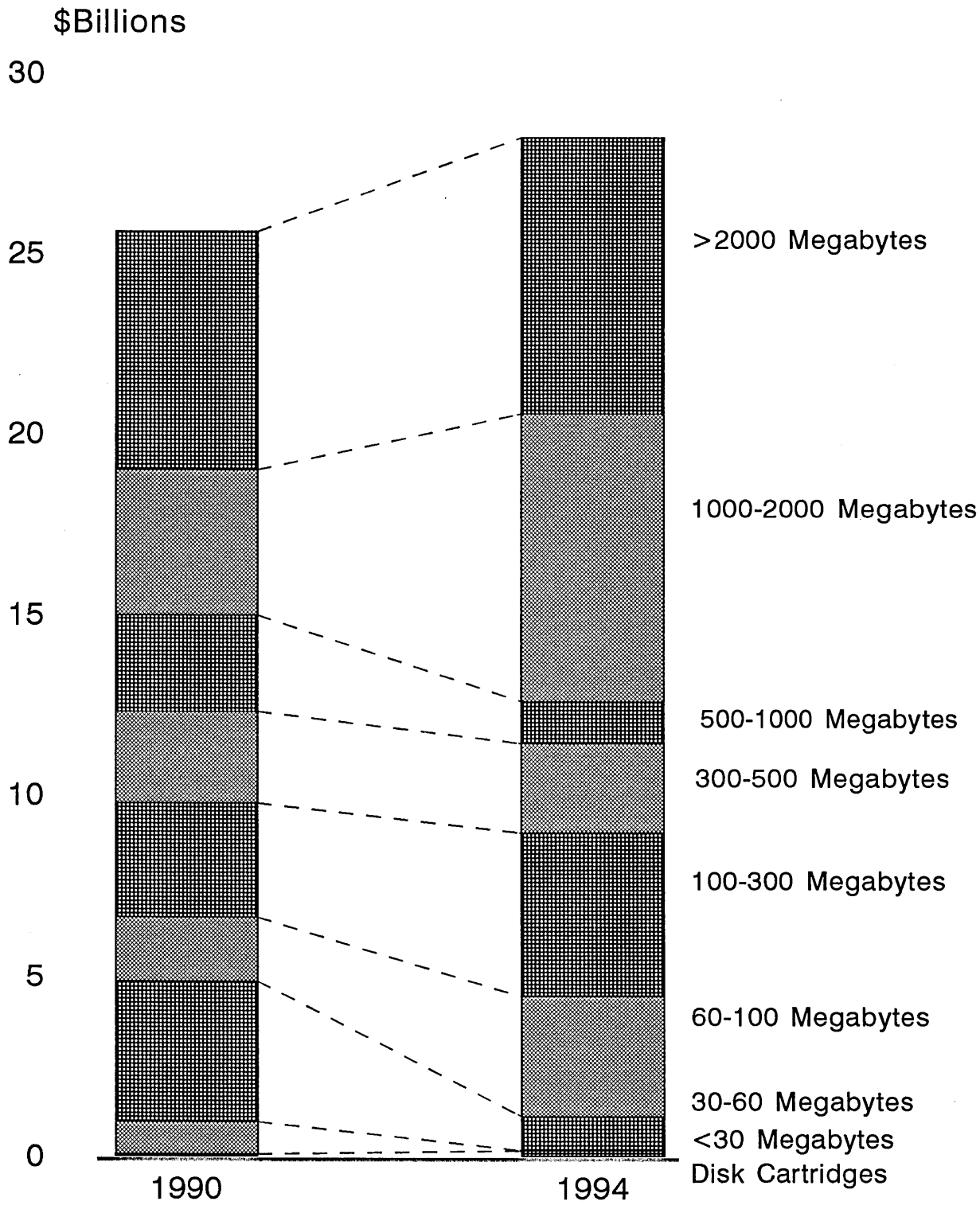
In the future, the increasing demand for 2.5" drives is expected to be stimulated also by desktop computer applications, now dominated by 3.5" drives. With 2.5" drives in the 60-100 and 100-300 megabyte range starting to become available, it is expected that many manufacturers of desktop personal computers will use them instead of 3.5" drives, in order to take advantage of 2.5" drives' smaller size, lower power, less heat and quieter operation. Due to the combination of the notebook and desktop computer market potential for 2.5" drives, worldwide shipments are expected to rise to 16.8 million drives in 1994, an average annual increase of 63.9% in the 1992-94 period.

The first 1.8" drive shipments are expected in late 1991, and dynamic growth is also predicted for this disk diameter, with the worldwide total for 1994 placed at 3.7 million drives. It is expected that as many as 10 companies will enter the 1.8" drive market by the end of 1992, in order to take part in the expected fast growth for the "sub-notebook" computer market. This new class of full-function computers in the 2-3 pound range is expected to be an excellent match for the even lower power and smaller physical size of the 1.8" drive.

Figure 1

CHANGING PRODUCT MIX

Worldwide Rigid Disk Drive Revenue



1991 DISK/TREND REPORT

TABLE 3

CONSOLIDATED WORLDWIDE REVENUES
RIGID DISK DRIVES
PRODUCT CATEGORY REVIEW

REVENUE SUMMARY

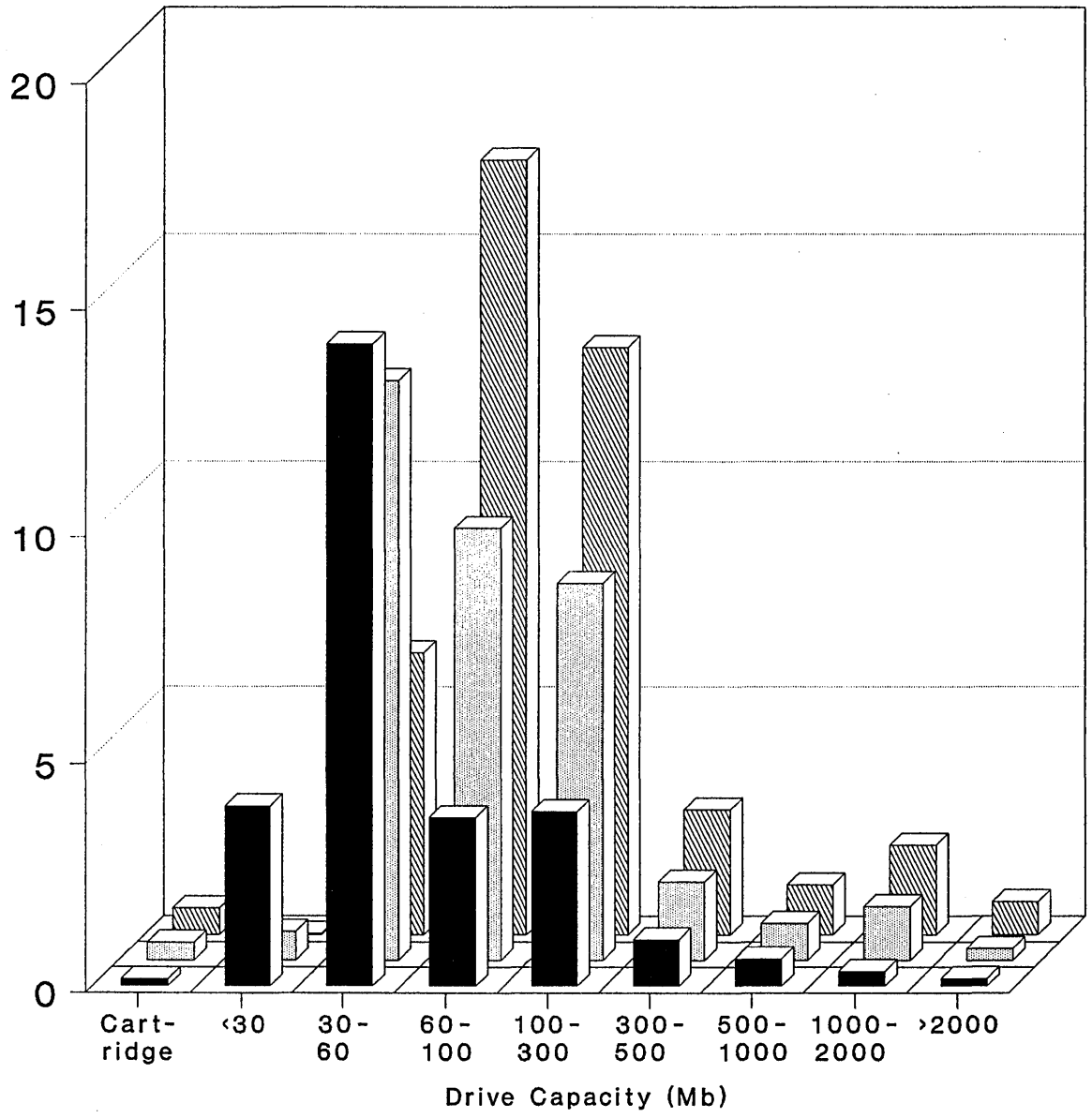
WORLDWIDE REVENUES ALL MANUFACTURERS	1990 Revenues $M	1990 Revenues %	1991 $M	1991 %	1992 $M	1992 %	1993 $M	1993 %	1994 $M	1994 %
DISK CARTRIDGE DRIVES	54.9 -16.7%	.2%	74.3 +35.3%	.3%	112.2 +51.0%	.4%	138.6 +23.5%	.5%	145.8 +5.2%	.5%
FIXED DISK DRIVES less than 30 Megabytes	881.4 -41.4%	3.4%	306.2 -65.3%	1.3%	121.7 -60.3%	.5%	29.6 -75.7%	.1%	5.4 -81.8%	--
FIXED DISK DRIVES 30 - 60 Megabytes	3,901.6 +17.9%	15.3%	3,183.7 -18.4%	13.1%	2,445.5 -23.2%	9.4%	1,703.7 -30.3%	6.2%	943.2 -44.6%	3.3%
FIXED DISK DRIVES 60 - 100 Megabytes	1,766.8 +1.9%	6.9%	2,227.2 +26.1%	9.2%	2,580.6 +15.9%	9.9%	2,971.8 +15.2%	10.9%	3,318.2 +11.7%	11.8%
FIXED DISK DRIVES 100 - 300 Megabytes	3,144.6 +41.1%	12.3%	3,659.2 +16.4%	15.1%	4,062.1 +11.0%	15.6%	4,354.5 +7.2%	15.9%	4,522.6 +3.9%	16.0%
FIXED DISK DRIVES 300 - 500 Megabytes	2,544.8 +10.8%	9.9%	2,804.9 +10.2%	11.6%	2,291.1 -18.3%	8.8%	2,212.3 -3.4%	8.1%	2,473.8 +11.8%	8.8%
FIXED DISK DRIVES 500 Megabytes to 1 GB	2,671.9 -.9%	10.4%	1,961.5 -26.6%	8.1%	1,405.0 -28.4%	5.4%	1,269.8 -9.6%	4.6%	1,170.4 -7.8%	4.2%
FIXED DISK DRIVES 1 - 2 Gigabytes	4,014.7 +12.2%	15.7%	4,163.6 +3.7%	17.2%	7,039.5 +69.1%	27.0%	8,179.6 +16.2%	29.9%	7,957.7 -2.7%	28.2%
FIXED DISK DRIVES more than 2 Gigabytes	6,597.3 +27.9%	25.8%	5,885.8 -10.8%	24.1%	6,018.2 +2.2%	23.0%	6,512.9 +8.2%	23.8%	7,649.4 +17.4%	27.1%
Total Worldwide Revenue	25,578.0 +13.3%	100.0%	24,266.4 -5.1%	100.0%	26,075.9 +7.5%	100.0%	27,372.8 +5.0%	100.0%	28,186.5 +3.0%	100.0%
% U.S. Manufacturing	78.6%		77.4%		80.7%		81.8%		80.9%	

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

Figure 2

UNIT SHIPMENT SUMMARY

Worldwide Shipments in Millions of Units



1991 DISK/TREND REPORT

TABLE 4

CONSOLIDATED WORLDWIDE SHIPMENTS
RIGID DISK DRIVES
PRODUCT CATEGORY REVIEW

UNIT SHIPMENT SUMMARY

UNIT SHIPMENTS IN THOUSANDS	1990 Shipments Units	1990 Shipments %	Forecast 1991 Units	1991 %	1992 Units	1992 %	1993 Units	1993 %	1994 Units	1994 %
DISK CARTRIDGE DRIVES	152.5 +41.9%	.5%	248.2 +62.8%	.8%	389.0 +56.7%	1.1%	516.0 +32.6%	1.3%	587.0 +13.8%	1.4%
FIXED DISK DRIVES less than 30 Megabytes	3,949.5 -37.1%	14.2%	1,539.5 -61.0%	5.1%	633.0 -58.9%	1.8%	152.0 -76.0%	.4%	33.0 -78.3%	.1%
FIXED DISK DRIVES 30 - 60 Megabytes	14,132.6 +38.4%	50.7%	13,572.6 -4.0%	44.7%	12,758.0 -6.0%	35.9%	9,950.0 -22.0%	25.0%	6,170.0 -38.0%	14.2%
FIXED DISK DRIVES 60 - 100 Megabytes	3,699.5 +62.0%	13.3%	6,245.3 +68.8%	20.6%	9,490.0 +52.0%	26.7%	13,475.0 +42.0%	33.9%	17,054.0 +26.6%	39.4%
FIXED DISK DRIVES 100 - 300 Megabytes	3,834.5 +115.0%	13.8%	5,949.8 +55.2%	19.6%	8,268.0 +39.0%	23.3%	10,486.0 +26.8%	26.4%	12,915.0 +23.2%	29.8%
FIXED DISK DRIVES 300 - 500 Megabytes	1,023.4 +21.4%	3.7%	1,340.2 +31.0%	4.4%	1,730.0 +29.1%	4.9%	2,190.0 +26.6%	5.5%	2,750.0 +25.6%	6.3%
FIXED DISK DRIVES 500 Megabytes to 1 GB	597.7 +73.4%	2.1%	661.4 +10.7%	2.2%	816.0 +23.4%	2.3%	960.0 +17.6%	2.4%	1,095.0 +14.1%	2.5%
FIXED DISK DRIVES 1 - 2 Gigabytes	322.4 +58.1%	1.2%	570.5 +77.0%	1.9%	1,186.0 +107.9%	3.3%	1,610.0 +35.8%	4.1%	1,975.0 +22.7%	4.6%
FIXED DISK DRIVES more than 2 Gigabytes	167.0 +45.6%	.5%	223.2 +33.7%	.7%	266.2 +19.3%	.7%	398.0 +49.5%	1.0%	729.0 +83.2%	1.7%
Total Worldwide Shipments	27,879.1 +25.8%	100.0%	30,350.7 +8.9%	100.0%	35,536.2 +17.1%	100.0%	39,737.0 +11.8%	100.0%	43,308.0 +9.0%	100.0%
% U.S. Manufacturing	83.5%		84.7%		86.3%		84.7%		81.2%	
Total Capacity (Terabytes)	3,727.1		4,920.8		6,744.2		9,512.8		12,947.0	

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

Figure 3

DISK DIAMETER SUMMARY

Worldwide Shipments in Millions of Units

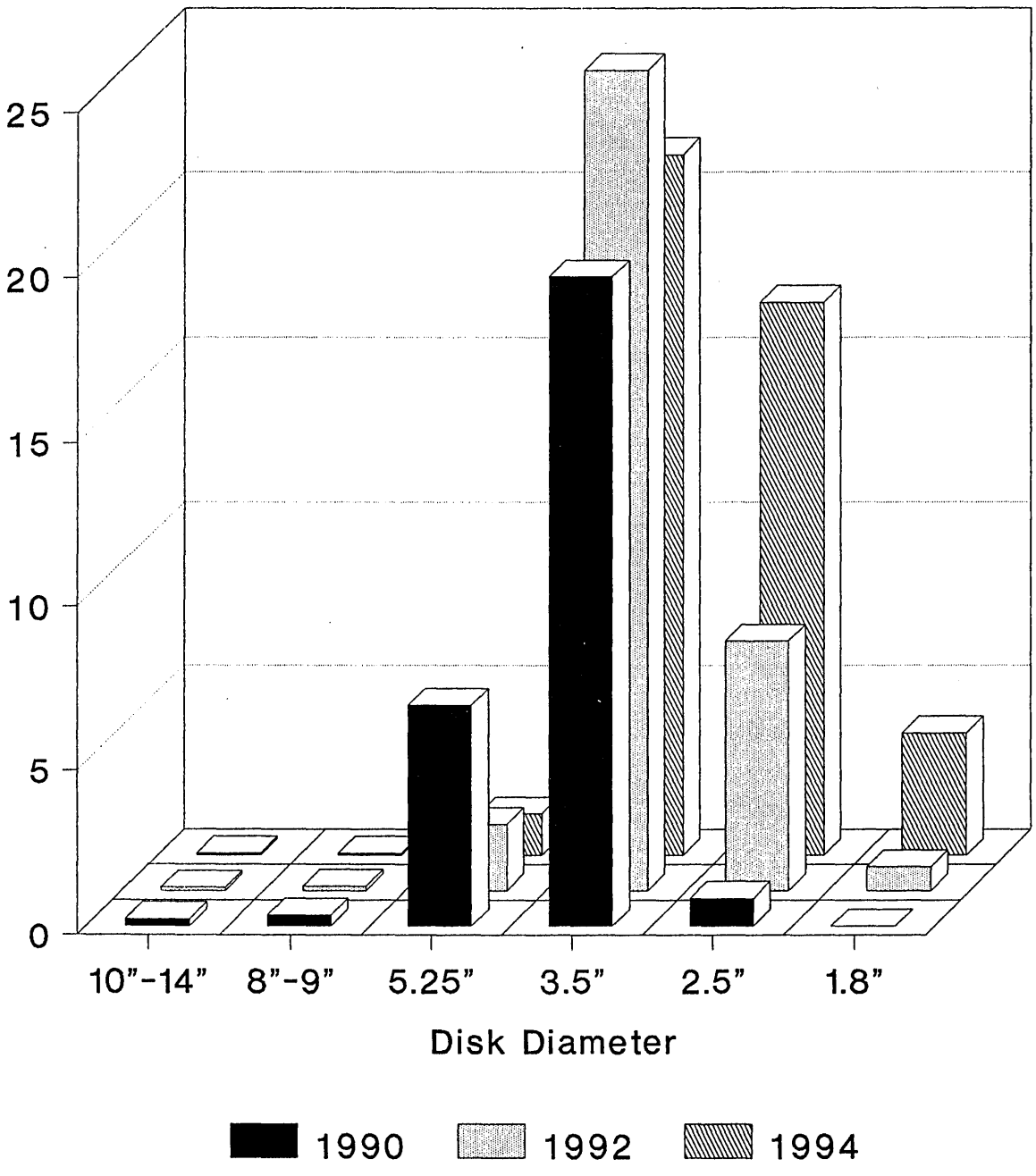


TABLE 5

CONSOLIDATED WORLDWIDE SHIPMENTS
RIGID DISK DRIVES
SUMMARY BY DISK DIAMETER

UNIT SHIPMENTS IN THOUSANDS	1990 Shipments Units	1990 Shipments %	Forecast 1991 Units	Forecast 1991 %	Forecast 1992 Units	Forecast 1992 %	Forecast 1993 Units	Forecast 1993 %	Forecast 1994 Units	Forecast 1994 %
10 - 14 INCH DISKS	217.7	.8%	151.6	.5%	100.0	.3%	93.0	.2%	62.0	.2%
	-13.6%		-30.4%		-34.0%		-7.0%		-33.3%	
8 - 9.5 INCH DISKS	334.1	1.2%	230.6	.7%	128.2	.4%	90.0	.2%	65.0	.2%
	-13.7%		-31.0%		-44.4%		-29.8%		-27.8%	
5.25 INCH DISKS	6,714.7	24.1%	2,963.6	9.8%	2,011.0	5.7%	1,641.0	4.1%	1,271.0	2.9%
	-19.2%		-55.9%		-32.1%		-18.4%		-22.6%	
3.5 INCH DISKS	19,765.6	70.9%	23,055.4	76.0%	24,967.0	70.2%	24,074.0	60.6%	21,325.0	49.2%
	+49.6%		+16.6%		+8.3%		-3.6%		-11.4%	
2.5 INCH DISKS	847.0	3.0%	3,947.5	13.0%	7,610.0	21.4%	12,394.0	31.2%	16,855.0	38.9%
	--		+366.1%		+92.8%		+62.9%		+36.0%	
1.8 INCH DISKS	--	--	2.0	--	720.0	2.0%	1,445.0	3.7%	3,730.0	8.6%
	--		--		--		+100.7%		+158.1%	
Total Worldwide Shipments	27,879.1	100.0%	30,350.7	100.0%	35,536.2	100.0%	39,737.0	100.0%	43,308.0	100.0%
	+25.8%		+8.9%		+17.1%		+11.8%		+9.0%	

Notes: 1. Percentage figures with plus/minus signs refer to year-to-year growth rates.

2. Disk cartridge drives with disk diameters less than 5.25" have been combined with 3.5" drives in this table.

Figure 4

CAPACITY SHIPMENT SUMMARY

Worldwide Shipments in Terabytes

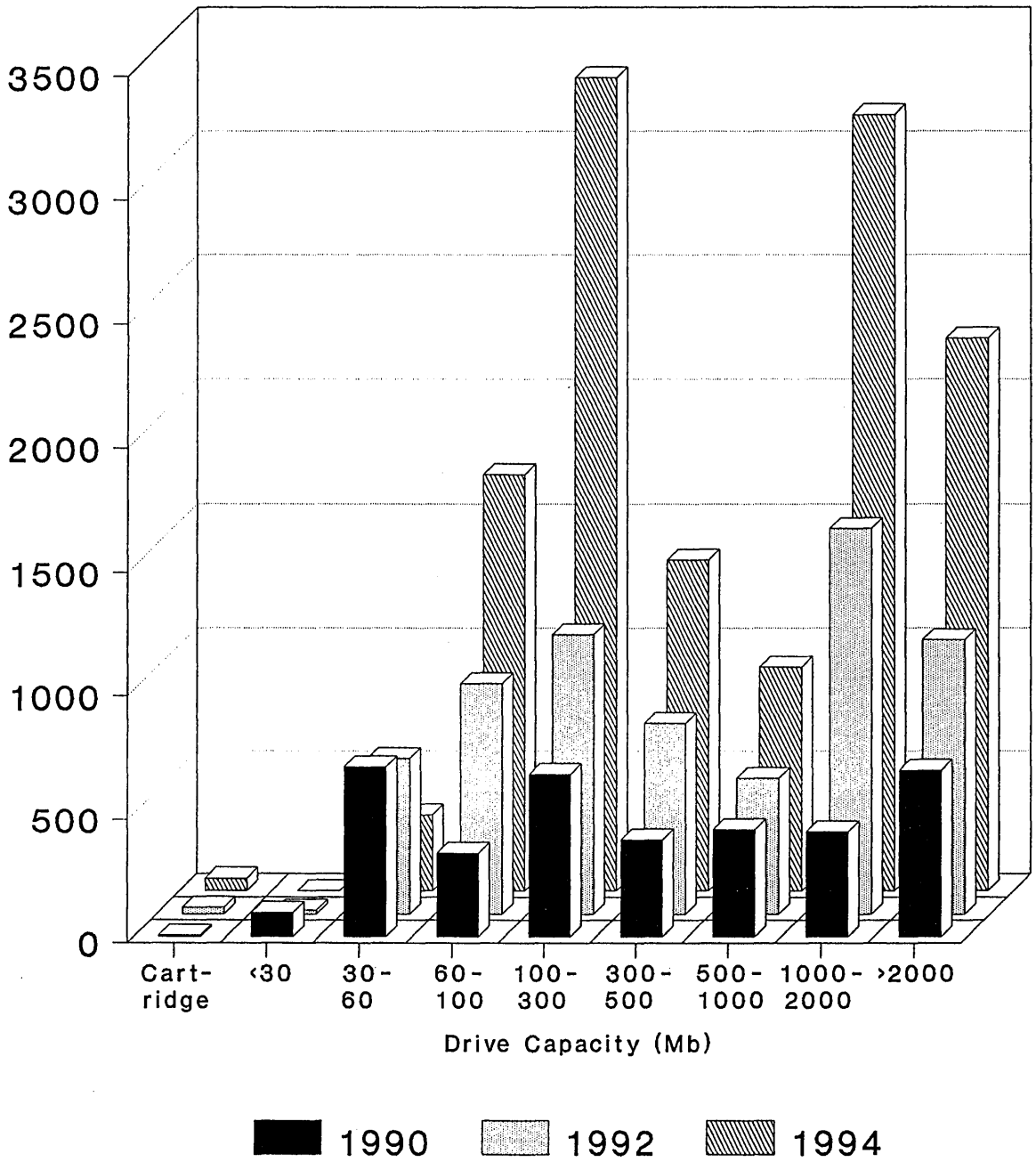


TABLE 6

CONSOLIDATED WORLDWIDE SHIPMENTS
RIGID DISK DRIVES
PRODUCT CATEGORY REVIEW

CAPACITY SHIPMENT SUMMARY

CAPACITY SHIPMENTS IN TERABYTES	1990 Shipments Tbytes	1990 Shipments %	Forecast 1991 Tbytes	1991 %	1992 Tbytes	1992 %	1993 Tbytes	1993 %	1994 Tbytes	1994 %
DISK CARTRIDGE DRIVES	7.7	.2%	14.6	.3%	26.0	.4%	39.2	.4%	50.2	.4%
	+58.9%		+88.1%		+78.6%		+50.5%		+27.9%	
FIXED DISK DRIVES less than 30 Megabytes	98.6	2.6%	38.4	.8%	15.8	.2%	3.8	--	.8	--
	-37.0%		-61.0%		-58.9%		-76.0%		-78.3%	
FIXED DISK DRIVES 30 - 60 Megabytes	690.8	18.5%	664.3	13.5%	631.8	9.4%	496.5	5.2%	309.2	2.4%
	+37.4%		-3.8%		-4.9%		-21.4%		-37.7%	
FIXED DISK DRIVES 60 - 100 Megabytes	338.3	9.1%	573.9	11.7%	933.3	13.8%	1,329.2	14.0%	1,685.4	13.0%
	+129.0%		+69.7%		+62.6%		+42.4%		+26.8%	
FIXED DISK DRIVES 100 - 300 Megabytes	660.1	17.7%	1,002.7	20.4%	1,132.9	16.8%	2,026.7	21.3%	3,284.9	25.4%
	+139.6%		+51.9%		+13.0%		+78.9%		+62.1%	
FIXED DISK DRIVES 300 - 500 Megabytes	394.3	10.6%	572.6	11.6%	775.4	11.5%	1,043.0	11.0%	1,342.1	10.4%
	+22.0%		+45.2%		+35.4%		+34.5%		+28.7%	
FIXED DISK DRIVES 500 Megabytes to 1 GB	435.8	11.7%	470.9	9.6%	552.4	8.2%	715.7	7.5%	906.8	7.0%
	+74.5%		+8.1%		+17.3%		+29.6%		+26.7%	
FIXED DISK DRIVES 1 - 2 Gigabytes	425.5	11.4%	754.5	15.3%	1,562.3	23.2%	2,323.4	24.4%	3,134.0	24.2%
	+62.9%		+77.3%		+107.1%		+48.7%		+34.9%	
FIXED DISK DRIVES more than 2 Gigabytes	675.6	18.1%	828.6	16.8%	1,114.1	16.5%	1,535.2	16.1%	2,233.2	17.2%
	+43.4%		+22.6%		+34.5%		+37.8%		+45.5%	
Total Capacity (Terabytes)	3,727.1	100.0%	4,920.8	100.0%	6,744.2	100.0%	9,512.8	100.0%	12,947.0	100.0%
	+55.8%		+32.0%		+37.1%		+41.1%		+36.1%	
% U.S. Manufacturing	81.0%		80.7%		81.5%		80.0%		77.5%	

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

Non-captive market

84.8% of the 1991 worldwide shipments of rigid disk drives consist of non-captive drives, reflecting the aggressive development programs and quick response to market opportunities which characterize the non-captive distribution channels for rigid disk drives. Please note that Tables 7, 8 and 9 in the summary section of this year's DISK/TREND Report include worldwide data for all non-captive drives, as did similar tables in last year's report, in a format which combines the OEM/Integrator tables from previous reports with data for the PCM/Reseller distribution channel.

The vigorous growth in shipments of small drives during the last decade was made possible by development of new drive formats by independent disk drive manufacturers for the OEM market, including various 5.25" and 3.5" configurations, plus newer 2.5" and 1.8" formats. OEM drives in each of these form factors arrived in the market well before captive drives and set the patterns for the entire industry.

The role of the PCM/reseller channel, a diverse mixture of computer dealers and wholesalers, subsystem manufacturers, electronic component distributors, mail order retailers and others has also become prominent. The majority of shipments of 5.25" drives below 100 megabytes are made through PCM/resellers, responding to demand for replacement and upgrade of older drives. However, most major personal computer manufacturers are now bundling at least one rigid disk drive in all mid-range and high-end PCs at the factory, so the practice of many dealers of upgrading new systems by installing drives in the store is fading. The outlook for future PCM/reseller sales continues to be good, but not at the same percentage of shipments that the industry saw during the 1980's.

TABLE 7

NON-CAPTIVE WORLDWIDE REVENUES
RIGID DISK DRIVES
PRODUCT CATEGORY REVIEW

REVENUE SUMMARY

WORLDWIDE REVENUES ALL MANUFACTURERS	1990 Revenues $M	%	1991 $M	%	1992 $M	%	Forecast 1993 $M	%	1994 $M	%
DISK CARTRIDGE DRIVES	54.9 -16.7%	.6%	74.3 +35.3%	.8%	112.2 +51.0%	1.2%	138.6 +23.5%	1.5%	145.8 +5.2%	1.4%
FIXED DISK DRIVES less than 30 Megabytes	741.3 -34.4%	8.1%	258.7 -65.1%	2.8%	100.3 -61.2%	1.1%	22.2 -77.9%	.2%	4.5 -79.7%	--
FIXED DISK DRIVES 30 - 60 Megabytes	2,835.7 +12.3%	31.2%	2,272.1 -19.9%	24.8%	1,628.6 -28.3%	18.1%	1,086.0 -33.3%	11.7%	660.2 -39.2%	6.4%
FIXED DISK DRIVES 60 - 100 Megabytes	988.2 +47.1%	10.8%	1,456.4 +47.4%	15.9%	1,706.6 +17.2%	18.8%	2,056.3 +20.5%	21.8%	2,479.7 +20.6%	23.9%
FIXED DISK DRIVES 100 - 300 Megabytes	1,642.8 +87.8%	18.0%	1,825.9 +11.1%	19.8%	1,846.9 +1.2%	20.3%	2,006.2 +8.6%	21.4%	2,306.3 +15.0%	22.1%
FIXED DISK DRIVES 300 - 500 Megabytes	708.8 -20.7%	7.7%	742.1 +4.7%	8.1%	1,025.5 +38.2%	11.3%	1,180.9 +15.2%	12.5%	1,226.3 +3.8%	11.8%
FIXED DISK DRIVES 500 Megabytes to 1 GB	744.0 +33.8%	8.2%	649.6 -12.7%	7.0%	643.9 -.9%	7.1%	657.5 +2.1%	7.0%	658.8 +.2%	6.3%
FIXED DISK DRIVES 1 - 2 Gigabytes	542.7 -12.5%	5.9%	670.1 +23.5%	7.3%	862.2 +28.7%	9.5%	967.6 +12.2%	10.3%	1,063.9 +10.0%	10.2%
FIXED DISK DRIVES more than 2 Gigabytes	876.5 +4.0%	9.5%	1,247.8 +42.4%	13.5%	1,152.2 -7.7%	12.6%	1,286.9 +11.7%	13.6%	1,872.9 +45.5%	17.9%
Total Worldwide Revenues	9,134.9 +11.7%	100.0%	9,197.0 +.7%	100.0%	9,078.4 -1.3%	100.0%	9,402.2 +3.6%	100.0%	10,418.4 +10.8%	100.0%
% U.S. Manufacturing	72.6%		73.3%		76.4%		75.1%		72.3%	

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

TABLE 8

NON-CAPTIVE WORLDWIDE SHIPMENTS
RIGID DISK DRIVES
PRODUCT CATEGORY REVIEW

UNIT SHIPMENT SUMMARY

UNIT SHIPMENTS IN THOUSANDS	1990 Shipments Units	1990 Shipments %	1991 Forecast Units	1991 Forecast %	1992 Forecast Units	1992 Forecast %	1993 Forecast Units	1993 Forecast %	1994 Forecast Units	1994 Forecast %
DISK CARTRIDGE DRIVES	152.5 +41.9%	.6%	248.2 +62.8%	1.0%	389.0 +56.7%	1.3%	516.0 +32.6%	1.6%	587.0 +13.8%	1.6%
FIXED DISK DRIVES less than 30 Megabytes	3,755.2 -34.4%	16.1%	1,486.8 -60.4%	5.8%	606.0 -59.2%	2.1%	142.0 -76.6%	.4%	31.0 -78.2%	.1%
FIXED DISK DRIVES 30 - 60 Megabytes	12,409.9 +35.1%	52.8%	11,897.8 -4.1%	46.9%	11,012.0 -7.4%	37.6%	8,406.0 -23.7%	25.9%	5,350.0 -36.4%	15.0%
FIXED DISK DRIVES 60 - 100 Megabytes	2,865.3 +100.3%	12.2%	5,280.9 +84.3%	20.8%	8,184.0 +55.0%	27.8%	11,817.0 +44.4%	36.1%	15,154.0 +28.2%	42.1%
FIXED DISK DRIVES 100 - 300 Megabytes	3,046.3 +143.7%	12.9%	4,700.7 +54.3%	18.5%	6,327.0 +34.6%	21.5%	8,011.0 +26.6%	24.6%	10,138.0 +26.6%	28.2%
FIXED DISK DRIVES 300 - 500 Megabytes	643.7 --	2.8%	843.2 +31.0%	3.3%	1,422.0 +68.6%	4.9%	1,879.0 +32.1%	5.7%	2,299.0 +22.4%	6.3%
FIXED DISK DRIVES 500 Megabytes to 1 GB	454.8 +109.1%	1.9%	540.1 +18.8%	2.1%	702.0 +30.0%	2.4%	834.0 +18.8%	2.6%	954.0 +14.4%	2.7%
FIXED DISK DRIVES 1 - 2 Gigabytes	136.7 +60.8%	.6%	311.1 +127.6%	1.2%	578.0 +85.8%	1.9%	810.0 +40.1%	2.4%	1,083.0 +33.7%	3.0%
FIXED DISK DRIVES more than 2 Gigabytes	48.2 +63.4%	.1%	115.2 +139.0%	.4%	168.2 +46.0%	.5%	246.0 +46.3%	.7%	396.0 +61.0%	1.0%
Total Worldwide Shipments	23,512.6 +25.9%	100.0%	25,424.0 +8.1%	100.0%	29,388.2 +15.6%	100.0%	32,661.0 +11.1%	100.0%	35,992.0 +10.2%	100.0%
% U.S. Manufacturing	84.2%		85.3%		87.8%		86.1%		82.2%	
Total Capacity (Terabytes)	2,489.9	100.0%	3,468.6	100.0%	4,627.3	100.0%	6,729.8	100.0%	9,494.4	100.0%

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

TABLE 9

NON-CAPTIVE WORLDWIDE SHIPMENTS
RIGID DISK DRIVES
PRODUCT CATEGORY REVIEW

CAPACITY SHIPMENT SUMMARY

CAPACITY SHIPPED IN TERABYTES	1990 Capacity Units	1990 Capacity %	1991 Forecast Units	1991 Forecast %	1992 Forecast Units	1992 Forecast %	1993 Forecast Units	1993 Forecast %	1994 Forecast Units	1994 Forecast %
DISK CARTRIDGE DRIVES	7.7 +58.9%	.3%	14.6 +88.1%	.4%	26.0 +78.6%	.6%	39.2 +50.5%	.6%	50.2 +27.9%	.5%
FIXED DISK DRIVES less than 30 Megabytes	93.8 -34.2%	3.8%	37.1 -60.4%	1.1%	15.1 -59.2%	.3%	3.5 -76.6%	--	.7 -78.2%	--
FIXED DISK DRIVES 30 - 60 Megabytes	620.3 +35.1%	25.0%	591.5 -4.6%	17.1%	550.6 -6.9%	12.0%	420.3 -23.7%	6.3%	267.5 -36.4%	2.9%
FIXED DISK DRIVES 60 - 100 Megabytes	277.7 +106.5%	11.2%	496.6 +78.8%	14.4%	808.0 +62.7%	17.5%	1,168.8 +44.7%	17.5%	1,499.7 +28.3%	15.9%
FIXED DISK DRIVES 100 - 300 Megabytes	542.6 +174.4%	21.7%	805.5 +48.5%	23.2%	829.4 +3.0%	17.9%	1,591.3 +91.9%	23.6%	2,752.8 +73.0%	28.9%
FIXED DISK DRIVES 300 - 500 Megabytes	248.4 +.9%	10.0%	362.2 +45.8%	10.4%	644.9 +78.1%	13.9%	900.5 +39.6%	13.4%	1,125.7 +25.0%	11.9%
FIXED DISK DRIVES 500 Megabytes to 1 GB	339.1 +114.1%	13.6%	389.1 +14.8%	11.3%	477.0 +22.6%	10.3%	622.2 +30.4%	9.2%	787.5 +26.6%	8.3%
FIXED DISK DRIVES 1 - 2 Gigabytes	189.4 +77.9%	7.6%	436.7 +130.5%	12.5%	782.6 +79.2%	16.9%	1,189.0 +51.9%	17.7%	1,732.6 +45.7%	18.2%
FIXED DISK DRIVES more than 2 Gigabytes	170.5 +49.0%	6.8%	334.9 +96.4%	9.6%	493.3 +47.3%	10.6%	794.7 +61.1%	11.7%	1,277.4 +60.7%	13.4%
Total Capacity (Terabytes)	2,489.9 +59.1%	100.0%	3,468.6 +39.3%	100.0%	4,627.3 +33.4%	100.0%	6,729.8 +45.4%	100.0%	9,494.4 +41.1%	100.0%
% U.S. Manufacturing	77.9%		77.9%		79.4%		77.7%		75.3%	

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

TABLE 10

1990 ESTIMATED MARKET SHARES

WORLDWIDE REVENUES OF ALL RIGID MAGNETIC DISK DRIVES
(Value of non-U.S. currencies estimated at average 1990 rates)

	CAPTIVE		PCM/RESELLER		OEM/INTEGRATOR		TOTAL INDUSTRY	
	$M	%	$M	%	$M	%	$M	%
U.S. MANUFACTURERS								
Conner Peripherals	--	--	181.3	5.2	1,156.0	20.4	1,337.3	5.2
Digital Equipment	1,195.5	7.3	--	--	--	--	1,195.5	4.7
Hewlett-Packard	356.7	2.2	.8	--	44.7	.8	402.2	1.6
IBM	11,844.7	72.0	15.4	.4	119.0	2.1	11,979.1	46.8
Kalok	--	--	68.1	2.0	7.4	.1	75.5	.3
Maxtor	--	--	306.1	8.8	473.4	8.4	779.5	3.0
Micropolis	--	--	103.5	3.0	264.5	4.7	368.0	1.4
Microscience International	--	--	56.4	1.6	20.3	.4	76.7	.3
PrairieTek	--	--	--	--	38.4	.7	38.4	.2
Quantum	--	--	232.4	6.6	477.7	8.4	710.1	2.7
Seagate Technology	--	--	1,466.0	42.2	1,177.4	20.8	2,643.4	10.3
Storage Technology	--	--	64.4	1.9	--	--	64.4	.3
Syquest Technology	--	--	38.3	1.1	5.8	.1	44.1	.2
Unisys	46.2	.3	--	--	--	--	46.2	.2
Western Digital	--	--	103.9	3.0	174.3	3.1	278.2	1.1
Other U.S.	30.6	.2	5.4	.2	34.0	.6	70.0	.3
U.S. Total	13,473.7	81.9	2,642.0	76.1	3,992.9	70.5	20,108.6	78.6
NON-U.S. MANUFACTURERS								
Fuji Electric	--	--	--	--	39.9	.7	39.9	.2
Fujitsu	1,107.4	6.7	227.9	6.6	563.3	9.9	1,898.6	7.4
Hitachi	567.4	3.5	444.4	12.8	167.8	3.0	1,179.6	4.6
JVC	--	--	--	--	95.2	1.7	95.2	.4
Mitsubishi Electric	11.4	.1	16.9	.5	16.9	.3	45.2	.2
NEC	1,068.0	6.5	--	--	282.0	5.0	1,350.0	5.3
Northern Telecom	29.5	.2	1.4	--	28.2	.5	59.1	.2
Rodime	--	--	--	--	92.6	1.6	92.6	.4
Siemens	60.0	.4	--	--	23.8	.4	83.8	.3
Sony	1.4	--	--	--	114.8	2.0	116.2	.5
Tokico	--	--	--	--	46.8	.8	46.8	.2
Toshiba	94.9	.6	86.2	2.5	53.1	.9	234.2	.9
Other Non-U.S.	29.4	.2	52.9	1.5	145.9	2.6	228.2	.9
Non-U.S. Total	2,969.4	18.1	829.7	23.9	1,670.3	29.5	5,469.4	21.4
WORLDWIDE TOTAL	16,443.1	100.0	3,471.7	100.0	5,663.2	100.0	25,578.0	100.0

Note: 1. Drives sold in the PCM/Reseller market by other than the original manufacturer are valued at PCM/Reseller prices above, to avoid distortion of total market value

2. The DISK/TREND estimates of revenue for each disk drive manufacturer include net sales of disk drives only and do not represent total revenues for individual companies

Codes: 1 = 1.8" C = Captive
2 = 2.5" P = PCM
3 = 3.5" O = OEM
5 = 5.25"
8 = 8"-9.5"
10 = 10.5"-10.8"
14 = 14"

TABLE 11

CURRENT PRODUCT LINES
MANUFACTURERS OF RIGID MAGNETIC DISK DRIVES

DISK/TREND PRODUCT GROUP:		1	2	3	4	5	6	7	8	9
U.S. Manufacturers	Type	Disk Cartridge Drives	Fixed Disk Drives <30 MB	Fixed Disk Drives 30-60 MB	Fixed Disk Drives 60-100 MB	Fixed Disk Drives 100-300 MB	Fixed Disk Drives 300-500 MB	Fixed Disk Drives 500 MB-1 GB	Fixed Disk Drives 1 GB-2 GB	Fixed Disk Drives >2 GB
Alpha Data	O							14		
Areal Technology	O				2	2				
Atasi Technology	O					5	5			
Brand Technologies	O					3				
Cerplex Technologies	P,O	8								
Conner Peripherals	O		2,3	2,3	2,3	3	3	3		
Digital Equipment	C					5	5	5	5,8	
DMA Technologies	O	5								
Ecol.2	O			3		3				
Hewlett-Packard	C,P,O		3			3	3,5	5,8	5	5
IBM	C,P,O		3	2,3,5	2,3,5	3,5,8	3,5,8	5,8	3,5,10,14	10,14
Integral Peripherals	O		1	1						
Kalok	O		3	3		3				
Maxtor	O			3	2,3,5	3,5	3,5	3,5	5	
MFM Technology	O	5								
Micropolis	O				5	5	5	5	3,5	5
Microscience International	O			3	3	3	3,5	5	5	
Miltope	O		5	5			5			
Orca Technology	O						3	5	5	
Quantum	P,O		3	2,3	2,3	3	3			
Seagate Technology	O		3,5	2,3,5	2,3,5	3,5	3,5,8	3,5,8	3,5,8	5,8
Sequel	O				8	8	8			
Storage Technology	P									14
SyQuest Technology	P,O	5								
Western Digital	P,O			2,3	2,3	3				
Asian Manufacturers										
Alps Electric	O			3	3	3				
Espert	O			3						
Fuji Electric	O		3	2,3		3				
Fujitsu	C,P,O		3,5	2,3,5	2,5	3,5,8	3,5,8,10	3,5,8,10	5,8,10	5,8,10
Greenery Technology	P,O				3	3				
Hitachi	C,P,O		3,5	3,5	5	3,5,8	3,5,8	5,8,14	5,8,14	8
Hyosung Computer	O				5	5				
JVC (Victor Company)	O		2	2,3	3					
Kyocera	O		3	3	3	3				
Kyushu Matsushita Electric	O					3				
Magtron	P,O			3	3	5	5	5	5	
Mitsubishi Electric	C							8	8	
Mitsumi Electric	O				3	3				
NEC	C,O			3		3,5	3,5	5,8	5,8	8
Ricoh	O	5								
Samsung Electronics	C,O			3		3				
Sony	O			3	3					
Teac	O			2,3	2,3	3				
Tokico	O				3	3				
Toshiba	C,O		2	2,3	3,5	3,5,8		3,5,8		
Zentek	P,O				3	3	3			
European Manufacturers										
DZU	O			5			14	14		
EZI	O						5			
Sagem	O					5				
South American Manufacturers										
Digirede	O			5	5	5				
Edisa Informatica	C,O					5	5	5		
Elebra	P,O		3	5	5			8		
Itautec	C		5			5				
Microlab	P,O		5	3,5	5					
Multidigit	P,O		3	3	5	5				
Prologica	C,O		3	3	3	3				
Qualitron	O		5	5	5					

TECHNICAL REVIEW

Competing technologies

Smaller, faster, more reliable, higher capacity, less expensive disk drives are still the hallmarks of customer desires for secondary storage. For the most part, the magnetic storage industry has continued to do well in meeting customer needs through increases in areal density, thinner disk substrates, improved functionality chips, smaller heads, lower flying heights, smaller motors and many other areas of continuing improvement in disk drive and recording technology.

Announcements by IBM and Hitachi of demonstrated areal densities of a gigabit or more per square inch indicate that progress in disk drive technology is guaranteed for many years. Faced with continuing rapid progress from magnetic disk recording, developers of would-be alternatives to magnetic disk recording continue to have a difficult time. While announcements of new "disk replacement" products are plentiful in the press, few system manufacturers are buying. Even if substitutes with performance and price equal to current disk drives existed today, most system designers would choose to stay with the familiar magnetic disk drives and their known system integration requirements rather than risk the unknown. In order to penetrate the market, the proposed substitute must be significantly better, faster, smaller, less expensive or demonstrate some other advantage.

The technologies which are currently the leading candidates to provide major competition to magnetic disk drives in applications where characteristics such as speed, removability, or environmental tolerance give them unique advantages, are discussed in the following sections.

* Semiconductor memory: The fast response time of semiconductor memory has already won it a secondary storage role in some large and small systems where it serves as a substitute for rigid drives when very fast access to data or programs is required. Even personal computer operating systems can allow part of main memory to be designated for use as a virtual disk. However, semiconductor memory is expensive, ranging from a few hundred to a few thousand dollars per megabyte, which limits its use to situations where its high speed or lack of moving parts are vitally necessary to meet system requirements.

  For instance, semiconductor memory modules packaged in 5.25" form factor enclosures are available in capacities from 20 to 80 megabytes from NEC and Hitachi, but at prices approximating $200 per megabyte they are suitable only for specialized applications.

  High density, high capacity packaging for large semiconductor memory is getting closer. For instance, Anamartic is working on a 40 megabyte wafer-scale integration project using two 6 inch wafers, each carrying 200 megabits. Another possible packaging technique is the stacking of chips vertically to make a three dimensional or "Z-plane" package. Assuming that a 4 megabit chip design were used, one module proposed would have 320 megabit capacity in a package roughly a half inch square and a quarter inch high. However, formidable heat dissipation and fabrication problems are yet to be resolved. The most probable early applications are in military or aerospace equipment, possibly by mid-decade.

  DRAM and SRAM memory chips, now readily available in 4 megabit configurations, are moving into pilot production status in 16 megabit configurations and should be widely available in 1993. Matsushita, Toshiba and Hitachi are expected to be volume producers, and IBM will be producing them for its own use. The arrival of 64 megabit chips, not expected until the later 1990s, is expected to signal the first real opportunity for semiconductor memory to compete with magnetic disks across a broader range of applications. Until that time and perhaps beyond, the cost and performance improvements of rigid magnetic drives will keep solid-state competitors at bay.

  Can progress in semiconductor memory technology over the next ten years proceed at the rate of improvement shown in the last 20 years? Because the complexity, packaging problems, and performance requirements of semiconductor memory have increased, the investment in time and capital required to produce succeeding generations of chips has also increased. As a result, the pace of semiconductor memory price decreases is expected to slow.

  Besides dynamic and static RAM chips, other forms of semiconductor memory may compete with magnetic disk storage in the future. The semiconductor devices most likely to provide additional competition include flash memory and ferroelectric memory.

Flash memories are a form of EEPROM in which a block of cells can be erased by an electrical signal. Current fabrication technology can fabricate flash memories with up to 4 megabits per chip. They are being developed by Intel, SunDisk, Seeq Technology, Toshiba and other firms.

While flash memories can be erased, it is not possible to change only a few bits; an entire block must be erased and this can take as long as half a second for the equivalent of a disk sector in some flash memories. This means that whatever is in the cell block must be saved to RAM and restored after the erase/write cycle on the flash memory chip. As a result, read operations can be very fast compared to a magnetic drive, but writing may be slower. There is also a limit to the number of times the memory device can be rewritten. At present, flash memory chips degrade beyond usability after about 100,000 write/erase cycles. Some chips are specified at only 10,000 cycles.

Flash memories using 1 megabit chips are currently in production and 4 megabit chips are becoming available. Some portable computer system makers have adopted cards containing from one to four megabytes of flash memory as substitutes for floppy disks, but a megabyte of flash memory currently costs about one hundred dollars. The cost per megabyte is expected by semiconductor producers to decline to $20 per megabyte in 1994.

In 1991, SunDisk announced a flash memory card of 20 megabyte capacity per card and a matching controller with an IDE interface. The combination looks like a disk drive to the host system. The target price is about $75 per megabyte for late 1991. The most optimistic projections for flash memories suggest OEM costs in the range of 10 to 20 dollars per megabyte by 1995.

Ferroelectric memories use the electrically reversible polarization of ferroelectric materials to form a capacitor, which is required in the circuitry of semiconductor memories. Proper design can produce a nonvolatile memory cell that can be fabricated with conventional planar processes but has smaller dimensions than cells made with silicon dioxide capacitor dielectrics. Sub-microsecond access times are possible. The number of write/erase cycles possible exceeds a trillion cycles for the best materials, and a billion cycles should be routinely achieved. Operating speed is equivalent to that of typical DRAM, but not quite as fast as conventional SRAM. The fabrication techniques required to construct ferroelectric chips are substantially the same as used for CMOS, which is a well understood technology, although some process changes may be needed to accommodate the different materials used.

Ramtron, which has been the most visible developer of ferroelectric memory technology, has licensed it to NMB Semiconductor Company, ITT and Seiko. Ramtron and NMB are jointly developing a

4 megabit ferroelectric memory chip as well as 16 megabit DRAM chips. National Semiconductor also has a ferroelectric memory development effort under way.

Supporters of ferroelectric memories project that in the 1992-1993 time frame, chips with 1 to 4 megabit capacity could be available selling at $10 to $20 per megabyte. 16 megabit chips, probably available in 1995, could sell in the $3 to $4 per megabyte range. Additional packaging and system costs will be incurred to make the equivalent of a disk drive.

Ferroelectric and flash memories will contend for acceptance in portable computers, "smart cards" and in applications where loss of memory due to a power lapse is a critical problem. Ferroelectric memory will probably compete with magnetic drives in applications where the environment is stressful and rapid access is required. This includes military, industrial, and some high value commercial applications, but does not embrace the broader classes of nonvolatile memory requirements served by rotating memory. Development of ferroelectric memory is lagging that of flash memory, and it isn't clear that both can succeed.

Portable computers will probably make extensive use of removable semiconductor memory packaged in a flat "credit card" format. Pin interconnect and packaging standards have been worked out, with the final result being a 68 pin connector and a package 3.3 millimeters thick. The cards are able to accept a variety of memory forms, including PROM, ROM, SRAM, DRAM, flash and, eventually, ferroelectric memory. DRAM cards to be used for host system memory expansion will probably have an 88 pin interface.

* Holographic storage: Holographic storage is a type of optical storage in which an array of spots, representing the mathematical transform of an image, is stored in an optically sensitive medium in either two or three dimensions. When the medium is illuminated, the image can be seen or projected upon a detector. Storage media can be fixed or removable, and both write-once and rewritable forms are possible. Early attempts to develop holographic storage for use in computer memories were unsuccessful due to technical difficulties, such as a tendency of read operations to degrade the stored data, and inability to meet cost and performance constraints. But the very high storage densities and fast access times theoretically achievable have encouraged ongoing research and development efforts by many organizations worldwide.

One of the more ambitious holographic storage programs is being conducted by MCC (Microelectronics and Computing Corporation), a research consortium sponsored by major U.S. technology firms. MCC is planning to show working prototypes of holographic memories in a 5.25" form factor in 1992. The devices will have targeted capacities in the range of 200 megabytes to 10 gigabytes, average access times in the 1 to 10 microsecond range and data transfer rates in the gigabyte per second range. The stor-

age medium, once written, can be read billions of times without significant degradation. Once the prototypes are working, it will be up to the companies supporting the research effort to convert the technology into working, practical products. Among the supporters of the MCC effort have been DEC, NCR, Eastman Kodak, General Dynamics and E-Systems.

In 1991, IBM revealed research efforts using holographic storage techniques in conjunction with inexpensive organic amorphous media. However, this material, and similar materials announced by other researchers, must be used at very low temperatures.

Because holographic storage systems have no moving mechanical parts, they have found usage in military, industrial, and other applications where ruggedized storage is essential. MCC is projecting that the cost per megabyte of its holographic storage will be 2 to 4 times the cost of magnetic storage of equivalent unit capacity. If practical, holographic storage can virtually eliminate the current limitations on throughput caused by mechanical drives, and must be considered as having the potential to effectively compete with magnetic and optical rotating disk drives for selected applications in the late 1990s.

Research is also proceeding in the area of nonholographic three-dimensional optical storage, but many of the same temperature and material problems must be overcome. The University of California at Irvine recently disclosed an experimental device capable of storing 6.5 trillion bits in an organically doped plastic module the size of a sugar cube. Two different lasers are needed to write and read data, and the device must be operated at cryogenic temperatures to avoid data loss.

* Optical disk drives: With track densities of 15,000 tracks per inch and linear bit densities of 18,000 bits per inch or more, optical disk drives are capable of higher areal densities than magnetic disk drives now in use. Optical drives range from 3.5" units with 128 megabyte capacity to 14" drives with several gigabytes of capacity. However, the current technologies cannot provide performance equivalent to magnetic disk technology, nor can optical drives yet compete on a product cost basis. Therefore, optical disk drives are preferred where removability of the media is desired, such as use in an automated library or for security concerns.

  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 to 30 years being commonly encountered specifications 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 can no longer cope with

the gradually increasing media defect density. More recently introduced media using organic dyes as the recording material have no metallic films and may offer improved stability.

Although storage devices using removable media have held only limited markets when their media was not interchangeable among drives of various manufacturers, optical drive producers have been slow to agree upon complete standards except in the read-only area. Write-once drives are largely nonstandardized, but 5.25" and 3.5" rewritable drives have reached a higher, although incomplete degree of standardization.

* Nonreversible optical disks: The first optical disk recording systems to enter the market were "nonreversible" or "write-once" systems. After many years of costly development programs undertaken by several European and Japanese manufacturers, such devices are now distributed by major system manufacturers, including IBM, Eastman Kodak, Toshiba, Hitachi, and Digital Equipment Corporation. Whereas the initial products manufactured were 12" in diameter, the trend is to 5.25" diameter drives. A 4.72" drive for professional use was introduced by Yamaha in 1989 and by Sony in 1990, and low cost 4.72" write-once drives from JVC are anticipated in 1991.

  Write-once drives operate by using a diode laser and suitable optics and positioning mechanisms to produce a concentrated beam that can remove, deform, or change the reflectivity of material at the focal point of the beam. For readback, a diode laser, operating at a lower power, scans the disk, and the varying light reflected from regions of differing reflectivity is translated into bit patterns. Once an area of the disk is written, it cannot be changed or rewritten, although it could be overwritten and destroyed. Hewlett-Packard, Sony and others offer write-once capability using rewritable magneto-optic media coded so that the drive recognizes it as write-once media and operates accordingly.

  Obviously, the market for write-once optical disk systems will be limited to the niches which can tolerate nonreversibility. 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 many disks make the use of large scale write-once optical storage attractive for users of permanent records such as governmental agencies, banks, insurance companies and other organizations with massive records that must be easily accessed. Library systems are needed in order to make optical storage practical in a larger system environment.

  Virtually no displacement of magnetic disk drives by nonreversible optical storage will occur in the foreseeable future. Some displacement of tape in archival applications is probable, but the growth of write-once technology is being capped by competition from rewritable optical drive technology.

* Erasable optical disks: As cost-effective rewritable drives with improved performance become available, the possibility for real inroads into the market for magnetic disk drives exists. Some rewritable optical drives have reached performance levels typical of small rigid magnetic drives in the mid-1980s, but cost improvements have lagged.

  Magneto-optical recording has seen development activity for more than twenty years, and rewritable phase change optical recording emerged as a competitor this year. The performance of magneto-optical drives exceeds that of write-once drives. Because it takes somewhat less laser power to change the state of a bit than required by write-once drives, the drive can rotate faster at a given laser power, reducing latency and improving data transfer rate. The best rewritable drives have finally reached 3,600 RPM spin rates. However, average seek times remain above the 30 millisecond mark, and it will be years before rewritable optical performance can approach the best magnetic drive technology. Improving optics, shorter wavelength, higher power lasers and other improvements will gradually permit closing the performance gap.

  Most current magneto-optical disk drives 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 drives now in production do not yet overwrite in place: A complete sector must be erased before the sector can be rewritten. Industry expectations are for elimination of the overwrite problem by the end of 1992.

  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. Phase change recording is capable of only a limited number of write/erase cycles before the signal to noise ratio from the written area degrades excessively. Matsushita Electric has reported achieving over a million cycles in the laboratory and has announced media with 100,000 cycles as being a practical product. Phase change erasable media, which arrived in the marketplace in 1990, can be directly overwritten. The first rewritable phase change drive was introduced by Matsushita Electric in 1990. It is backward compatible with previous write-once drives from the same firm.

A third possibility, potentially the least expensive to manufacture, is erasable dye-based technology. As of yet, only limited success has been obtained with this technique because developers have not been able to demonstrate an adequately high number of write/erase cycles, but there are applications, such as backup, where this is not a major disadvantage. In mid-1988, Tandy Corporation announced its intention to supply such a drive in the future, but unexpected problems have delayed its development effort.

Individual firms are also working on other proposed reversible optical recording technologies, but none of them have overcome all of the problems, which have included: Slow completion of the reversal cycle, sensitivity to ambient light, limitations on the number of reversals before degradation, expensive optical or laser components, poor shelf life, limited lifetime of stored data, and low recording density.

Magneto-optical storage is well into the manufacturing stage. Over 130,000 5.25" drives were shipped in 1990 and IBM, Sony and other firms introduced 3.5" drives in 1991. Rewritable 5.25" drives are now in volume production from Canon, Sony, Maxoptix and Ricoh, and both IBM and Hewlett-Packard will begin volume shipments of 5.25" optical drives in 1992.

* Read-only optical disks: The read-only optical disk category is dominated by the CD-ROM, which has capacities of 550 to 600 megabytes, but long access times. It is technically feasible to develop read-only media for read/write drives, and a few firms are producing read-only media for 3.5" optical disk drives. 3.5" drive standards include definitions of read-only capability, which is expected to be important in software distribution and multimedia related applications.

  Because they do not have recording capability, no significant displacement of magnetic disk drives by read-only optical drives is anticipated. They will retain a specialized role as a form of electronic publishing and will appear on systems as an adjunct to a rigid disk drive rather than as a replacement device.

* Magnetic bubbles: Bubble memories continue to succeed in markets requiring specialized packaging or operation under environmental stress. At one time considered a possible challenger to magnetic disk storage, bubble memory suffered a serious loss of credibility after the 1981 departure of National Semiconductor, Texas Instruments and Rockwell International from the field. The highest manufacturing levels are still maintained by Hitachi, with most production used by Nippon Telephone and Telegraph for a variety of telecommunication applications. Hitachi is currently exploring 64 megabit bubble devices.

  By the late 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. Such memory chips might contain from 100 megabits to 1 gigabit of data. R&D efforts at Purdue, Carnegie Mellon University, Boston University and at NEC and Kyushu University in Japan have shown promise, but much remains to be done to make VBL a zpractical technology. In the industrial sector, Magnesys has begun commercial development of VBL memory technology in conjunction with Jet Propulsion Laboratories and Boston University. A development period of several years is anticipated.

The nonvolatility 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. Although bubble memory densities have reached 4 megabits per device, they are still not cost competitive with magnetic disk technology. It is improbable that bubbles' prices will approach disks' prices -- and bubbles will now have to defend their specialized markets against encroachments from flash and ferroelectric semiconductor memory.

* High capacity flexible disk drives: It is within the capabilities of today's technology to fabricate a 3.5" floppy disk drive offering over 40 megabytes of storage capacity, and drives with 20 megabyte capacity are in volume production. These high capacity floppy drives could compete in the very low end of magnetic and optical disk drive markets and against tape drives for backup applications.

10 and 20 megabyte 5.25" flexible disk drives available in the market over the past several years have achieved only marginal success. However, the 3.5" drives with capacity in the 20 megabyte range which have been announced by Brier Technology and Insite Peripherals have created considerable interest. Several other Japanese floppy drive manufacturers are cooperating in a standards activity for 10 and 20 megabyte floppy disk drives.

Unfortunately, none of the new high capacity flexible disk drive formats are compatible with each other. Insite's 3.5" drive uses standard magnetic media with an optical servo pattern on the disk surface, combined with optical tracking methods. Brier uses a dual layer writing technique to embed its servo data beneath the data on each track. The Japanese standards group plans to use conventional embedded servo technology. Each has recognized the need for read and write downward compatibility with one and two megabyte 3.5" floppy disks, delaying volume manufacturing in some cases to incorporate downward compatibility.

Perpendicular recording for flexible disks has the potential to increase capacity without any significant increases in track density. By using a sputtered thin film, metal powder, or a barium ferrite coating on a Mylar substrate, perpendicular re-

cording disks could achieve linear densities potentially several times higher than today's drives. Higher track densities achieved through embedded servo techniques or optical tracking methods could increase capacities by a factor of four or more.

The 5.25" Bernoulli disk drives offered by Iomega have now reached 90 megabytes in capacity and compete strongly with removable 5.25" rigid cartridge type disk drives. At least one start-up company plans to develop a 2.5" high performance drive using flexible media, with 20 megabytes capacity, and optimized for low power and shock resistance, in order to compete in the notebook computer market.

* Stretched surface recording: SSR, as this technique is commonly known, was originally devised by the 3M Corporation. It employs a disk composed of a thin plastic film with a magnetic coating 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 under the head. This provides close head-media separation needed for high capacity but also prevents head crashes. Disk drives using this design technique could be produced in either fixed or removable format and could offer the same capacity as a small Winchester drive. The media, however, might have a cost only 1/3 to 1/4 that of the rigid disk media in current or projected use. 3M has had various arrangements with other firms interested in developing SSR drives, most of which are now inactive. Reports of joint activity between 3M and Sony appeared in the trade press in 1989 but there has been little visible activity since. Unless substantial improvements in SSR capacity can be shown, it is possible that the market has passed SSR by.

Disk drive enhancements

IBM introduced the first moving head rigid magnetic disk drive in 1956 and disk drive technology has improved rapidly ever since. After two decades of disk technology leadership, IBM contributions were outstripped by a legion of aggressive competitors in the area of small diameter drives. But the 1980's saw a resurgence in IBM contributions, especially in packaging -- including IBM's 320 megabyte 3.5" drive with 8 disks, an 857 megabyte 5.25" drive with 12 disks, and a 2.5" 40 megabyte drive only 12.7 millimeters high introduced in 1991. The critical areas being addressed by IBM and others are discussed below.

* Head flying height: For some of today's latest high density rigid disk drives, head flying height is in the 4 microinch range. Several firms are attempting to design drives in which there is no measurable flying height, and IBM has discussed advanced research projects in which the head "flies" at 2 microinches above the surface, essentially contact recording. Because head flying height determines the achievable areal density, reductions are of critical importance, but each reduction requires a new level of sophistication in the preparation of substrates, coatings, overcoatings, heads and test equipment. For instance, it appears that glass substrates may be required to obtain the required smoothness and flatness for the lowest flying heights. Determining reliable processes for manufacturing, coating, texturing and testing disk media using glass substrates are major challenges, and the ability of substrate and media producers to ramp up production is an unproven capability.

  As flying height decreases, maintaining a constant flying height becomes critical to reliable performance. Some firms are looking at contact recording, while others are developing new slider designs capable of maintaining a stable flying height. Censtor is developing an unusual low mass, low contact area head design in which the head is normally in contact with the disk. While wear does occur, the rate of wear of the critical parts of the head is low enough to permit head lifetimes to exceed expected drive lifetimes. VISqUS Corporation, acquired by Conner Peripherals in 1991, has been developing a "water skiing" technique in which close head/disk contact is controlled by a continuous lubrication system.

  Developers of conventional sliders are adding slots to the outer rails or contouring the edges of the rails. Both approaches show promise in controlling flying height and stabilizing the head

position, although they add cost. A few firms are working on negative pressure sliders, a design which forms a partial vacuum under the head. The head can stably fly very close to the disk surface, although there is a risk of debris accumulating in the negative pressure cavity on the underside of the head.

* Recording heads: Monolithic ferrite heads patterned after IBM's 3350 designs dominated in early Winchester disk drives. During the following years, PCM drives using heads designed to compete against IBM's 3370, 3375, 3380, and other new drives with ferrite heads having sliders with 3370 contours (mini-sliders) became common. The outpouring of small diameter disk drives from multiple OEM sources in the last decade embraced the small head contours and drove the demand for high performance small heads. These pressures, in turn, drove the development of composite and digital application metal-in-gap heads.

  Sliders have continued to decline in size under the pressure to make ever smaller HDAs. The 70% form factor micro-slider (70% of the volume of a mini-slider) is being used in thin 3.5" and 2.5" diameter drives and the 50% form factor nano-slider will probably also see wide use in very thin 2.5" and 1.8" diameter drives. As spacing between disks diminishes, use of the smaller sliders becomes mandatory. Additional advantages of the small sliders include less mass to inhibit rapid positioner movement or cause damaging head/disk interference. The smaller size also relieves stiction problems, although some new drive designs also utilize ramp loaded heads, eliminating the possibility of stiction and reducing power requirements for starting drive motors. The 70% sliders are in large volume production currently, while 50% sliders will probably be entering general production in 1992. The IBM 1 gigabyte, 3.5" drive that began to ship in the last half of 1991 also uses 50% sliders.

  Ferrite heads continue to be widely used, but thin film heads are taking over in situations requiring very high areal densities. MIG (metal-in-gap) heads are able to substitute for thin film heads in 3.5" and 2.5" mid-range drive applications and are less expensive, but thin film heads are probably the technology of choice for 3.5" drives with capacities of 500 megabytes and above. Waiting in the wings are magneto-resistive heads, which may appear in both high performance and very small form factor drives. IBM introduced the first disk drives using MR heads in 1991.

  Conventional and composite ferrite heads, now 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 captive and OEM drives, though metal-in-gap and thin film heads have reached high production levels and are becoming more price competitive with ferrite monolithic and composite heads. Single crystal ferrite heads and cores, beginning volume production in 1991, provide improved performance and

should extend the life of ferrite head technology. Risk is relatively low, as single crystal technology has been used in video heads for a number of years.

Metal-in-gap heads were first used by Japanese firms in the late 1970s for video tape applications, and are now used in DAT recorders as well as small, high performance disk drives. They can compete effectively with thin film heads in many of today's applications, although thin film heads are capable of performance extensions that metal-in-gap heads are unlikely to reach. The choice of head type depends upon the flying height, desired areal density, the characteristics of the media, and cost. Alps Electric is the leading supplier of metal-in-gap (MIG) heads.

The ability of thin film heads to operate at areal densities well above those achievable by other head technologies guarantees them a role in future high capacity, high performance designs. 1984 saw the beginning of thin film head shipments for small diameter OEM disk drives. Production is large and increasing as more vendors master the process and gain control of process yields. Current major producers include IBM, Seagate, Applied Magnetics, Dastek, Yamaha and Read-Rite. Lower cost MIG heads have proven capable of operation in many applications originally targeted by thin film heads, so until the late eighties the demand for thin film heads was much slower to develop than many prospective producers had hoped. As a result, production capacity lagged, and as a consequence, the production surge of small drives using very high recording densities that began in 1989-90 has created a shortage of thin film heads that has supported higher price levels. Production is closing on demand, however.

Magneto-resistive (MR) thin film heads are expected to gradually be introduced in sub-2.5" form factor disk drives to provide adequate readback signal to noise ratios without resorting to ultra-high spin rates. They will also appear in high end drives where their ability to read very narrow tracks enhances drive areal density and minimizes crosstalk from adjacent tracks. However, internally generated noise and low yield remain challenges to be overcome before MR heads see wide use in disk drives. IBM, which has been developing MR heads for many years, included them in the 1 gigabyte 3.5" drive that started to ship in the last half of 1991.

* Recording disks: As the disk drive industry progressed through succeeding generations of disk drives, disk media underwent a refinement of the basic coating process to achieve a continually thinner application of a uniform coating, plus improvements in surface lubricants. Today, thin film media has largely displaced oxide, because oxide coated media was unable to satisfy increasing areal density requirements. Even IBM, a longtime oxide champion, now ships large quantities of drives with thin film media, and is using thin film disks on the new 3390-3 drive with 10.8" disks introduced in September, 1991.

Many of the early manufacturers of thin film disks lacked adequate process control and were unable to sustain high production yields or to meet delivery commitments on a consistent basis. Plating was the primary method used to produce early generations of thin film disks, but plating is being supplanted by sputtering as the preferred production technique. Sputtered disks are perceived as more capable of obtaining the higher coercivities and tight tolerances required by disk drives operating at high areal densities and low flying heights. Although plated disks have achieved coercivities up to 1,400 oersteds, most drive producers believe that plated media practically tops out at 1,200 oersteds. The migration to sputtered media was enhanced by the departure of Domain Technology from the ranks of media producers, which left much of the field to suppliers of sputtered disks.

Firms producing sputtered disks claim 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 difficulty that producers of 8" disk drives have in obtaining sources of sputtered 8" media. Sputtered disk producers are concentrating on 5.25", 3.5", and 2.5" media because the bulk of the near term demand is in those sizes, and many are preparing to manufacture 1.8" media, which is the next step in the size progression. Media with coercivity in the 1,200 to 1,500 oersted range is routinely producible, and some companies have demonstrated fabrication of media up to 2,300 oersted coercivity on production quality sputtering systems.

While most thin film media production has been from independent producers, major system manufacturers, including Hewlett-Packard, Digital Equipment and IBM, also produce much of their media requirements. Some drive manufacturers, such as Conner and Seagate also produce much of their media needs. This has had the effect of reducing external disk purchases by these drive manufacturers, but the effect on the independent disk media manufacturers has been masked by the very strong demand for 3.5" and 2.5" drives.

Aluminum has always been the substrate of choice for rigid disk media, but some high capacity 2.5" disk drives, such as those of Areal Technology and Toshiba, use glass or glass/ceramic as a substrate material. Glass substrates are potentially smoother and flatter than aluminum, have fewer impurities that can cause defects, and can be made very thin. These characteristics allow for lower flying heights and the inclusion of more disks in a stack, both highly desirable features. However, because of low production volume, glass disks currently cost significantly more than aluminum substrates. There is also limited industry production capacity at present. However, as flying heights decline below 4 microinches, it is likely that glass and ceramic substrates will gradually begin to displace aluminum.

Disk substrate thickness is declining in order to allow placement of more disks in small diameter drive HDAs. In 1989, 50 mil substrates were standard practice for 3.5" diameter drives, but 31.5 mil substrates have seen increasing use since IBM introduced them in the "Lightning" 3.5" drive introduced in 1989. The next step is expected to be a move to 20-25 mil substrates, possibly in drives appearing in 1993. 2.5" drive substrates, now at 35 mils, may move to that range even sooner.

While very smooth disk surfaces are needed to obtain low flying height, they may produce stiction effects when the head is in contact with the disk. Some media suppliers are considering the use of dual texturing, making the texture in the head landing zone rough to prevent stiction but keeping a smoother texture in the read/write area of the disk to help maintain low flying height.

* Track density: The industry is moving forward gradually with TPI improvements. Some small drives operate at up to 2,200 TPI, but such precision is costly. The industry still has plenty of room for innovation in this area. IBM's 3390-3 operates at 2,984 TPI, and some firms are investigating the use of optical tracking techniques to obtain higher TPI. IBM has shown the feasibility in the laboratory of creating media with very narrow tracks with sub-micron dimensions. However, considerable work will have to be done to develop heads capable of working with such narrow track widths.

  New materials and designs are being developed to improve vibration suppression damping in head gimbal assemblies and positioning mechanisms. This also should assist in reaching higher track densities.

* Perpendicular recording: Today's rigid disk drives all use longitudinal recording, making use of magnetic domains oriented parallel to the surface of the recording medium. More than 100,000 BPI could theoretically be resolved by recording heads if magnetization were oriented in a plane perpendicular to the recording surface, and TPI could also be sharply increased, provided that head to disk spacing is minimized.

  A very large amount of development activity in perpendicular recording has been underway in Japan since 1977, 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 the first drive using perpendicular recording, introduced by Northern Telecom in 1989 with heads and disks developed by Censtor, was withdrawn when they decided to discontinue disk drive operations.

  Early developers of perpendicular recording discovered that the high bit densities implicit in perpendicular recording resulted

in very high data transfer rates that available controllers for small disk drives couldn't handle. Censtor avoided this problem by improving track density as well as bit density, permitting the use of current controller technology. This approach required Censtor to develop both heads and media and to completely manage the head/disk interface.

* Multiple spindle arrays: A single high capacity drive can be replaced with an array of smaller capacity drives having aggregate equivalent capacity and a file organization that appears to the host system to be similar to that of the larger drive. Data is typically "striped" across each drive in the array, and the drives can operate with their rotation rate and phase synchronized to minimize the skew between related bits.

  Such arrays can offer several advantages compared to drives limited by a single actuator. Depending upon the way the array is configured and upon the degree of sophistication of associated subsystems, it can also offer fault tolerance, very high data transfer rates, or volumetric efficiencies, compared to single large drives. Options such as caching and multiple data pathing can also be added. The term RAID (Redundant Array of Inexpensive Disks) denotes multiple drive configurations generically, with specific configurations ranging from multiple, uncoordinated disk drives to striped, synchronized drives defined within the RAID designation as RAID-1, RAID-2, etc., through RAID-5. The RAID nomenclature, which derives from papers published by the University of California, has been formally defined only up to the RAID-5 level, but various firms are developing advanced architectures informally defined as RAID-6 or RAID-7.

* Performance: Significant improvements in data transfer rates and average access times are expected during the next few years. The single most important factor in initiating these improvements will be the increase in disk rotation rate, which both decreases latency and increases data transfer rate. A secondary, but significant technique may be the use of multiple heads per surface and/or multiple heads per slider to permit parallel access to large amounts of data without head movement.

  Drives having rotation rates in the range of 5,400 RPM appeared in 1989 when Imprimis announced a family of high capacity 5.25" drives operating at 5,400 RPM. Most of the 1 gigabyte 3.5" drives announced to date offer 4,300 RPM or faster spin rates. Some firms are considering the use of motors operating in the 9,000 to 10,000 RPM range for use with disk drives having diameters under 2.5".

  The use of parallel transfer from multiple heads to achieve data rates of 12 megabytes or more per second has been a practice for many years, with such drives typically used for supercomputers and high-end imaging applications. Drives with data transfer rates of 24 megabytes per second or more are in demand for super-

computing applications. 27 megabytes per second is achieved by Seagate's Sabre PTD, an 8" 2.4 gigabyte 9 head parallel transfer drive introduced in 1990.

Average seek times have now dipped down to the 9 millisecond range for the fastest drives, although 14 to 16 millisecond seek times are more common in high performance 5.25" and 3.5" drives. Higher energy magnetic materials and lower mass microslider heads are contributing to the improved performance. Some drives are specified with read seek times that are a millisecond or two faster than the write seek time as a result of drive intelligence permitting usable readback signals to be acquired before the head has fully settled after a seek.

* Form factor: Sub-3.5" drives will become an increasingly significant part of the market. Driven by demands from manufacturers of notebook and laptop computers, small footprint, low height, low power drive designs are proliferating. Drive height has steadily declined, with IBM's 12.7 millimeter high 2.5" 43 megabyte representing the 1991 benchmark on drive height. 1.8" drives are being shipped by Integral Peripherals, and several major producers including IBM are expected to join them.

  Competition in providing higher capacity and thinner sub-3.5" disk diameter drives will be keen. 15 to 19 millimeter heights are available for new low-end drives for desktop computers, so that half of an existing "half high" disk drive bay can be free for other peripheral devices. 2.5" drives are already in the 12.7 to 15 millimeter high range, to allow maximum volume for batteries in notebook computers.

  The first indications of the next reduction in form factor below 1.8" are starting to appear. Some companies are now looking seriously at disk drives with 1.2" to 1.3" diameters. Technologically, form factor reduction is being driven by improvements in areal density, smaller heads, and higher energy magnetic materials that permit fabrication of smaller motors and actuators without reducing performance.

  Another aspect of form factor reduction is the need to operate the drive at low power to conserve battery life in portable systems. This requires the drive to have several operating modes to conserve power when not in use. Typically, the drive does not spin when data is not being transferred and other power consuming functions may also be shut down when the drive is inactive. A related need is for the drive to quickly come up to operating speed when needed. Some designs incorporate ramp loading of heads, enabling removal of the heads from disk contact when the drive spins down. The removal of head drag on the disk enables the drive to spin up faster with less power demand and lessens the danger of a stiction caused malfunction.

The voltage required by the drive is also a factor. Future drives for portable systems will probably be capable of operating within specification over a range of voltage from 3.0 to 3.3 volts. This permits the drive to be operated directly from a battery supply without incurring the cost and power dissipation of a voltage regulator.

* Interfaces and controllers: There is an established trend to intelligent interfaces embedded within the disk drive and able to communicate with a host system data bus without the need for a separate controller. Embedded SCSI and PC/AT controllers have become widely used in drives for personal computer applications, and embedded SCSI is now used with the majority of drives used with workstations, servers and equivalent applications.

  Intelligent controllers provide disk drive suppliers with an opportunity to add value, but more importantly to give them freedom to design the drive to meet various needs while maintaining a common interface to the host system. For small diameter drives under 500 megabytes capacity, some version of SCSI will probably be employed in 20 to 25 percent of the drives shipped in 1991. However, PC/AT interfaces far outnumber SCSI interfaces in the personal computer market.

  The use of embedded intelligent interfaces has allowed drive manufacturers to make use of techniques such as varying bit density by zones over the band of recording tracks and advanced data coding. Other features, such as on-board error monitoring and diagnostics, error correction, digital servos, intelligent caching, zero latency read/write and multiport buffering can be included but made transparent to the using system. However, there is a delicate balance between overall system performance and the design of the intelligent controller. For instance, the use of too large a buffer can slow data retrieval if all of the buffer contents must be examined to service each request for data from the system.

* Digital Servos: Digital servos are increasingly popular as VLSI density improves and smaller disk drive form factors make printed circuit board space a scarcer commodity. The ability to incorporate programmable servo function in a single chip or chip set provides both functional and economic advantages. Typical servo control chips employ digital signal processors coupled with a standard microprocessor. By the mid-1990s, it is probable that well over 80% of the rigid disk drives produced will incorporate digital servos. Digital servo chips are expected to include motor power control functions as well as servo functions.

* Encoding and error correction: Effective linear bit density can be improved beyond the raw flux change density by the use of appropriate data encoding schemes. Run-length-limited codes such as 2,7 RLL and 1,7 RLL are the most often used currently, but the Probable Response Maximum Likelihood (PRML) code recently intro-

duced by IBM on its 9336 model 5.25" and 1 gigabyte 3.5" drives may be used widely once it is well understood by the rest of the industry.

In-line error correction of the read-back data stream will also become increasingly common, because as areal density becomes higher, the size of a media defect required to cause an error becomes smaller and the number of error causing defects per unit area increases. The Reed-Solomon codes used in optical disk drives to perform error correction are migrating to the rigid disk drive world, permitting the reliable use of media that would otherwise have to be discarded. The effective improvement in media yield provides a strong incentive to adopt error correction techniques.

If other in-line processing of data within the drive is performed, data compression within the drive can also be expected as a functional capability. In addition to improving capacity, the effective data transfer rate is also improved. The degree of compression obtainable is highly influenced by the format of the data and the degree of processing allowable by real-time requirements on drive performance. In any event, the compression algorithms used will be restricted to lossless compression techniques.

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/Reseller and OEM/Integrator disk drive marketing activities.

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

Examples:

* Drives sold by Hewlett-Packard, IBM or NEC to computer system end users are considered captive, if internally manufactured.

* In the case of a joint venture disk drive manufacturer, such as Conner Peripherals Europe (owned by Conner Peripherals and Olivetti), drive sales are considered captive or non-captive depending upon the method of sale by each joint venture partner.

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

Example:

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

* Shipments made by Micropolis are non-captive.

PCM/Reseller: Disk drives sold or leased by "plug compatible manufacturers" or their distributing organizations directly to end users for use with systems sold by another manufacturer. Also includes drives sold in the "aftermarket" -- shipments by drive manufacturers to subsystem producers, distributors, retail chains, mail order firms and individual dealers.

It includes drives to be connected to systems of all types, including personal computers, minicomputers and mainframes, or drives sold as add-on devices by distributors and dealers.

Examples:

* Disk drive-on-a-card products such as those of Plus Development.

* Disk drives sold by Storage Technology to end users of IBM equipment.

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

OEM/Integrator: Drives sold by the original producer to system manufacturers which resell them as part of complete computer systems. Also includes sales to system integrators or value-added resellers which combine finished system components and software to provide complete systems for specific applications. Sales by a disk drive manufacturer to a second drive manufacturer for resale are included only in shipment totals for the originating manufacturer, except when drives or libraries 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.

Examples:

* Drives produced by Micropolis or Maxtor for sale to system manufacturers.

* Drives sold by Quantum but made to Quantum designs by Matsushita Kotobuki Electronics.

GEOGRAPHIC CLASSIFICATION

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

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

Examples:

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

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

U.S. vs. Non-U.S. MANUFACTURERS: Manufacturers are classified U.S. or non-U.S., depending on the location of the firm's headquarters, regardless of the location of individual manufacturing plants.

Examples:

* Seagate is considered a U.S. manufacturer, even though the firm manufactures many of its disk drives in non-U.S locations.

UNITS OF MEASUREMENT

Spindles: The basic unit in counting disk drives. One spindle or spindle disk assembly consists of the disk drive mechanism required to utilize a single disk or disk stack. All DISK/TREND unit totals are counted in spindles. 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 or more spindles are equivalent to one IBM 3380 or 3390 spindle (noted in the statistical tables as appropriate).

Revenue: Based on sales of disk drives alone, as normally sold by individual manufacturers. Controllers sold as separate units are not included in disk drive revenue, nor are spare parts or service. When individual 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/Reseller or OEM/Integrator levels. All prices are in 1991 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 single density 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.

APPLICATION CLASSIFICATION

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

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

Minicomputers/multiple user microcomputers: Drives attached to smaller general purpose processors typically serving multiple users, including network file servers. Examples: IBM System AS/400, AT&T 3B2, Hewlett-Packard 3000.

Personal computers: Attached to a general purpose microcomputer normally used by a single user. Examples: IBM PS/2, Apple Macintosh, Compaq LTE

Office systems/workstations: Specialized equipment for dedicated use in specific office applications such as word processing, electronic mail or document storage. Specialized hardware is normally used. Examples: Wang OIS series, Toshiba TOSFILE.

Non-office systems/workstations: Attached to dedicated processors and workstations used in a non-office application, such as order processing/shipping, point-of-sale, medical, factory production control, law enforcement, CAD/CAM/CAE, military, etc.

Consumer and hobby computers: Systems sold primarily to consumers for non-business applications. Examples: Commodore 64, MSX systems, most Atari models (Apple II is considered to be a professional/business microcomputer).

Other applications: Any application not included above, including non-conventional uses such as intelligent fax machines and copiers.

DISK CARTRIDGE DRIVES

1991 DISK/TREND REPORT

DISK CARTRIDGE DRIVES

Coverage

Examples of disk drives in this group include:

8" disk diameter

Cerplex (Century Data)	7110, 7130

5.25" disk diameter

DMA Technologies	360
MFM Technology	11/11, 20R
Ricoh	RH5260, RH5500
SyQuest Technology	SQ555, SQ5110, SyDOS 88e

This product group includes all drives using a removable disk cartridge, which is sometimes combined with one or more fixed disks in a single drive. Each fixed/removable combination drive is counted as one spindle.

The character of the disk cartridge drive business has changed drastically in recent years, as older models are discontinued, replaced with drives using smaller disks. None of the companies which led in shipments of 14" OEM disk cartridge drives during the heyday of this group -- Control Data, Diablo or Western Dynex -- are currently represented with products. In fact, all production of 14" drives has been phased out, and 8" drives are now close to extinction. In 1991, 5.25" drives provide almost all of the shipments in this product group.

Market status

DISK/TREND estimate of total market size:

Worldwide sales ($M)	1990	1991	1992	1993	1994
U.S. manufacturers	47.9	65.1	101.7	126.7	135.0
All manufacturers	54.9	74.3	112.2	138.6	145.8

5.25" disk cartridge drives continued to establish new records in unit shipments in 1990, up 64% in that year, with another 65% increase forecasted for 1991. Total revenues for 1990 were down, due to the absence of 14" drive shipments, which occurred for the last time in 1989. The revenue total was impacted by the phase out of older drives produced in the Eastern Bloc, which were typically sold at substantially higher prices than in the West.

Last year's growth in unit shipments was again attributable entirely to expansion of the market for 5.25" disk cartridge drives, with worldwide 1990 shipments of 149,900 drives expected to climb to 248,100 units in 1991. 1990 was the last year for significant 8" and 3.9" drive production.

Older 14" and 8" captive disk cartridge drive programs by Digital Equipment, Control Data and other companies have been phased out, accounting for absence in captive revenues. The growth expectations of several years ago for 14" and 8" drives were largely unfulfilled.

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 which 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.

While the initial growth of 3.9" and 5.25" disk cartridge drive shipments was largely driven by the demand for removable media in security markets, in which data must be stored in locked facilities under government or private requirements, shipments in recent years have been stimulated mostly by use of newer graphics and desktop publishing software on personal computers. Removable disk cartridges make it possible to keep individual projects on separate cartridges, which can be quickly mounted in disk drives as updates become necessary.

SyQuest continues to dominate shipments of disk cartridge drives. After achieving early growth in security markets, the firm has become the leader in add-on removable disk storage for Macintosh systems used in graphics and desktop publishing applications, and has recently added a new program focused on the same applications used with IBM personal computers. The firm's 1990 shipments of 134,000 drives accounted for 87.9% of the worldwide shipments of disk cartridge drives.

Marketing trends

5.25" drives are expected to continue to dominate this product group through 1994, as user preferences in the specialized market for disk cartridge drives push drive manufacturers toward higher capacity models. However, given the industry's inevitable trend toward smaller disk diameters, development of 3.5" and 2.5" disk cartridge drives is also under way, and the first product introductions will probably occur before the end of this year.

With the expected appearance of smaller drives, the growth rate for

5.25" disk cartridge drives will slow down, falling to a forecasted level of only 2.8% in 1994, representing worldwide shipments of 397,000 drives in that year. 1994 shipments of drives with disk diameters less than 5.25" are expected to reach 190,000, following a start for production shipments in 1992.

As expected, SyQuest started shipments of its 88 megabyte 5.25" model in the first quarter of 1991, and has experienced strong demand for the higher capacity. The major competition for SyQuest is not currently provided by other manufacturers of rigid disk cartridge drives, but by Iomega, maker of the high capacity Bernoulli floppy disk drive. Iomega's 44 megabyte 5.25" drive has been recently supplemented with a 90 megabyte model, with the result that SyQuest and Iomega are competing directly in both the Macintosh and IBM personal computer markets for the same graphics and desktop publishing applications.

So far, the recent sales growth for disk cartridge drives has occurred mostly in the aftermarket, with disk subsystems designed as add-ons to be used with existing computers. Given the earlier background of technical difficulties, shaky financial status of some manufacturers, lack of media interchange standards and excellent competition from fixed disk drives, it is easy to understand why a majority of the computer industry's system manufacturers are no longer using disk cartridge drives.

However, the expected availability of smaller disk cartridge drives starting in 1992 may provoke more interest by system manufacturers in factory installation of these drives. With many end users already sold on the use of removable media for selected applications, the time for renewed growth of OEM shipments for disk cartridge drives may have arrived.

Technical trends

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 the higher areal densities already in use with high capacity fixed disk drives, heads must fly at lower altitudes, increasing the need for reduced contamination levels.

It is possible to increase density in removable disk drives, building upon the design experience accumulated with today's 5.25" drives. Changes in heads, filtration systems and seals may be necessary, and thin film disks will continue to be used because of improved surface durability. Due to the new growth being experienced by this product group, development of both 3.5" and 2.5" drives is well under way.

The basic recording technologies now in use for products in this group will continue to predominate for years. The smaller drives expected in the near future may be expected to embody the mechanical design lessons accumulated during years of production of larger removable disk drives, but will be able to take advantage of the rapid design advancements in recent years in recording heads, disks, head positioning and electronic components originally intended for fixed disk drives.

Forecasting assumptions

1. Significant shipments of 3.5" and 2.5" disk cartridge drives will start in 1992, with successful sales to both system manufacturers and the aftermarket.

2. Production for 5.25" disk cartridge drives with capacities over 40 megabytes will continue to increase, driven mostly by graphics and desktop publishing applications.

TABLE 12

DISK CARTRIDGE DRIVES

REVENUE SUMMARY

	DISK DRIVE REVENUES, BY SHIPMENT DESTINATION ($M)									
	1990 Revenues		Forecast 1991		1992		1993		1994	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM Captive	--	--	--	--	--	--	--	--	--	--
Other U.S. Captive	--	--	--	--	--	--	--	--	--	--
TOTAL U.S. CAPTIVE	--	--	--	--	--	--	--	--	--	--
PCM/Reseller	30.3	38.5	42.6	54.6	64.4	84.0	75.4	100.1	74.4	102.0
OEM/Integrator	6.9	9.4	7.4	10.5	13.5	17.7	19.9	26.6	24.4	33.0
TOTAL U.S. NON-CAPTIVE	37.2	47.9	50.0	65.1	77.9	101.7	95.3	126.7	98.8	135.0
TOTAL U.S. REVENUES	37.2	47.9	50.0	65.1	77.9	101.7	95.3	126.7	98.8	135.0
Non-U.S. Manufacturers										
Captive	--	--	--	--	--	--	--	--	--	--
PCM/Reseller	4.5	7.0	5.6	9.2	6.3	10.5	7.3	11.9	6.8	10.8
OEM/Integrator	--	--	--	--	--	--	--	--	--	--
TOTAL NON-U.S. REVENUES	4.5	7.0	5.6	9.2	6.3	10.5	7.3	11.9	6.8	10.8
Worldwide Recap										
TOTAL WORLDWIDE REVENUES	41.7	54.9	55.6	74.3	84.2	112.2	102.6	138.6	105.6	145.8
OEM Average Price ($000)		.4		.3		.3		.2		.2

TABLE 13

DISK CARTRIDGE DRIVES

UNIT SHIPMENT SUMMARY

	DISK DRIVE UNIT SHIPMENTS, BY SHIPMENT DESTINATION (000)									
	1990		Forecast							
	Shipments		1991		1992		1993		1994	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM Captive	--	--	--	--	--	--	--	--	--	--
Other U.S. Captive	--	--	--	--	--	--	--	--	--	--
TOTAL U.S. CAPTIVE	--	--	--	--	--	--	--	--	--	--
PCM/Reseller	92.4	117.4	152.4	195.4	230.0	300.0	290.0	385.0	310.0	425.0
OEM/Integrator	15.2	19.5	22.5	29.8	45.0	59.0	71.0	95.0	94.0	127.0
TOTAL U.S. NON-CAPTIVE	107.6	136.9	174.9	225.2	275.0	359.0	361.0	480.0	404.0	552.0
TOTAL U.S. SHIPMENTS	107.6	136.9	174.9	225.2	275.0	359.0	361.0	480.0	404.0	552.0
Non-U.S. Manufacturers										
Captive	--	--	--	--	--	--	--	--	--	--
PCM/Reseller	10.0	15.6	14.0	23.0	18.0	30.0	22.0	36.0	22.0	35.0
OEM/Integrator	--	--	--	--	--	--	--	--	--	--
TOTAL NON-U.S. SHIPMENTS	10.0	15.6	14.0	23.0	18.0	30.0	22.0	36.0	22.0	35.0
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	117.6	152.5	188.9	248.2	293.0	389.0	383.0	516.0	426.0	587.0
Total Capacity (Terabytes)	6.0	7.7	11.1	14.6	19.7	26.0	29.2	39.2	36.5	50.2
Cumulative Shipments (Units in thousands)										
IBM	53.3	79.0	53.3	79.0	53.3	79.0	53.3	79.0	53.3	79.0
Non-IBM	1,240.5	2,047.7	1,429.4	2,295.9	1,722.4	2,684.9	2,105.4	3,200.9	2,531.4	3,787.9
WORLDWIDE TOTAL	1,293.8	2,126.7	1,482.7	2,374.9	1,775.7	2,763.9	2,158.7	3,279.9	2,584.7	3,866.9

TABLE 14

DISK CARTRIDGE DRIVES

WORLDWIDE REVENUES ($M)

BREAKDOWN BY DISK DIAMETER

	1990 Revenues			Forecast							
				1991		1992		1993		1994	
	8"	5.25"	<5.25"	8"	5.25"	5.25"	<5.25"	5.25"	<5.25"	5.25"	<5.25"
U.S. MANUFACTURERS											
PCM/Reseller	--	38.5	--	--	54.6	71.4	12.6	76.7	23.4	74.4	27.6
OEM/Integrator	1.8	6.8	.8	.3	10.2	13.2	4.5	15.4	11.2	13.5	19.5
TOTAL U.S. REVENUES	1.8	45.3	.8	.3	64.8	84.6	17.1	92.1	34.6	87.9	47.1
NON-U.S. MANUFACTURERS											
PCM/Reseller	--	7.0	--	--	9.2	10.5	--	11.9	--	10.8	--
TOTAL NON-U.S. REVENUES	--	7.0	--	--	9.2	10.5	--	11.9	--	10.8	--
WORLDWIDE RECAP											
PCM/Reseller	-- --	45.5 +50.2%	-- -100.0%	-- --	63.8 +40.2%	81.9 +28.4%	12.6 --	88.6 +8.2%	23.4 +85.7%	85.2 -3.8%	27.6 +17.9%
OEM/Integrator	1.8 -25.0%	6.8 -25.3%	.8 -61.9%	.3 -83.3%	10.2 +50.0%	13.2 +29.4%	4.5 --	15.4 +16.7%	11.2 +148.9%	13.5 -12.3%	19.5 +74.1%
Total Revenues	1.8 -25.0%	52.3 +32.7%	.8 -71.4%	.3 -83.3%	74.0 +41.5%	95.1 +28.5%	17.1 --	104.0 +9.4%	34.6 +102.3%	98.7 -5.1%	47.1 +36.1%
ANNUAL SHARE, BY DIAMETER	3.3%	95.4%	1.3%	.4%	99.6%	84.9%	15.1%	75.1%	24.9%	67.8%	32.2%

TABLE 15

DISK CARTRIDGE DRIVES

WORLDWIDE SHIPMENTS (000)

BREAKDOWN BY DISK DIAMETER

	1990 Shipments			Forecast							
				1991		1992		1993		1994	
	8"	5.25"	<5.25"	8"	5.25"	5.25"	<5.25"	5.25"	<5.25"	5.25"	<5.25"
U.S. MANUFACTURERS											
PCM/Reseller	--	117.4	--	--	195.4	255.0	45.0	295.0	90.0	310.0	115.0
OEM/Integrator	.6	16.9	2.0	.1	29.7	44.0	15.0	55.0	40.0	52.0	75.0
TOTAL U.S. SHIPMENTS	.6	134.3	2.0	.1	225.1	299.0	60.0	350.0	130.0	362.0	190.0
NON-U.S. MANUFACTURERS											
PCM/Reseller	--	15.6	--	--	23.0	30.0	--	36.0	--	35.0	--
TOTAL NON-U.S. SHIPMENTS	--	15.6	--	--	23.0	30.0	--	36.0	--	35.0	--
WORLDWIDE RECAP											
PCM/Reseller	--	133.0	--	--	218.4	285.0	45.0	331.0	90.0	345.0	115.0
	--	+75.9%	-100.0%	--	+64.2%	+30.5%	--	+16.1%	+100.0%	+4.2%	+27.8%
OEM/Integrator	.6	16.9	2.0	.1	29.7	44.0	15.0	55.0	40.0	52.0	75.0
	-25.0%	+7.6%	-61.5%	-83.3%	+75.7%	+48.1%	--	+25.0%	+166.7%	-5.5%	+87.5%
Total Shipments	.6	149.9	2.0	.1	248.1	329.0	60.0	386.0	130.0	397.0	190.0
	-25.0%	+64.2%	-71.0%	-83.3%	+65.5%	+32.6%	--	+17.3%	+116.7%	+2.8%	+46.2%
ANNUAL SHARE, BY DIAMETER	.4%	98.4%	1.2%	--	100.0%	84.7%	15.3%	74.9%	25.1%	67.7%	32.3%
TOTAL CAPACITY (Terabytes)	--	7.7	--	--	14.6	22.5	3.6	30.2	9.1	35.0	15.2

TABLE 16

DISK CARTRIDGE DRIVES

APPLICATIONS SUMMARY
Percentage of Worldwide Shipments

APPLICATION	1990 Estimate Units (000)	1990 Estimate %	1994 Projection Units (000)	1994 Projection %
MAINFRAME/SUPERMINI General purpose	--	--	--	--
MINICOMPUTERS AND MULTI-USER MICROS Business and professional, including networks	3.2	2.1	5.9	1.0
PERSONAL COMPUTERS Business and professional, single user	120.8	79.3	516.5	88.0
OFFICE SYSTEMS AND WORKSTATIONS Dedicated application	12.7	8.3	17.6	3.0
NON-OFFICE SYSTEMS AND WORKSTATIONS Technical, distribution, medical, other specialized	15.8	10.3	47.0	8.0
CONSUMER AND HOBBY COMPUTERS	--	--	--	--
OTHER APPLICATIONS	--	--	--	--
Total	152.5	100.0	587.0	100.0

TABLE 17

DISK CARTRIDGE DRIVES

MARKET SHARE SUMMARY
Worldwide Shipments of Non-Captive Disk Drives

	1990 Net Shipments									
	To United States Destinations					Worldwide				
	Units (000)				%	Units (000)				%
Drive Manufacturers	8"	5.25"	3.9"	Total		8"	5.25"	3.9"	Total	
Syquest	--	104.0	2.0	106.0	90.1	--	132.0	2.0	134.0	87.9
Ricoh	--	10.0	--	10.0	8.5	--	15.6	--	15.6	10.2
Other U.S.	.5	1.1	--	1.6	1.4	.6	2.3	--	2.9	1.9
Other Non-U.S.	--	--	--	--	--	--	--	--	--	--
TOTAL	.5	115.1	2.0	117.6	100.0	.6	149.9	2.0	152.5	100.0

FIXED DISK DRIVES, LESS THAN 30 MEGABYTES

1991 DISK/TREND REPORT

FIXED DISK DRIVES, LESS THAN 30 MEGABYTES

Coverage

Examples of disk drives in this group include:

5.25" disk diameter

Fujitsu	M2235AS
DZU	ES 5300, CM 5508
Hitachi	DK505-2*
Itautec	DRG20
Microlab	DFW 5025*
Miltope	RDS-1500
Qualitron	QW-521*
Seagate Technology	ST225*

3.5" disk diameter

Alps Electric	DRP020A**, DRP020Q*
Conner Peripherals	CP3020**, CP4024**
Elebra	W320
Fuji Electric	FK309X-26*, FK311A-26**
Fujitsu	M2225D2*
Hewlett-Packard	9153
Hitachi	DK302-2*
IBM	WD-325*
Kalok	KL320*
Kyocera	KC20B*
Multidigit	DW 2061
NEC	D3821*
Plus Development	Hardcard 20**, Passport*
Prologica	W320B*
Seagate Technology	ST125*, ST3025N**
Western Digital	WD93024-A*

2.5" disk diameter

Conner Peripherals	CP-2020**, CP-2024**
JVC	JD-E2825P**
Toshiba	MK-1022FC

1.8" disk diameter

Integral Peripherals	1820**

*Indicates drives with maximum 41.3 mm height, or less.
**Indicates drives with maximum 25.4 mm height, or less.

All drives in this group use variations of the technology loosely described as "Winchester," utilizing a variety of head configurations, mostly "mini-slider" heads in 3370/3380-type sliders. Some of the 5.25" drives in the group use conventional oxide disks, but most of the 3.5" drives, and all of the 2.5" drives, use thin film disks.

The majority of the drives in the group use head positioning systems driven by stepping motors, with relatively slow average access times, but low costs. Many newer drives use voice coil or torque motor actuators, rotary or linear, to produce faster head positioning times.

Utilizing the higher areal densities now possible with advanced heads and disks, Conner's one inch high 20 megabyte drive using a single 3.5" disk appeared in 1988, signaling a major trend, and Conner introduced a 3/4" high model in 1989.

The PrairieTek original 2.5" drive introduced in 1988, although now out of production, was the pathfinder for many drives to follow. JVC and Conner joined PrairieTek in shipping 2.5" drives with 20 megabyte capacities in 1990, but most of the other manufacturers which have entered the 2.5" drive market have concentrated on drives with capacities above the range covered by this product group. Integral Peripherals has announced a 1.8" drive, the first of many to come.

Market status

DISK/TREND estimate of total market size:

Worldwide sales ($M)	1990	1991	1992	1993	1994
U.S. manufacturers	679.7	210.2	93.6	21.5	4.2
All manufacturers	881.4	306.2	121.7	29.6	5.4

The rapid decline for this product group started in 1989, and shipments continue to drop even faster than predicted. Worldwide unit shipments dropped 37.1% in 1990 and are expected to decline another 61% in 1991, to only 1.5 million drives -- a sharp comparison to the 1988 total of 7.9 million drives. Worldwide revenues were $881.4 million in 1990, and are expected to be only $306.2 million in 1991. The movement to higher capacities continues to come faster than anticipated, as the personal computer market transitions to more powerful processors and adopts more versatile software.

In recent years, 3.5" drives have led this product group in shipments, but 3.5" drives' share of the group total peaked in 1989, at 69.4% of worldwide unit shipments. Large scale shipments of 2.5" drives started in 1990, totaling 780,000 units, for 19.6% of the group total. However, in 1991 shipments of 2.5" drives with capacities below 30 megabytes have already started to decline as the computer market's appetite for high capacities affects notebook computers, and the 1991 total is expected to reach only 535,000 drives.

For years, the PC/AT standard continued to prosper even without IBM's support, providing a strong residual market for low-end 5.25" disk drives through both clone manufacturers and the dealer aftermarket. And the many technical and legal delays faced by clone manufacturers in entering the PS/2 compatible market slowed the growth of low-end 3.5" drive shipments, helping to keep alive the market for half high 5.25" drives in this product group. More than 75% of worldwide unit shipments of 5.25" drives are aftermarket products sold in the PCM/Reseller channel.

The laptop computer market, now in eclipse, provided an early dynamic market for the 1" high 3.5" drives which first appeared in 1988. Conner

Peripherals' early production capability for 1" high 3.5" models in both 20 and 40 megabyte capacities was the critical factor, and Conner captured most of the laptop market with both U.S. and Japanese system manufacturers. But notebook computers weighing only one third as much as some laptop models have taken over much of the laptop market, and today's notebook computers use smaller drives. 2.5" drives in this product group have dominated the notebook computer market, but newer models have already transitioned to 2.5" drives with capacities above 30 megabytes, and many of the "sub-notebook" computers expected soon will use 1.8" drives.

Usage of hard disk drives with personal computers has now become standard practice in most offices, and the PC market continues to be the dominant application area for drives in this product group, accounting for 97.9% of 1990 unit shipments.

Despite the changing product mix and declining shipments, Seagate continued as the dominant leader in non-captive shipments for this product group, on the strength of its leadership in industry shipments of low-end 5.25" and 3.5" drives. Seagate shipped 1,545,000 drives in 1990, for 41.1% of the worldwide total for the product group. Conner Peripherals' share increased to 28.8%, boosted by large shipments of 2.5" drives, and Kalok followed with 10.5%, all 3.5" drives.

Marketing trends

It is expected that worldwide unit shipments for drives with less than 30 megabytes capacity will decline at an average annual rate of 71% during the 1992-94 period, as the movement to drive capacities above the level included in this product group accelerates. The 1994 worldwide unit

shipment total is projected at only 33,000 drives, representing the effective end of life for the product group.

Small diameter drives started at 5 megabytes (formatted), then quickly upgraded to 10 megabytes, and during the second half of the 1980s fixed disk drives in this group became mostly 20 megabyte models. It is clear that the typical office personal computer now uses disk drives with capacities above this product range.

Even as the total for the group declines, the product mix will continue to change:

Worldwide total Unit shipments (000)	1990	1991	1992	1993	1994
5.25" full size	24.8	20.4	9.1	4.0	--
	.6%	1.3%	1.4%	2.6%	--
5.25" half high	919.0	282.0	72.9	14.0	--
	23.3%	18.3%	11.5%	9.2%	--
3.5" 1.625" high	1,570.2	490.1	123.0	24.0	8.0
	39.8%	31.8%	19.4%	15.8%	24.2%
3.5" 1" high or less	655.5	210.0	52.0	3.0	--
	16.6%	13.6%	8.2%	2.0%	--
2.5"	780.0	535.0	96.0	12.0	--
	19.7%	34.8%	15.2%	7.9%	--
1.8"	--	2.0	280.0	95.0	25.0
	--	.1%	44.2%	62.5%	75.8%
	3,949.5	1,539.5	633.0	152.0	33.0

3.5" drives have held the shipment leadership in this product group only since 1988, but DISK/TREND projections assume that drives with smaller disks will account for more than half of the group total in 1992.

Ironically, both 1.8" and 2.5" drives in this group will be losing ground during the 1992-94 period to higher capacity models in other

DISK/TREND product groups. The shipment decline for drives with less than 30 megabytes affects all disk diameters, and is driven not by form factor but by software requirements, processor capabilities and user preferences.

Captive shipments by U.S. manufacturers of drives with capacities below 30 megabytes have slowed to a trickle, as IBM and other captive drive producers emphasize personal computers with higher level capabilities. IBM did not introduce a 2.5" drive in this capacity range for use with notebook computers, and instead confined its initial 2.5" drive product line to higher capacities.

Technical trends

The challenges of large production volume and low cost requirements have been the key engineering targets for the older disk drives in this group. The problem was to achieve high production volumes despite use of continually higher recording densities. The challenge of higher areal densities became even more acute with the movement to 2.5" disks, followed by 1.8" disks.

Although several initially available 3.5" drives used disks with 40 millimeter inner diameters, 25 millimeter became the industry standard, to increase the recording area per disk. The result is linear densities in the 13,000 bits per inch range for 3.5" 20 megabyte drives using two disks, and up to 21,500 BPI for single disk models. 20 megabyte 2.5" drives (disks with 65 millimeter OD, 20 millimeter ID) were offered initially with two disks, but current 2.5" models in this product group all use a single disk with linear densities in the 34,000 to 40,000 range.

Two interrelated developments are increasing the cost-effectiveness of 3.5", 2.5", and 1.8" drives in this group. It is cheaper to package

the controller function within the disk drive, and usage of embedded controllers provides the disk drive designer with greater flexibility, since the physical characteristics of drives are masked from systems. As a result, embedded controllers now dominate shipments of 3.5" and smaller drives.

Most 3.5" floppy drives are already produced in one inch high configurations, and production of one inch high 3.5" rigid disk drives using only one disk has also reached high volume. A further reduction in box height was pioneered by Conner Peripherals with a 3/4" drive introduced in late 1989, following the lead of several Japanese floppy drive manufacturers, which are already in production with 3/4" high models. However, in view of the rapid movement to higher disk drive capacities, most of the development effort by drive manufacturers to reduce package size of 3.5" drives will probably be devoted to capacity ranges above this one.

Forecasting assumptions

1. Shipments of 5.25", 3.5" and 2.5" drives in this product group will continue to decline, as the market transitions to higher capacity ranges for desktop and portable computer applications.

2. 1.8" drives in this product group will continue rapid growth in notebook computer applications until higher capacity drives become available in quantity production in the first half of 1992. 1.8" drives in this group will subsequently decline.

TABLE 18

FIXED DISK DRIVES, LESS THAN 30 MEGABYTES

REVENUE SUMMARY

	DISK DRIVE REVENUES, BY SHIPMENT DESTINATION ($M)									
	1990 Revenues		Forecast 1991		1992		1993		1994	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM Captive	32.0	50.0	--	--	--	--	--	--	--	--
Other U.S. Captive	9.6	24.0	7.5	16.5	2.8	7.0	1.3	2.6	--	--
TOTAL U.S. CAPTIVE	41.6	74.0	7.5	16.5	2.8	7.0	1.3	2.6	--	--
PCM/Reseller	136.8	269.6	42.2	85.4	10.5	20.6	1.5	2.6	--	.4
OEM/Integrator	95.9	336.1	24.4	108.3	9.1	66.0	1.8	16.3	.5	3.8
TOTAL U.S. NON-CAPTIVE	232.7	605.7	66.6	193.7	19.6	86.6	3.3	18.9	.5	4.2
TOTAL U.S. REVENUES	274.3	679.7	74.1	210.2	22.4	93.6	4.6	21.5	.5	4.2
Non-U.S. Manufacturers										
Captive	--	66.1	--	31.0	--	14.4	--	4.8	--	.9
PCM/Reseller	--	8.2	--	7.9	--	2.2	--	--	--	--
OEM/Integrator	10.5	127.4	3.7	57.1	1.3	11.5	--	3.3	--	.3
TOTAL NON-U.S. REVENUES	10.5	201.7	3.7	96.0	1.3	28.1	--	8.1	--	1.2
Worldwide Recap										
TOTAL WORLDWIDE REVENUES	284.8	881.4	77.8	306.2	23.7	121.7	4.6	29.6	.5	5.4
OEM Average Price ($000)		.227		.198		.180		.163		.152

TABLE 19

FIXED DISK DRIVES, LESS THAN 30 MEGABYTES

UNIT SHIPMENT SUMMARY

	DISK DRIVE UNIT SHIPMENTS, BY SHIPMENT DESTINATION (000)									
	1990		Forecast							
	Shipments		1991		1992		1993		1994	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM Captive	64.0	100.0	--	--	--	--	--	--	--	--
Other U.S. Captive	6.4	16.0	5.0	11.0	2.0	5.0	1.0	2.0	--	--
TOTAL U.S. CAPTIVE	70.4	116.0	5.0	11.0	2.0	5.0	1.0	2.0	--	--
PCM/Reseller	853.9	1,670.6	303.0	608.5	82.0	162.0	13.0	22.0	--	4.0
OEM/Integrator	488.2	1,563.2	135.7	584.2	52.6	378.0	12.0	103.0	3.0	25.0
TOTAL U.S. NON-CAPTIVE	1,342.1	3,233.8	438.7	1,192.7	134.6	540.0	25.0	125.0	3.0	29.0
TOTAL U.S. SHIPMENTS	1,412.5	3,349.8	443.7	1,203.7	136.6	545.0	26.0	127.0	3.0	29.0
Non-U.S. Manufacturers										
Captive	--	78.3	--	41.7	--	22.0	--	8.0	--	2.0
PCM/Reseller	--	42.3	--	43.3	--	13.0	--	--	--	--
OEM/Integrator	51.0	479.1	20.0	250.8	7.0	53.0	--	17.0	--	2.0
TOTAL NON-U.S. SHIPMENTS	51.0	599.7	20.0	335.8	7.0	88.0	--	25.0	--	4.0
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	1,463.5	3,949.5	463.7	1,539.5	143.6	633.0	26.0	152.0	3.0	33.0
Total Capacity (Terabytes)	36.5	98.6	11.5	38.4	3.5	15.8	.6	3.8	--	.8
Cumulative Shipments (Units in thousands)										
IBM	2,285.4	3,344.9	2,285.4	3,344.9	2,285.4	3,344.9	2,285.4	3,344.9	2,285.4	3,344.9
Non-IBM	17,673.5	34,546.0	18,137.2	36,085.5	18,280.8	36,718.5	18,306.8	36,870.5	18,309.8	36,903.5
WORLDWIDE TOTAL	19,958.9	37,890.9	20,422.6	39,430.4	20,566.2	40,063.4	20,592.2	40,215.4	20,595.2	40,248.4

TABLE 20

FIXED DISK DRIVES, LESS THAN 30 MEGABYTES

WORLDWIDE REVENUES ($M)

BREAKDOWN BY DISK DIAMETER

	1990 Revenues			Forecast													
				1991				1992				1993				1994	
	5.25"	3.5"	2.5"	5.25"	3.5"	2.5"	1.8"	5.25"	3.5"	2.5"	1.8"	5.25"	3.5"	2.5"	1.8"	3.5"	1.8"
U.S. MANUFACTURERS																	
IBM Captive	--	50.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Other U.S. Captive	--	24.0	--	--	16.5	--	--	--	7.0	--	--	--	2.6	--	--	--	--
PCM/Reseller	124.0	144.8	.8	30.5	53.9	1.0	--	5.6	14.2	.8	--	.6	1.8	.2	--	.4	--
OEM/Integrator	13.4	167.0	155.7	7.2	27.3	73.3	.5	2.2	2.6	10.8	50.4	.3	--	.8	15.2	--	3.8
TOTAL U.S. REVENUES	137.4	385.8	156.5	37.7	97.7	74.3	.5	7.8	23.8	11.6	50.4	.9	4.4	1.0	15.2	.4	3.8
NON-U.S. MANUFACTURERS																	
Captive	24.8	41.3	--	13.7	17.3	--	--	4.8	9.6	--	--	2.8	2.0	--	--	.9	--
PCM/Reseller	1.3	6.9	--	1.4	6.5	--	--	.7	1.5	--	--	--	--	--	--	--	--
OEM/Integrator	19.7	59.6	48.1	8.8	17.9	30.4	--	3.6	3.1	4.8	--	1.3	1.1	.9	--	.3	--
TOTAL NON-U.S. REVENUES	45.8	107.8	48.1	23.9	41.7	30.4	--	9.1	14.2	4.8	--	4.1	3.1	.9	--	1.2	--
WORLDWIDE RECAP																	
Captive	24.8	115.3	--	13.7	33.8	--	--	4.8	16.6	--	--	2.8	4.6	--	--	.9	--
	-27.9%	-66.0%	--	-44.8%	-70.7%	--	--	-65.0%	-50.9%	--	--	-41.7%	-72.3%	--	--	-80.4%	--
PCM/Reseller	125.3	151.7	.8	31.9	60.4	1.0	--	6.3	15.7	.8	--	.6	1.8	.2	--	.4	--
	-47.9%	-36.8%	-52.9%	-74.5%	-60.2%	+25.0%	--	-80.3%	-74.0%	-20.0%	--	-90.5%	-88.5%	-75.0%	--	-77.8%	--
OEM/Integrator	33.1	226.6	203.8	16.0	45.2	103.7	.5	5.8	5.7	15.6	50.4	1.6	1.1	1.7	15.2	.3	3.8
	-69.8%	-57.3%	--	-51.7%	-80.1%	-49.1%	--	-63.7%	-87.4%	-85.0%	--	-72.4%	-80.7%	-89.1%	-69.8%	-72.7%	-75.0%
Total Revenues	183.2	493.6	204.6	61.6	139.4	104.7	.5	16.9	38.0	16.4	50.4	5.0	7.5	1.9	15.2	1.6	3.8
	-52.3%	-55.6%	--	-66.4%	-71.8%	-48.8%	--	-72.6%	-72.7%	-84.3%	--	-70.4%	-80.3%	-88.4%	-69.8%	-78.7%	-75.0%
ANNUAL SHARE, BY DIAMETER	20.8%	56.1%	23.1%	20.1%	45.6%	34.2%	.1%	13.9%	31.3%	13.5%	41.3%	16.9%	25.4%	6.4%	51.3%	29.7%	70.3%

TABLE 21

FIXED DISK DRIVES, LESS THAN 30 MEGABYTES

WORLDWIDE SHIPMENTS (000)

BREAKDOWN BY DISK DIAMETER

	1990 Shipments			Forecast														
				1991				1992				1993				1994	
	5.25"	3.5"	2.5"	5.25"	3.5"	2.5"	1.8"	5.25"	3.5"	2.5"	1.8"	5.25"	3.5"	2.5"	1.8"	3.5"	1.8"
U.S. MANUFACTURERS																	
IBM Captive	--	100.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Other U.S. Captive	--	16.0	--	--	11.0	--	--	--	5.0	--	--	--	2.0	--	--	--	--
PCM/Reseller	800.0	867.6	3.0	226.0	377.5	5.0	--	51.0	106.0	5.0	--	6.0	15.0	1.0	--	4.0	--
OEM/Integrator	75.2	896.0	592.0	40.2	167.0	375.0	2.0	13.0	22.0	63.0	280.0	3.0	--	5.0	95.0	--	25.0
TOTAL U.S. SHIPMENTS	875.2	1,879.6	595.0	266.2	555.5	380.0	2.0	64.0	133.0	68.0	280.0	9.0	17.0	6.0	95.0	4.0	25.0
NON-U.S. MANUFACTURERS																	
Captive	23.1	55.2	--	14.7	27.0	--	--	6.0	16.0	--	--	4.0	4.0	--	--	2.0	--
PCM/Reseller	2.0	40.3	--	3.0	40.3	--	--	2.0	11.0	--	--	--	--	--	--	--	--
OEM/Integrator	43.5	250.6	185.0	18.5	77.3	155.0	--	10.0	15.0	28.0	--	5.0	6.0	6.0	--	2.0	--
TOTAL NON-U.S. SHIPMENTS	68.6	346.1	185.0	36.2	144.6	155.0	--	18.0	42.0	28.0	--	9.0	10.0	6.0	--	4.0	--
WORLDWIDE RECAP																	
Captive	23.1	171.2	--	14.7	38.0	--	--	6.0	21.0	--	--	4.0	6.0	--	--	2.0	--
	-5.3%	-67.8%	--	-36.4%	-77.8%	--	--	-59.2%	-44.7%	--	--	-33.3%	-71.4%	--	--	-66.7%	--
PCM/Reseller	802.0	907.9	3.0	229.0	417.8	5.0	--	53.0	117.0	5.0	--	6.0	15.0	1.0	--	4.0	--
	-44.7%	-28.0%	-40.0%	-71.4%	-54.0%	+66.7%	--	-76.9%	-72.0%	--	--	-88.7%	-87.2%	-80.0%	--	-73.3%	--
OEM/Integrator	118.7	1,146.6	777.0	58.7	244.3	530.0	2.0	23.0	37.0	91.0	280.0	8.0	6.0	11.0	95.0	2.0	25.0
	-72.0%	-55.3%	--	-50.5%	-78.7%	-31.8%	--	-60.8%	-84.9%	-82.8%	--	-65.2%	-83.8%	-87.9%	-66.1%	-66.7%	-73.7%
Total Shipments	943.8	2,225.7	780.0	302.4	700.1	535.0	2.0	82.0	175.0	96.0	280.0	18.0	27.0	12.0	95.0	8.0	25.0
	-50.3%	-48.9%	--	-68.0%	-68.5%	-31.4%	--	-72.9%	-75.0%	-82.1%	--	-78.0%	-84.6%	-87.5%	-66.1%	-70.4%	-73.7%
ANNUAL SHARE, BY DIAMETER	23.9%	56.5%	19.6%	19.6%	45.6%	34.8%	--	13.0%	27.7%	15.2%	44.1%	11.8%	17.8%	7.9%	62.5%	24.2%	75.8%
TOTAL CAPACITY (Terabytes)	23.5	55.6	19.5	7.6	17.5	13.4	--	2.1	4.4	2.4	7.0	.5	.7	.3	2.4	.2	.6

TABLE 22

FIXED DISK DRIVES, LESS THAN 30 MEGABYTES

APPLICATIONS SUMMARY
Percentage of Worldwide Shipments

APPLICATION	1990 Estimate Units (000)	1990 Estimate %	1994 Projection Units (000)	1994 Projection %
MAINFRAME/SUPERMINI General purpose	--	--	--	--
MINICOMPUTERS AND MULTI-USER MICROS Business and professional, including networks	9.5	.2	--	--
PERSONAL COMPUTERS Business and professional, single user	3,864.2	97.9	30.7	93.4
OFFICE SYSTEMS AND WORKSTATIONS Dedicated application	12.2	.3	.1	.2
NON-OFFICE SYSTEMS AND WORKSTATIONS Technical, distribution, medical, other specialized	24.1	.6	.1	.2
CONSUMER AND HOBBY COMPUTERS	39.1	1.0	2.0	6.0
OTHER APPLICATIONS	--	--	.1	.2
Total	3,949.5	100.0	33.0	100.0

TABLE 23

FIXED DISK DRIVES, LESS THAN 30 MEGABYTES

MARKET SHARE SUMMARY
Worldwide Shipments of Non-Captive Disk Drives

	1990 Net Shipments									
	To United States Destinations					Worldwide				
	Units (000)				%	Units (000)				%
Drive Manufacturers	5.25"	3.5"	2.5"	Total		5.25"	3.5"	2.5"	Total	
Seagate Technology	480.0	355.0	--	835.0	59.9	875.0	670.0	--	1545.0	41.1
Conner Peripherals	--	201.0	50.0	251.0	18.0	--	597.0	485.0	1082.0	28.8
Kalok	--	180.0	--	180.0	12.9	--	395.0	--	395.0	10.5
JVC	--	16.0	5.0	21.0	1.5	--	38.0	185.0	223.0	5.9
Prairietek	--	--	25.0	25.0	1.8	--	--	110.0	110.0	2.9
Fuji Electric	--	--	--	--	--	--	88.0	--	88.0	2.3
Western Digital	--	47.0	--	47.0	3.4	--	84.0	--	84.0	2.2
Other U.S.	.2	3.9	--	4.1	.3	.2	17.6	--	17.8	.6
Other Non-U.S.	--	30.0	--	30.0	2.2	45.5	164.9	--	210.4	5.7
TOTAL	480.2	832.9	80.0	1393.1	100.0	920.7	2054.5	780.0	3755.2	100.0

FIXED DISK DRIVES, 30-60 MEGABYTES

1991 DISK/TREND REPORT

FIXED DISK DRIVES, 30-60 MEGABYTES

Coverage

Examples of disk drives in this group include:

5.25" disk diameter

Digirede	W525/50
DZU	SM 5509
Elebra	530, 540
Fujitsu	M2241, M2242
Hitachi	DK511-5, DK521-5*
IBM	4956
Microlab	DFW 5053
Miltope	RDS-5000
Qualitron	540*
Seagate Technology	ST251*

3.5" disk diameter

Alps Electric	DRQ040A**
Conner Peripherals	CP3040**, CP4044**
Ecol.2	EC-50**
Espert	EP-340A*
Fuji Electric	FK303-52*, FK312S-53R**
Fujitsu	M2226D2*, M2611S**
Hitachi	DK302-3*
IBM	8555-041, WDA-L40**
JVC	JD-3848H*, JD-E3848V**
Kalok	KL330*
Kyocera	KC 30B*
Maxtor	7040A/S**
Microscience International	8040**
Multidigit	DW 4063*
NEC	D3142*, D3735**
Plus Development	Hardcard II 40**, Passport*
Quantum	40S/AT ProDrive*
Samsung Electronics	SHD2040N*
Seagate Technology	ST138*, ST157A*, ST351A/X**
Sony	SRD2040Z*, SRD3040Z**
Teac	SD-340**
Toshiba	MK-133FA*, MK-232FB*
Western Digital	WDAC140**

2.5" disk diameter

Conner Peripherals	CP-2034**, CP-2044**
Fuji Electric	FK201-43R**
Fujitsu	M2631S/T**
IBM	WDA-240**, WDS-240**

2.5" disk diameter (continued)

JVC	JD-E2850P**
Quantum	40S/AT Go.Drive**
Seagate Technology	ST9051A**
Teac	SD-240**
Toshiba	MD-1122FC**
Western Digital	WDAB130**, WDAB140**

1.8" disk diameter

Integral Peripherals	1842**

*Indicates drives with maximum 41.3 mm height, or less.
**Indicates drives with maximum 25.4 mm height, or less.

Drives in this capacity range are all nominally "Winchester" drives, but variations to that technology are used, including thin film disks and both ferrite and thin film heads in various configurations. Most use voice coil head positioning systems, but a few use other techniques, such as stepping or torque motors.

During the last four years, numerous 3.5" drives were introduced in this product group. Intense competition developed at the 40 megabyte (formatted) level, which led to a variety of attempts to reduce product costs, with the result that most of the newer 3.5" drives use only one disk.

Conner Peripheral's two platter 40 megabyte drive became the leader in this product group after its introduction in 1987, and provided the model for many later drive introductions by other firms. In 1988, Conner's single platter 1" high 40 megabyte drive took higher densities a step further, quickly became the leader for laptop portables, and served as a model for numerous competitive drives.

The first 2.5" drive at the 40 megabyte level was PrairieTek's two platter 1" high model. However, most 2.5" drives with 30 and 40 megabyte

capacities now use only one disk, with drive height limited to the 15-17 millimeter range. Despite the manufacturing difficulties caused by such high areal densities, the potential cost advantages from reduced parts count and mechanical simplification will continue to stimulate further innovation, such as IBM's 43 megabyte drive with a height of only 12.7 millimeters, exactly one half inch.

Future competition will also come from the expected wave of 1.8" drive introductions, following Integral Peripheral's initial announcement of a 42 megabyte 1.8" drive scheduled for first delivery in second quarter of 1992.

Market status

DISK/TREND estimate of total market size:

Worldwide sales ($M)	1990	1991	1992	1993	1994
U.S. manufacturers	3,089.0	2,512.3	2,005.5	1,397.8	757.3
All manufacturers	3,901.6	3,183.7	2,445.5	1,703.7	943.2

1990 unit shipments for the 30-60 megabyte product group were higher than projected, but it now appears that 1990 was the peak year for this group as the computer industry's relentless movement to higher disk capacities continues. Worldwide shipments of 30-60 megabyte drives were 14.1 million drives in 1990, up 38.4% over the previous year, and more than three times larger than the unit shipments of any other DISK/TREND product group.

DISK/TREND forecasts now predict a decline in worldwide shipments for this product group in 1991, down 4% to 13.5 million drives. The difference in 1991 is that growth for 3.5" drives in this group is slowing down

in the face of the current economic recession and continuing demand for higher capacities, and is no longer able to offset the continuing decline in shipments of 5.25" drives. While shipments of 5.25" drives are expected to be down more than 2.5 million units in 1991, the increase for 3.5" drives is forecasted at 289,700 units, up only 2.6%. 1991 estimated shipments of 1.7 million 2.5" drives, while impressive, is not enough to make the difference for the product group.

For several years, the combination of the 3.5" form factor with capacities in the 30-40 megabyte range proved to be a major winner. Most of this growth was driven by personal computer users' demand for more disk capacity than earlier personal computers provided, to cope with new software programs and ever-increasing file storage requirements. Availability of the two disk 3.5" drives with 41.3 millimeter (1.625 inch) height (30 megabytes from IBM; 40 megabytes from almost everyone else) starting in 1987 was a perfect match for the growing demand.

The subsequent introduction of single disk 3.5" drives with 25.4 millimeter (1 inch) height was again very timely. It caught the wave of hard disk upgrades to the early laptop systems, and became another winner. U.S. drive manufacturers were the first to establish volume production capability for 1" high 3.5" drives, and their success in this segment accounts for their higher share of worldwide unit shipments in 1991, estimated at 87.7%.

2.5" drives have benefited from the strong market performance of notebook computers, despite the recession. Rapid growth of 1991 shipments for 30 and 40 megabyte 2.5" drives has more than offset the decline in 20 megabyte drive shipments which started in the Spring.

Seagate held its share of non-captive unit shipments in 1990, with

36.5% of the worldwide total. More than half of Seagate's shipment total of 4.5 million units were 5.25" drives. Conner Peripherals increased its share of the product group to 20.8%, with 2.5 million drives, mostly 3.5" models. Western Digital and Quantum trailed the leaders with 9.7% and 8.3% of the total.

Single user personal computer applications continue to dominate applications for 30-60 megabyte drives with 95.5% of the worldwide market for drives in this group in 1990, and are expected to hold 94.4% of the 1994 market, with minor shares expected for non-office dedicated applications and consumer and hobby computers.

Marketing trends

Changing usage patterns for personal computers and the advent of the graphical user interface have depressed the long-term outlook for 30-60 megabyte drives. The migration to higher average disk capacities for the PC market continues, and the overall future for drives in this group is downward. DISK/TREND projections now indicate worldwide shipments of only 6.1 million drives in 1994, an average annual decline of 22%. Total revenues are expected to fall even faster, at an average of 32.7% per year through 1994.

This product group is completely dominated by 3.5" drives, now mostly 1" high models, which are expected to hold over 80% of total shipments in 1994, despite inroads by 2.5" and 1.8" drives. The smaller drives are expected to have an early surge of growth in this capacity range, but both 2.5" and 1.8" will be subjected to the same movement to higher capacities which has impacted 3.5" models. The result for each of the smaller sizes

will be a year or two of sales growth in this capacity group, then declines in favor of higher capacity versions.

In 1994, 1" high 3.5" drives will remain the group leader:

Worldwide total Unit shipments (000)	1990	1991	1992	1993	1994
5.25" full size	38.5	11.5	8.1	2.0	--
	3%	.1%	.1%	--	--
5.25" half high	3,057.3	531.6	103.9	20.0	--
	21.6%	3.9%	.8%	.2%	--
3.5" 1.625" high	6,584.5	2,701.1	1,078.0	425.0	165.0
	46.6%	19.9%	8.4%	4.3%	2.7%
3.5" 1" high or less	4,401.3	8,574.4	9,857.0	8,218.0	5,305.0
	31.1%	63.2%	77.3%	82.6%	86.0%
2.5"	51.0	1,754.0	1,271.0	695.0	280.0
	.4%	12.9%	10.0%	7.0%	4.5%
1.8"	--	--	440.0	590.0	420.0
	--	--	3.4%	5.9%	6.8%
	14,132.6	13,572.6	12,758.0	9,950.0	6,170.0

Shipments through all distribution channels are expected to share in the decline of this product group, but not equally. While captive and OEM/Integrator shipments will lead the decline, PCM/Reseller shipments will fade much more slowly and will account for half of the group's 1994 estimated worldwide shipments.

Technical trends

The technical developments that are pushing drives below 30 megabytes in capacity toward single disk configurations are having a similar impact on this product group, resulting in pressure to cut costs by reducing the parts count. Most 3.5" drives in the 40 megabyte range now use single

disks, and single disk drives are in the process of becoming the standard for 2.5" drives, with similar configurations expected for future 1.8" drives.

In addition to lower costs, higher areal density has also had the effect of speeding the transition to intelligent embedded controllers. Higher recording densities mean higher transfer rates, and frequently will be used with multiple recording bands, each with different densities. In order to mask individual drive peculiarities, most new drives offer embedded controllers, with the choice of either SCSI or PC/AT interfaces.

Higher areal density has also made smaller box sizes practical. 2.5" drives with heights as low as 12.7 millimeters are now available in the product group, and some 1.8" drives are expected to be even smaller.

Forecasting assumptions

1. Growth for 3.5" drives will have peaked in 1991, except for 1" high models, which will peak in 1992.

2. The decline of OEM 5.25" drives will continue, replaced by the movement to 3.5" drives.

3. Shipments of 2.5" drives will decline after 1991, and 1.8" shipments will peak in 1993, impacted by the continuing movement to higher capacities for all personal computer applications.

TABLE 24

FIXED DISK DRIVES, 30 - 60 MEGABYTES

REVENUE SUMMARY

	DISK DRIVE REVENUES, BY SHIPMENT DESTINATION ($M)									
	1990		Forecast							
	Revenues		1991		1992		1993		1994	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM Captive	491.1	736.7	393.3	602.3	349.0	535.0	252.3	388.7	91.7	144.5
Other U.S. Captive	--	--	--	--	--	--	--	--	--	--
TOTAL U.S. CAPTIVE	491.1	736.7	393.3	602.3	349.0	535.0	252.3	388.7	91.7	144.5
PCM/Reseller	777.2	1,234.5	535.4	837.3	487.8	768.2	360.1	577.0	232.7	382.1
OEM/Integrator	677.2	1,117.8	702.1	1,072.7	439.2	702.3	262.9	432.1	140.1	230.7
TOTAL U.S. NON-CAPTIVE	1,454.4	2,352.3	1,237.5	1,910.0	927.0	1,470.5	623.0	1,009.1	372.8	612.8
TOTAL U.S. REVENUES	1,945.5	3,089.0	1,630.8	2,512.3	1,276.0	2,005.5	875.3	1,397.8	464.5	757.3
Non-U.S. Manufacturers										
Captive	48.0	329.2	35.0	309.3	40.8	281.9	32.2	229.0	22.0	138.5
PCM/Reseller	36.0	56.0	4.1	20.4	2.0	14.0	1.4	8.7	1.8	7.0
OEM/Integrator	144.2	427.4	80.5	341.7	38.2	144.1	20.2	68.2	13.5	40.4
TOTAL NON-U.S. REVENUES	228.2	812.6	119.6	671.4	81.0	440.0	53.8	305.9	37.3	185.9
Worldwide Recap										
TOTAL WORLDWIDE REVENUES	2,173.7	3,901.6	1,750.4	3,183.7	1,357.0	2,445.5	929.1	1,703.7	501.8	943.2
OEM Average Price ($000)		.232		.203		.153		.132		.126

TABLE 25

FIXED DISK DRIVES, 30 - 60 MEGABYTES

UNIT SHIPMENT SUMMARY

	DISK DRIVE UNIT SHIPMENTS, BY SHIPMENT DESTINATION (000)									
	1990		Forecast							
	Shipments		1991		1992		1993		1994	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM Captive	812.0	1,218.0	715.0	1,095.0	705.0	1,080.0	592.0	910.0	248.0	390.0
Other U.S. Captive	--	--	--	--	--	--	--	--	--	--
TOTAL U.S. CAPTIVE	812.0	1,218.0	715.0	1,095.0	705.0	1,080.0	592.0	910.0	248.0	390.0
PCM/Reseller	3,471.4	5,502.9	3,114.1	4,855.9	3,445.0	5,418.0	2,858.0	4,573.0	1,925.0	3,160.0
OEM/Integrator	3,052.6	5,095.1	3,527.2	5,493.2	2,947.1	4,757.0	2,042.0	3,368.0	1,138.0	1,880.0
TOTAL U.S. NON-CAPTIVE	6,524.0	10,598.0	6,641.3	10,349.1	6,392.1	10,175.0	4,900.0	7,941.0	3,063.0	5,040.0
TOTAL U.S. SHIPMENTS	7,336.0	11,816.0	7,356.3	11,444.1	7,097.1	11,255.0	5,492.0	8,851.0	3,311.0	5,430.0
Non-U.S. Manufacturers										
Captive	80.0	504.7	70.0	579.8	100.0	666.0	90.0	634.0	68.0	430.0
PCM/Reseller	162.5	239.0	19.5	67.6	8.0	68.0	8.0	50.0	10.0	40.0
OEM/Integrator	509.9	1,572.9	342.8	1,481.1	218.0	769.0	131.0	415.0	93.0	270.0
TOTAL NON-U.S. SHIPMENTS	752.4	2,316.6	432.3	2,128.5	326.0	1,503.0	229.0	1,099.0	171.0	740.0
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	8,088.4	14,132.6	7,788.6	13,572.6	7,423.1	12,758.0	5,721.0	9,950.0	3,482.0	6,170.0
Total Capacity (Terabytes)	393.9	690.8	379.1	664.3	367.2	631.8	285.4	496.5	174.6	309.2
Cumulative Shipments (Units in thousands)										
IBM	2,066.1	3,046.0	2,781.1	4,141.0	3,486.1	5,221.0	4,078.1	6,131.0	4,326.1	6,521.0
Non-IBM	19,842.3	33,576.1	26,915.9	46,053.7	33,634.0	57,731.7	38,763.0	66,771.7	41,997.0	72,551.7
WORLDWIDE TOTAL	21,908.4	36,622.1	29,697.0	50,194.7	37,120.1	62,952.7	42,841.1	72,902.7	46,323.1	79,072.7

TABLE 26

FIXED DISK DRIVES, 30 - 60 MEGABYTES

WORLDWIDE REVENUES ($M)

BREAKDOWN BY DISK DIAMETER

	1990 Revenues			Forecast													
				1991			1992				1993				1994		
	5.25"	3.5"	2.5"	5.25"	3.5"	2.5"	5.25"	3.5"	2.5"	<2.5"	5.25"	3.5"	2.5"	<2.5"	3.5"	2.5"	<2.5"
U.S. MANUFACTURERS																	
IBM Captive	15.0	720.0	1.7	--	550.0	52.3	--	425.0	90.0	20.0	--	225.1	90.1	73.5	80.0	30.0	34.5
PCM/Reseller	566.1	668.4	--	76.6	751.8	8.9	12.8	741.4	14.0	--	3.0	562.4	10.6	1.0	373.6	5.6	2.9
OEM/Integrator	73.4	1,029.3	15.1	20.2	817.8	234.7	4.7	578.0	84.6	35.0	--	393.7	14.1	24.3	213.1	2.3	15.3
TOTAL U.S. REVENUES	654.5	2,417.7	16.8	96.8	2,119.6	295.9	17.5	1,744.4	188.6	55.0	3.0	1,181.2	114.8	98.8	666.7	37.9	52.7
NON-U.S. MANUFACTURERS																	
Captive	27.2	302.0	--	14.8	247.0	47.5	7.6	134.3	112.0	28.0	--	103.0	82.3	43.7	62.1	40.6	35.8
PCM/Reseller	19.5	36.1	.4	4.4	3.4	12.6	1.2	.8	12.0	--	--	--	7.7	1.0	--	3.2	3.8
OEM/Integrator	27.6	398.0	1.8	9.8	178.4	153.5	4.4	62.8	47.2	29.7	2.0	34.8	11.1	20.3	26.5	1.6	12.3
TOTAL NON-U.S. REVENUES	74.3	736.1	2.2	29.0	428.8	213.6	13.2	197.9	171.2	57.7	2.0	137.8	101.1	65.0	88.6	45.4	51.9
WORLDWIDE RECAP																	
Captive	42.2	1,022.0	1.7	14.8	797.0	99.8	7.6	559.3	202.0	48.0	--	328.1	172.4	117.2	142.1	70.6	70.3
	-51.6%	+46.8%	--	-64.9%	-22.0%	--	-48.6%	-29.8%	+102.4%	--	-100.0%	-41.3%	-14.7%	+144.2%	-56.7%	-59.0%	-40.0%
PCM/Reseller	585.6	704.5	.4	81.0	755.2	21.5	14.0	742.2	26.0	--	3.0	562.4	18.3	2.0	373.6	8.8	6.7
	-7.6%	+106.4%	--	-86.2%	+7.2%	--	-82.7%	-1.7%	+20.9%	--	-78.6%	-24.2%	-29.6%	--	-33.6%	-51.9%	+235.0%
OEM/Integrator	101.0	1,427.3	16.9	30.0	996.2	388.2	9.1	640.8	131.8	64.7	2.0	428.5	25.2	44.6	239.6	3.9	27.6
	-65.9%	+13.8%	--	-70.3%	-30.2%	--	-69.7%	-35.7%	-66.0%	--	-78.0%	-33.1%	-80.9%	-31.1%	-44.1%	-84.5%	-38.1%
Total Revenues	728.8	3,153.8	19.0	125.8	2,548.4	509.5	30.7	1,942.3	359.8	112.7	5.0	1,319.0	215.9	163.8	755.3	83.3	104.6
	-28.3%	+37.6%	--	-82.7%	-19.2%	--	-75.6%	-23.8%	-29.4%	--	-83.7%	-32.1%	-40.0%	+45.3%	-42.7%	-61.4%	-36.1%
ANNUAL SHARE, BY DIAMETER	18.7%	80.9%	.4%	4.0%	80.1%	15.9%	1.3%	79.5%	14.7%	4.5%	.3%	77.5%	12.7%	9.5%	80.2%	8.8%	11.0%

TABLE 27

FIXED DISK DRIVES, 30 - 60 MEGABYTES

WORLDWIDE SHIPMENTS (000)

BREAKDOWN BY DISK DIAMETER

	1990 Shipments			Forecast													
				1991			1992				1993				1994		
	5.25"	3.5"	2.5"	5.25"	3.5"	2.5"	5.25"	3.5"	2.5"	<2.5"	5.25"	3.5"	2.5"	<2.5"	3.5"	2.5"	<2.5"
U.S. MANUFACTURERS																	
IBM Captive	15.0	1,200.0	3.0	--	1,000.0	95.0	--	850.0	180.0	50.0	--	500.0	200.0	210.0	200.0	75.0	115.0
PCM/Reseller	2,565.0	2,937.9	--	403.0	4,417.9	35.0	75.0	5,273.0	70.0	--	18.0	4,488.0	62.0	5.0	3,110.0	35.0	15.0
OEM/Integrator	310.2	4,742.9	42.0	90.2	4,474.0	929.0	22.0	4,115.0	445.0	175.0	--	3,145.0	88.0	135.0	1,775.0	15.0	90.0
TOTAL U.S. SHIPMENTS	2,890.2	8,880.8	45.0	493.2	9,891.9	1,059.0	97.0	10,238.0	695.0	225.0	18.0	8,133.0	350.0	350.0	5,085.0	125.0	220.0
NON-U.S. MANUFACTURERS																	
Captive	16.0	488.7	--	8.5	476.3	95.0	4.0	312.0	280.0	70.0	--	274.0	235.0	125.0	195.0	125.0	110.0
PCM/Reseller	87.0	151.0	1.0	16.6	16.0	35.0	3.0	5.0	60.0	--	--	--	45.0	5.0	--	20.0	20.0
OEM/Integrator	102.6	1,465.3	5.0	24.8	891.3	565.0	8.0	380.0	236.0	145.0	4.0	236.0	65.0	110.0	190.0	10.0	70.0
TOTAL NON-U.S. SHIPMENTS	205.6	2,105.0	6.0	49.9	1,383.6	695.0	15.0	697.0	576.0	215.0	4.0	510.0	345.0	240.0	385.0	155.0	200.0
WORLDWIDE RECAP																	
Captive	31.0	1,688.7	3.0	8.5	1,476.3	190.0	4.0	1,162.0	460.0	120.0	--	774.0	435.0	335.0	395.0	200.0	225.0
	-58.1%	+78.1%	--	-72.6%	-12.6%	--	-52.9%	-21.3%	+142.1%	--	-100.0%	-33.4%	-5.4%	+179.2%	-49.0%	-54.0%	-32.8%
PCM/Reseller	2,652.0	3,088.9	1.0	419.6	4,433.9	70.0	78.0	5,278.0	130.0	--	18.0	4,488.0	107.0	10.0	3,110.0	55.0	35.0
	+5.2%	+147.7%	--	-84.2%	+43.5%	--	-81.4%	+19.0%	+85.7%	--	-76.9%	-15.0%	-17.7%	--	-30.7%	-48.6%	+250.0%
OEM/Integrator	412.8	6,208.2	47.0	115.0	5,365.3	1,494.0	30.0	4,495.0	681.0	320.0	4.0	3,381.0	153.0	245.0	1,965.0	25.0	160.0
	-59.1%	+40.8%	--	-72.1%	-13.6%	--	-73.9%	-16.2%	-54.4%	--	-86.7%	-24.8%	-77.5%	-23.4%	-41.9%	-83.7%	-34.7%
Total Shipments	3,095.8	10,985.8	51.0	543.1	11,275.5	1,754.0	112.0	10,935.0	1,271.0	440.0	22.0	8,643.0	695.0	590.0	5,470.0	280.0	420.0
	-14.1%	+66.3%	--	-82.5%	+2.6%	--	-79.4%	-3.0%	-27.5%	--	-80.4%	-21.0%	-45.3%	+34.1%	-36.7%	-59.7%	-28.8%
ANNUAL SHARE, BY DIAMETER	21.9%	77.8%	.3%	4.0%	83.2%	12.8%	.9%	85.8%	10.0%	3.3%	.2%	87.0%	7.0%	5.8%	88.8%	4.5%	6.7%
TOTAL CAPACITY (Terabytes)	154.8	533.7	2.4	27.1	553.8	83.4	5.6	541.6	62.5	22.1	1.1	431.1	34.4	29.9	273.9	14.2	21.2

TABLE 28

FIXED DISK DRIVES, 30 - 60 MEGABYTES

APPLICATIONS SUMMARY
Percentage of Worldwide Shipments

APPLICATION	1990 Estimate Units (000)	1990 Estimate %	1994 Projection Units (000)	1994 Projection %
MAINFRAME/SUPERMINI				
General purpose	--	--	--	--
MINICOMPUTERS AND MULTI-USER MICROS				
Business and professional, including networks	254.4	1.8	--	--
PERSONAL COMPUTERS				
Business and professional, single user	13,500.8	95.5	5,824.5	94.4
OFFICE SYSTEMS AND WORKSTATIONS				
Dedicated application	130.0	.9	12.3	.2
NON-OFFICE SYSTEMS AND WORKSTATIONS				
Technical, distribution, medical, other specialized	124.4	.9	18.5	.3
CONSUMER AND HOBBY COMPUTERS	123.0	.9	308.5	5.0
OTHER APPLICATIONS	--	--	6.2	.1
Total	14,132.6	100.0	6,170.0	100.0

TABLE 29

FIXED DISK DRIVES, 30 - 60 MEGABYTES

MARKET SHARE SUMMARY
Worldwide Shipments of Non-Captive Disk Drives

	1990 Net Shipments									
	To United States Destinations					Worldwide				
	Units (000)				%	Units (000)				%
Drive Manufacturers	5.25"	3.5"	2.5"	Total		5.25"	3.5"	2.5"	Total	
Seagate Technology	1975.0	1150.0	--	3125.0	43.4	2815.0	1720.0	--	4535.0	36.5
Conner Peripherals	--	1278.0	11.0	1289.0	17.9	--	2569.0	12.0	2581.0	20.8
Western Digital	--	662.0	--	662.0	9.2	--	1202.0	--	1202.0	9.7
Quantum	--	904.9	--	904.9	12.6	--	1107.1	--	1107.1	8.9
Maxtor	--	400.9	--	400.9	5.6	--	934.7	--	934.7	7.5
Fujitsu	--	78.1	--	78.1	1.1	--	381.5	--	381.5	3.1
NEC	--	67.0	--	67.0	.9	8.0	358.0	--	366.0	2.9
Sony	--	191.0	--	191.0	2.7	--	239.0	--	239.0	1.9
Mitsubishi Electric	117.0	--	--	117.0	1.6	169.0	--	--	169.0	1.4
Toshiba	--	54.0	1.0	55.0	.8	--	121.0	5.0	126.0	1.0
Other U.S.	40.2	110.6	20.0	170.8	2.4	60.2	222.3	30.0	312.5	2.5
Other Non-U.S.	.3	164.0	--	164.3	2.2	12.6	516.8	1.0	530.4	4.4
TOTAL	2132.5	5031.9	32.0	7196.4	100.0	3064.8	9297.1	48.0	12409.0	100.0

FIXED DISK DRIVES, 60-100 MEGABYTES

1991 DISK/TREND REPORT

FIXED DISK DRIVES, 60-100 MEGABYTES

Coverage

Examples of disk drives in this group include:

8" disk diameter

Sequel	7050, 803

5.25" disk diameter

Digirede	W525/85
Elebra	W580
Fujitsu	M2243B, M2243T*
Hitachi	DK511-8
Hyosung	HC 8085
IBM	4965-E00
Itautec	ADR96
Maxtor	XT-1085
Microlab	DFW 5096
Micropolis	1335
Seagate Technology	ST277N*, ST4096
Toshiba	MK-56FB

3.5" disk diameter

Conner Peripherals	CP-3184*, CP-30080**, CP-30084E**
Greenery	G3100*
IBM	8555-081, WDA-380*
JVC	JD-E3896V**
Magtron	MT3080A**
Maxtor	7080A/S**
Microscience International	8080**
Mitsumi Electric	HD309AA*
Plus Development	Hardcard II 80*
Prologica	V366ST*
Quantum	52S/AT ProDrive LPS*
Seagate Technology	ST1096N*, ST3096A**
Teac	SD-380**
Tokico	TD3081C*
Western Digital	WDAC160**, WDAC180**
Zentek	ZH 3100*

Areal Technology	MD-2060**, MD-2080**
Conner Peripherals	CP-2064**, CP-2084**
Fujitsu	M2633S/T**
IBM	WDA-260**, WDS-280**
Maxtor	2585A/S**

2.5" disk diameter (continued)

Quantum	80S/AT Go.Drive**
Seagate	ST9077A**, ST9096A**
Teac	SD-260**
Western Digital	WDAH260**, WDAH280**

*Indicates drives with maximum 41.3 mm height, or less.
**Indicates drives with maximum 25.4 mm height, or less.

Significant shipments in this product group got under way in 1981 with early entrants such as the 8" Priam and Fujitsu drives, which developed quick acceptance of the 8" form factor at this capacity level, and rapidly displaced earlier 14" drives.

More substantial displacement came in the mid-1980s, with 8" drives becoming the first to suffer, following the 1984 arrival of 85 megabyte 5.25" drives. By providing a major reduction in price and making possible the addition of higher disk capacities to desktop workstations, 85 megabyte full size 5.25" drives became one of the industry's classic success stories, later followed by successful half high versions.

1988 saw the start of production shipments for 3.5" drives by many additional companies, plus several of the existing 5.25" drive producers, and they quickly rose to provide more than half of this product group's total, before peaking in shipments in 1991. Many 1" high 3.5" drives are now available, with shipments now increasing rapidly. The majority of the 3.5" drives are targeted at personal computer applications, with embedded controllers compatible with IBM PC/AT standards, as well as SCSI, commonly offered.

2.5" drives in this capacity first appeared in 1990. Shipments of 60 megabyte drives started late in the year, and have grown rapidly, now joined by 80 megabyte models. Most of the 2.5" drives in the group have

two disks, with heights of 19 millimeters or less, with some drives only 17 millimeters high.

Market status

DISK/TREND estimate of total market size:

Worldwide sales ($M)	1990	1991	1992	1993	1994
U.S. manufacturers	1,651.4	2,074.7	2,317.6	2,521.7	2,623.0
All manufacturers	1,766.8	2,227.2	2,580.6	2,971.8	3,318.2

As the typical disk capacity in demand for personal computer markets moves upward, shipments of disk drives in the 60-100 megabyte range are receiving much of the positive impact. Worldwide shipments of drives in this product group totaled 3.7 million units in 1990, up 62%, with a further increase of 68.8% expected in 1991.

Increases in total revenues continue to be more modest, however, with negative impacts from product mix changes, as older 5.25" drives are replaced by 3.5" drives at lower prices, and as competition intensifies between producers of non-captive 3.5" drives. As expected, worldwide revenues barely increased in 1990, up only 1.9%, and the forecast for 1991 is up only 26.1%.

U.S. manufacturers of non-captive drives have provided most of the recent shipment growth for this product group. 3.5" drives, including new 1" high models, achieved particularly rapid shipment growth during 1990 in the PCM/Reseller channel. Strong demand has emerged for easy-to-install drives which enable the aftermarket to offer replacement and upgrade products in both older systems and newly installed systems. The current 3.5" drives, with embedded PC/AT and SCSI controllers, make that possible.

The large production shipments of 2.5" drives starting in 1991 are mostly direct to manufacturers of notebook computers.

The personal computer market continues to absorb an increasing share of worldwide production 60-100 megabyte drives, taking 95.8% of 1990's shipments, as the minicomputer and technical workstation markets moved to higher capacity drives. This trend is continuing, with personal computers expected to account for 96.0% of 1994 shipments.

Seagate continued to hold more than one third of non-captive unit shipments in the 60-100 megabyte range in 1990, almost doubling its volume. Seagate shipped just over one million drives, for 37.3% of the worldwide total. Quantum held 27.4%, with 787,300 drives.

Marketing trends

The inevitable trend to high disk capacities will make the 60-100 megabyte range the largest DISK/TREND product group in unit shipments within two years, according to current DISK/TREND projections. However, most of that growth is expected to come from 2.5" drives, boosted after 1993 by 1.8" drives. Total shipments of 3.5" drives are expected to peak in 1991, and 1" high models are also expected to decline in shipments after 1992.

The dramatic product mix changes expected for this product group will be driven by the combination of continued strong demand for 2.5" drives in the notebook computer market, especially for drives in the 60-100 megabyte range, and new inroads by 2.5" drives in the desktop personal computer market. The rapid upward migration in disk capacities used with notebook computers is obvious, stimulated by user preferences and the requirements of popular software. It is believed that drives in this product group

will satisfy the largest segment of the notebook computer market during the next few years.

Worldwide total Unit shipments (000)	1990	1991	1992	1993	1994
8"	.6	.2	--	--	--
	--	--	--	--	--
5.25" full size	319.4	111.5	46.0	10.0	--
	8.6%	1.8%	.5%	.1%	--
5.25" half high	401.1	55.0	28.0	13.0	--
	10.8%	.9%	.3%	.1%	--
3.5" 1.625" high	2,036.1	1,742.1	426.0	245.0	155.0
	55.0%	27.9%	4.5%	1.8%	.9%
3.5" 1" high or less	926.3	2,717.0	3,837.0	3,780.0	3,329.0
	25.0%	43.5%	40.4%	28.1%	19.5%
2.5"	16.0	1,619.5	5,153.0	8,667.0	10,845.0
	.4%	25.9%	54.3%	64.3%	63.6%
1.8"	--	--	--	760.0	2,725.0
	--	--	--	5.6%	16.0%
	3,699.5	6,245.3	9,490.0	13,475.0	17,054.0

In recent years, 3.5" drives have largely driven 5.25" drives out of the market for desktop personal computers offered by major system manufacturers. But now that 2.5" drives are available in the 60-80 megabyte range, and increasing shipment levels are expected to depress average OEM prices, it is reasonable to assume significant penetration of the desktop personal computer market.

2.5" drives will provide advantages in the design of desktop personal computer systems. In addition to the obvious advantages of smaller physical size, 2.5" drives require less power, generate less heat, and make less noise than larger drives. These are important considerations to

system manufacturers, resulting in lower system cost and potentially making possible a desktop computer without the cost and noise of a fan.

When 1.8" drives in the 60-80 megabyte range make their projected appearance in 1993, the progression to smaller disk drives for "sub-notebook" computers requiring drives in this capacity range will continue. DISK/TREND forecasts anticipate rapid growth for 1.8" drives once available, with 1994 worldwide shipments placed at 2.7 million drives.

Technical trends

Technology employed for drives in this product group has been derived mostly from programs developed for the groups above and below it in capacity. The extensive development of 3.5" drives with capacities above 100 megabytes has resulted in achievement of high areal densities, now employed with drives in this group, using heads, disks and other components made available through the pioneering at higher capacities.

The packaging techniques developed for 2.5" drives and 1" high 3.5" drives with lower capacities were also adapted to this product group, taking advantage of the availability of miniaturized drive motors, head positioning mechanisms and electronic components. Considerable activity continues in development of even smaller form factors.

Interfaces offered on 3.5" and 2.5" drives in this group are also following the patterns established on lower capacity drives. Because of the higher areal densities employed, embedded controllers are used with all new drives, with most disk drive manufacturers offering an optional choice of the PC/AT or SCSI controllers compatible with popular personal computers.

Forecasting assumptions

1. IBM's production of 5.25" drives will stop in 1991, and 3.5" shipments will peak in 1992. IBM will rely mostly on internal manufacturing for drives in this group, but may supplement internal shortfalls with outside purchases.

2. Growth for OEM 5.25" drives has ended, limited by movement to higher capacities, and by a movement to 3.5" drives.

3. Availability of non-captive 2.5" and 3.5" drives will be adequate to satisfy growing demand.

4. First shipments of 1.8" drives in this capacity range will start in 1993, from multiple vendors.

TABLE 30

FIXED DISK DRIVES, 60 - 100 MEGABYTES

REVENUE SUMMARY

	DISK DRIVE REVENUES, BY SHIPMENT DESTINATION ($M)									
	1990 Revenues		Forecast 1991		1992		1993		1994	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM Captive	527.0	768.0	511.4	765.0	515.0	790.0	473.8	735.1	379.0	595.0
Other U.S. Captive	1.8	4.8	1.1	2.2	--	--	--	--	--	--
TOTAL U.S. CAPTIVE	528.8	772.8	512.5	767.2	515.0	790.0	473.8	735.1	379.0	595.0
PCM/Reseller	266.5	406.3	176.0	298.6	129.6	216.6	105.2	182.2	100.4	175.7
OEM/Integrator	332.7	472.3	685.2	1,008.9	935.4	1,311.0	1,160.0	1,604.4	1,333.4	1,852.3
TOTAL U.S. NON-CAPTIVE	599.2	878.6	861.2	1,307.5	1,065.0	1,527.6	1,265.2	1,786.6	1,433.8	2,028.0
TOTAL U.S. REVENUES	1,128.0	1,651.4	1,373.7	2,074.7	1,580.0	2,317.6	1,739.0	2,521.7	1,812.8	2,623.0
Non-U.S. Manufacturers										
Captive	--	5.8	--	3.6	12.5	84.0	31.1	180.4	46.0	243.5
PCM/Reseller	1.1	3.8	--	3.4	.8	5.4	1.8	8.2	3.8	13.8
OEM/Integrator	19.4	105.8	46.9	145.5	52.1	173.6	77.0	261.5	135.9	437.9
TOTAL NON-U.S. REVENUES	20.5	115.4	46.9	152.5	65.4	263.0	109.9	450.1	185.7	695.2
Worldwide Recap										
TOTAL WORLDWIDE REVENUES	1,148.5	1,766.8	1,420.6	2,227.2	1,645.4	2,580.6	1,848.9	2,971.8	1,998.5	3,318.2
OEM Average Price ($000)		.356		.288		.209		.174		.164

TABLE 31

FIXED DISK DRIVES, 60 - 100 MEGABYTES

UNIT SHIPMENT SUMMARY

	DISK DRIVE UNIT SHIPMENTS, BY SHIPMENT DESTINATION (000)									
	1990		Forecast							
	Shipments		1991		1992		1993		1994	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM Captive	570.0	830.0	643.3	962.0	750.0	1,150.0	820.0	1,270.0	830.0	1,300.0
Other U.S. Captive	.8	2.1	.5	1.0	--	--	--	--	--	--
TOTAL U.S. CAPTIVE	570.8	832.1	643.8	963.0	750.0	1,150.0	820.0	1,270.0	830.0	1,300.0
PCM/Reseller	816.3	1,237.9	754.0	1,274.6	630.0	1,063.0	595.0	1,033.0	615.0	1,077.0
OEM/Integrator	940.3	1,374.6	2,387.6	3,588.0	4,563.0	6,409.0	6,745.0	9,328.0	8,226.0	11,426.0
TOTAL U.S. NON-CAPTIVE	1,756.6	2,612.5	3,141.6	4,862.6	5,193.0	7,472.0	7,340.0	10,361.0	8,841.0	12,503.0
TOTAL U.S. SHIPMENTS	2,327.4	3,444.6	3,785.4	5,825.6	5,943.0	8,622.0	8,160.0	11,631.0	9,671.0	13,803.0
Non-U.S. Manufacturers										
Captive	--	2.1	--	1.4	25.0	156.0	69.0	388.0	115.0	600.0
PCM/Reseller	1.7	3.6	--	4.4	4.0	18.0	10.0	45.0	22.0	81.0
OEM/Integrator	48.3	249.2	136.8	413.9	205.0	694.0	416.0	1,411.0	793.0	2,570.0
TOTAL NON-U.S. SHIPMENTS	50.0	254.9	136.8	419.7	234.0	868.0	495.0	1,844.0	930.0	3,251.0
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	2,377.4	3,699.5	3,922.2	6,245.3	6,177.0	9,490.0	8,655.0	13,475.0	10,601.0	17,054.0
Total Capacity (Terabytes)	216.2	338.3	355.2	573.9	607.8	933.3	853.9	1,329.2	1,047.8	1,685.4
Cumulative Shipments (Units in thousands)										
IBM	1,891.1	2,726.0	2,534.4	3,688.0	3,284.4	4,838.0	4,104.4	6,108.0	4,934.4	7,408.0
Non-IBM	5,103.5	7,671.6	8,382.4	12,954.9	13,809.4	21,294.9	21,644.4	33,499.9	31,415.4	49,253.9
WORLDWIDE TOTAL	6,994.6	10,397.6	10,916.8	16,642.9	17,093.8	26,132.9	25,748.8	39,607.9	36,349.8	56,661.9

TABLE 32

FIXED DISK DRIVES, 60 - 100 MEGABYTES

WORLDWIDE REVENUES ($M)

BREAKDOWN BY DISK DIAMETER

	1990 Revenues				Forecast													
	1991				1992			1993				1994		
	8"	5.25"	3.5"	2.5"	8"	5.25"	3.5"	2.5"	5.25"	3.5"	2.5"	5.25"	3.5"	2.5"	1.8"	3.5"	2.5"	1.8"
U.S. MANUFACTURERS																		
IBM Captive	--	48.0	720.0	--	--	3.0	720.0	42.0	--	700.0	90.0	--	570.0	110.0	55.1	300.0	160.0	135.0
Other U.S. Captive	--	4.8	--	--	--	2.2	--	--	--	--	--	--	--	--	--	--	--	--
PCM/Reseller	--	162.0	244.3	--	--	33.5	246.6	18.5	16.3	179.9	20.4	4.6	136.0	41.6	--	107.2	64.8	3.7
OEM/Integrator	1.6	54.3	408.8	7.6	.6	17.1	465.3	525.9	2.7	390.3	918.0	--	351.6	1,172.9	79.9	328.4	1,283.2	240.7
TOTAL U.S. REVENUES	1.6	269.1	1,373.1	7.6	.6	55.8	1,431.9	586.4	19.0	1,270.2	1,028.4	4.6	1,057.6	1,324.5	135.0	735.6	1,508.0	379.4
NON-U.S. MANUFACTURERS																		
Captive	--	5.8	--	--	--	3.6	--	--	2.5	14.0	67.5	--	22.8	130.5	27.1	17.5	138.0	88.0
PCM/Reseller	--	3.8	--	--	--	2.6	.8	--	2.0	1.2	2.2	--	2.4	5.8	--	3.1	9.9	.8
OEM/Integrator	--	14.8	91.0	--	--	14.1	113.8	17.6	8.8	79.0	85.8	3.8	51.1	171.5	35.1	37.9	266.5	133.5
TOTAL NON-U.S. REVENUES	--	24.4	91.0	--	--	20.3	114.6	17.6	13.3	94.2	155.5	3.8	76.3	307.8	62.2	58.5	414.4	222.3
WORLDWIDE RECAP																		
Captive	--	58.6	720.0	--	--	8.8	720.0	42.0	2.5	714.0	157.5	--	592.8	240.5	82.2	317.5	298.0	223.0
	--	-79.9%	-6.5%	--	--	-85.0%	--	--	-71.6%	-.8%	+275.0%	-100.0%	-17.0%	+52.7%	--	-46.4%	+23.9%	+171.3%
PCM/Reseller	--	165.8	244.3	--	--	36.1	247.4	18.5	18.3	181.1	22.6	4.6	138.4	47.4	--	110.3	74.7	4.5
	--	-19.3%	+451.5%	--	--	-78.2%	+1.3%	--	-49.3%	-26.8%	+22.2%	-74.9%	-23.6%	+109.7%	--	-20.3%	+57.6%	--
OEM/Integrator	1.6	69.1	499.8	7.6	.6	31.2	579.1	543.5	11.5	469.3	1,003.8	3.8	402.7	1,344.4	115.0	366.3	1,549.7	374.2
	-75.8%	-65.5%	+132.6%	--	-62.5%	-54.8%	+15.9%	--	-63.1%	-19.0%	+84.7%	-67.0%	-14.2%	+33.9%	--	-9.0%	+15.3%	+225.4%
Total Revenues	1.6	293.5	1,464.1	7.6	.6	76.1	1,546.5	604.0	32.3	1,364.4	1,183.9	8.4	1,133.9	1,632.3	197.2	794.1	1,922.4	601.7
	-75.8%	-58.0%	+42.3%	--	-62.5%	-74.1%	+5.6%	--	-57.6%	-11.8%	+96.0%	-74.0%	-16.9%	+37.9%	--	-30.0%	+17.8%	+205.1%
ANNUAL SHARE, BY DIAMETER	.1%	16.6%	83.0%	.3%	--	3.4%	69.5%	27.1%	1.3%	53.0%	45.7%	.3%	38.3%	54.9%	6.5%	24.0%	57.9%	18.1%

TABLE 33

FIXED DISK DRIVES, 60 - 100 MEGABYTES

WORLDWIDE SHIPMENTS (000)

BREAKDOWN BY DISK DIAMETER

	1990 Shipments				Forecast													
	1991				1992			1993				1994		
	8"	5.25"	3.5"	2.5"	8"	5.25"	3.5"	2.5"	5.25"	3.5"	2.5"	5.25"	3.5"	2.5"	1.8"	3.5"	2.5"	1.8"
U.S. MANUFACTURERS																		
IBM Captive	--	30.0	800.0	--	--	2.0	900.0	60.0	--	1,000.0	150.0	--	950.0	220.0	100.0	600.0	400.0	300.0
Other U.S. Captive	--	2.1	--	--	--	1.0	--	--	--	--	--	--	--	--	--	--	--	--
PCM/Reseller	--	506.7	731.2	--	--	97.0	1,123.1	54.5	52.0	914.0	97.0	18.0	770.0	245.0	--	650.0	405.0	22.0
OEM/Integrator	.6	160.1	1,197.9	16.0	.2	46.8	2,081.0	1,460.0	8.0	2,030.0	4,371.0	--	2,009.0	6,899.0	420.0	1,990.0	8,020.0	1,416.0
TOTAL U.S. SHIPMENTS	.6	698.9	2,729.1	16.0	.2	146.8	4,104.1	1,574.5	60.0	3,944.0	4,618.0	18.0	3,729.0	7,364.0	520.0	3,240.0	8,825.0	1,738.0
NON-U.S. MANUFACTURERS																		
Captive	--	2.1	--	--	--	1.4	--	--	1.0	20.0	135.0	--	38.0	290.0	60.0	35.0	345.0	220.0
PCM/Reseller	--	3.6	--	--	--	2.4	2.0	--	2.0	6.0	10.0	--	12.0	33.0	--	17.0	60.0	4.0
OEM/Integrator	--	15.9	233.3	--	--	15.9	353.0	45.0	11.0	293.0	390.0	5.0	246.0	980.0	180.0	192.0	1,615.0	763.0
TOTAL NON-U.S. SHIPMENTS	--	21.6	233.3	--	--	19.7	355.0	45.0	14.0	319.0	535.0	5.0	296.0	1,303.0	240.0	244.0	2,020.0	987.0
WORLDWIDE RECAP																		
Captive	--	34.2	800.0	--	--	4.4	900.0	60.0	1.0	1,020.0	285.0	--	988.0	510.0	160.0	635.0	745.0	520.0
	--	-77.7%	+14.3%	--	--	-87.1%	+12.5%	--	-77.3%	+13.3%	+375.0%	-100.0%	-3.1%	+78.9%	--	-35.7%	+46.1%	+225.0%
PCM/Reseller	--	510.3	731.2	--	--	99.4	1,125.1	54.5	54.0	920.0	107.0	18.0	782.0	278.0	--	667.0	465.0	26.0
	--	+3.7%	+772.6%	--	--	-80.5%	+53.9%	--	-45.7%	-18.2%	+96.3%	-66.7%	-15.0%	+159.8%	--	-14.7%	+67.3%	--
OEM/Integrator	.6	176.0	1,431.2	16.0	.2	62.7	2,434.0	1,505.0	19.0	2,323.0	4,761.0	5.0	2,255.0	7,879.0	600.0	2,182.0	9,635.0	2,179.0
	-76.9%	-55.9%	+216.1%	--	-66.7%	-64.4%	+70.1%	--	-69.7%	-4.6%	+216.3%	-73.7%	-2.9%	+65.5%	--	-3.2%	+22.3%	+263.2%
Total Shipments	.6	720.5	2,962.4	16.0	.2	166.5	4,459.1	1,619.5	74.0	4,263.0	5,153.0	23.0	4,025.0	8,667.0	760.0	3,484.0	10,845.0	2,725.0
	-76.9%	-31.1%	+139.6%	--	-66.7%	-76.9%	+50.5%	--	-55.6%	-4.4%	+218.2%	-68.9%	-5.6%	+68.2%	--	-13.4%	+25.1%	+258.6%
ANNUAL SHARE, BY DIAMETER	--	19.5%	80.2%	.3%	--	2.7%	71.5%	25.8%	.8%	45.0%	54.2%	.2%	30.0%	64.3%	5.5%	20.5%	63.6%	15.9%
TOTAL CAPACITY (Terabytes)	--	67.3	269.7	1.2	--	15.3	423.2	135.4	6.7	416.5	510.1	2.1	393.8	858.0	75.2	342.1	1,073.7	269.8

TABLE 34

FIXED DISK DRIVES, 60 - 100 MEGABYTES

APPLICATIONS SUMMARY
Percentage of Worldwide Shipments

APPLICATION	1990 Estimate Units (000)	1990 Estimate %	1994 Projection Units (000)	1994 Projection %
MAINFRAME/SUPERMINI General purpose	--	--	--	--
MINICOMPUTERS AND MULTI-USER MICROS Business and professional, including networks	57.0	1.5	102.3	.6
PERSONAL COMPUTERS Business and professional, single user	3,541.9	95.8	16,371.8	96.0
OFFICE SYSTEMS AND WORKSTATIONS Dedicated application	30.3	.8	51.2	.3
NON-OFFICE SYSTEMS AND WORKSTATIONS Technical, distribution, medical, other specialized	58.1	1.6	170.5	1.0
CONSUMER AND HOBBY COMPUTERS	11.5	.3	341.1	2.0
OTHER APPLICATIONS	--	--	17.1	.1
Total	3,699.5	100.0	17,054.0	100.0

TABLE 35

FIXED DISK DRIVES, 60 - 100 MEGABYTES

MARKET SHARE SUMMARY
Worldwide Shipments of Non-Captive Disk Drives

	1990 Net Shipments											
	To United States Destinations						Worldwide					
	Units (000)					%	Units (000)					%
Drive Manufacturers	8"	5.25"	3.5"	2.5"	Total		8"	5.25"	3.5"	2.5"	Total	
Seagate Technology	--	329.0	396.0	--	725.0	40.1	--	505.0	563.0	--	1068.0	37.3
Quantum	--	--	585.2	--	585.2	32.4	--	--	787.3	--	787.3	27.4
Conner Peripherals	--	--	139.0	13.0	152.0	8.4	--	--	227.0	15.0	242.0	8.4
Maxtor	--	10.6	90.8	--	101.4	5.6	--	21.0	207.8	--	228.8	8.0
Western Digital	--	--	79.0	--	79.0	4.4	--	--	144.0	--	144.0	5.0
Microscience Inter.	--	70.0	--	--	70.0	3.9	--	90.0	--	--	90.0	3.1
Sony	--	--	--	--	--	--	--	--	79.0	--	79.0	2.8
Rodime	--	--	36.0	--	36.0	2.0	--	--	61.0	--	61.0	2.1
Micropolis	--	42.7	--	--	42.7	2.4	--	50.8	--	--	50.8	1.8
Other U.S.	.3	--	16.7	1.0	18.0	1.0	.6	--	45.9	1.0	47.5	1.7
Other Non-U.S.	--	4.0	10.0	--	14.0	.7	--	19.5	93.3	--	112.8	3.9
TOTAL	.3	456.3	1336.0	14.0	1806.6	100.0	.6	686.3	2162.4	16.0	2865.3	100.0

FIXED DISK DRIVES, 100-300 MEGABYTES

1991 DISK/TREND REPORT

FIXED DISK DRIVES, 100-300 MEGABYTES

Coverage

Examples of disk drives in this group include:

8" disk diameter

Fujitsu	M2322
Hitachi	DK812S-12, DK814S-17
Sequel	806
Toshiba	MK186FB

5.25" disk diameter

Atasi Technology	519
Digirede	W525/190
Edisa	ED 71204
Digital Equipment	RF31F*
Fujitsu	M2245E, M2243R*
Hitachi	DK512-17, DK522C-10*
Hyosung	HC8170E
IBM	671-284
Magtron	4170*
Maxtor	XT-1140, XT-2190
Micropolis	1355, 1674-7*
Multidigit	DW 0178
NEC	D5655*, D5852
Sagem	MSA 252-100
Seagate Technology	ST4182E/N, ST2106N*
Toshiba	MK-156FB

3.5" disk diameter

Alps Electric	DRR100C**
Brand Technology	BT9220*
Conner Peripherals	CP-3100*, CP-3200*, CP-30170**
Ecol.2	EC3-200**
Fuji Electric	FK314S-90R**
Fujitsu	M2614S*
Hewlett-Packard	C2233S/A*
IBM	8570-161, WD-3158G*, WD-3160*
Kalok	KL3100*
Kyocera	KC 120DA*
Kyushu Matsushita Electric	RD-210AA**
Maxtor	LXT-213S/A*, 7120S/A**
Microscience International	5100-20*, 8200**
Mitsumi Electric	HD313HC*
NEC	D3661*, D3755**
Prologica	V380ST*
Quantum	210S/A ProDrive*, 105S/AT LPS**

3.5" disk diameter (continued)

Samsung	SHD3201S*
Seagate Technology	ST1144A*, ST3283N**
Teac	SD-3210**
Tokico	TD3135A*
Toshiba	MK-234FB*
Western Digital	WDAP4200*, WDNC2120**
Y-E Data	YD-3084B*, YD-3162B**
Zentek	H3380*

2.5" disk diameter

Areal Technology	A120**, A180**

*Indicates drives with maximum 41.3 mm height, or less.
**Indicates drives with maximum 25.4 mm height, or less.

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 middle of the decade, then by a wave of 3.5" drives starting in 1987, and now by the first announced 2.5" drives.

These, as well as the older 14" drives, all use variations of Winchester technology. Disks used with the 14" and 8" drives are oxide coated, but disks used on smaller drives are mostly sputtered. Heads currently in use range from older ferrite types on the 8" drives to the latest thin film head configurations on some of the 1" high 3.5" drives.

Market status

DISK/TREND estimate of total market size:

Worldwide sales ($M)	1990	1991	1992	1993	1994
U.S. manufacturers	2,179.9	2,907.2	3,349.2	3,618.3	3,674.3
All manufacturers	3,144.6	3,659.2	4,062.1	4,354.5	4,522.6

As expected, percentage growth in unit shipments for the 100-300 megabyte group exceeded all other DISK/TREND product groups in 1990, at 115%. This product group has been impacted more than any other by the rapid growth of the market for 386-based personal computers and the more sophisticated software which has become available for use with these systems. 3.8 million drives were shipped in 1990, and the estimate for 1991 is 5.9 million drives, up another 55.2%.

After passing up 5.25" drive shipments in 1989, 3.5" drives have quickly dominated shipments for the product group, with 86.6% of the group total in 1990. The trend continues in 1991, with 5.25" estimated shipments of 275,700 drives providing only 4.6% of the worldwide group total, while shipments of 5.6 million 3.5" drives account for 94.8%.

The majority of non-captive shipments are still going to system manufacturers, but growth in aftermarket sales through PCM/Reseller channels is now a major factor, led by the newer 3.5" drives. The leading application for drives in this group has become the personal computer market, which captured 78.5% of worldwide unit shipments in 1990, with growth to 85.7% projected for 1994. Minicomputers and multiuser micros, which previously were the dominant application, was down to 8.8% in 1990, with non-office systems and workstations limited to 7.6%.

Conner Peripherals continued to hold the leadership in non-captive drive shipments in 1990 with 913,000 3.5" drives, for 30.0% of the worldwide market. Seagate was again in second position with 18.9%, but most of the drives Seagate shipped in this product group in 1990 were 3.5" models, contrasting sharply with 1989, in which the firm shipped mostly 5.25" drives in the 100-300 megabyte product group.

Marketing trends

It is expected that this product group will continue to sustain a high overall growth rate in shipments, averaging 29.6% in the 1992-94 period. As usual in the disk drive business, revenue increases will follow a lower trajectory, an annual average of only 7.4%, as non-captive distribution predominates and prices decline.

The continuing transition to smaller disk drives is expected to continue:

Worldwide total Unit shipments (000)	1990	1991	1992	1993	1994
8"	10.1	2.2	--	--	--
	.3%	--	--	--	--
5.25" full size	260.4	132.6	42.0	11.0	--
	6.8%	2.2%	.5%	.1%	--
5.25" half high	242.9	143.1	54.0	22.0	--
	6.3%	2.4%	.7%	.2%	--
3.5" 1.625" high	3,006.6	3,292.9	2,049.0	1,065.0	473.0
	78.4%	55.3%	24.8%	10.2%	3.7%
3.5" 1" high or less	314.5	2,340.0	5,153.0	6,848.0	7,252.0
	8.2%	39.3%	62.3%	65.3%	56.2%
2.5"	--	39.0	970.0	2,540.0	4,630.0
	--	.7%	11.7%	24.2%	35.8%
1.8"	--	--	--	--	560.0
	--	--	--	--	4.3%
	3,834.5	5,949.8	8,268.0	10,486.0	12,915.0

Although total shipments of 3.5" drives are expected to grow through 1993, and 1" high 3.5" drives will continue for another year or so after 1993, shipments of 2.5" drives are forecasted to increase at a higher rate during the same period, reaching a total of 4.6 million drives in 1994. In 1994, the projected 12.9 million drives to be shipped will make this

the second largest in unit shipments of all of the DISK/TREND product groups.

Until 1988-89, the big growth for 5.25" drives in the 100-300 megabyte range was fueled by demand for technical workstations and minicomputers, but the even larger market for 3.5" drives is built upon the personal computer market, which is rapidly upgrading to more capable processors, being used for applications which need more data storage.

Although significant usage of 3.5" drives in this product group with technical workstations started in 1989, sharp growth in shipments of personal computers using 80386 processors has been the main stimulus for growth. Since most of the new personal computers introduced in the last four years have used 3.5" floppies and hard disk drives, the PC industry's product planners have preferred to use that form factor for increased disk storage as their systems migrate to better processors and as more versatile software becomes available.

The high-end 2.5" drives expected to be available from multiple vendors in the first half of 1992, followed by 1.8" drives in 1994, will find ready acceptance in more sophisticated notebook computers. But many of the 2.5" drives will also start to find a market in desktop computer applications starting next year. 2.5" drives, in addition to being small in size, also have lower power requirements, generate less heat, and are quieter than 3.5" drives. These cost and marketing advantages will be important to manufacturers of desktop personal computers and will greatly broaden the market available to higher capacity 2.5" drives.

Half high 5.25" drives maintained more momentum than expected, but shipments finally peaked in 1989. Half high drives were a major business

success for Imprimis, but other manufacturers of high-end 5.25" drives which eventually chose to offer half high models arrived in the market too late -- the movement to the 3.5" form factor was already under way.

Underlying the rapid decline in full size 5.25" drives was the movement by the minicomputer and technical workstation markets to higher capacity 5.25" models, above this product group. 3.5" drives have become the choice for low-end workstations. With 200 megabyte 3.5" drives now in production from multiple vendors, further penetration of the workstation market is inevitable.

Technical trends

The continuing transition to 3.5" drives in this group, combined with the 2.5" and 1.8" drives to follow, continues to make severe demands on the key components used in achieving the high recording densities necessary to meet the small packaging requirements.

The high capacity 3.5" and smaller drives now being developed throughout the world by disk drive manufacturers present some of the most demanding design challenges facing the industry. Not only are areal densities very high, but packaging requirements are severe, involving drive heights as low as 1/2 inch, new head suspensions, embedded controllers, and very fast actuators.

1" high 3.5" drives in the 100-300 megabyte capacity range are now available with more than 100 megabytes per disk, using areal densities which approach those employed with the recently announced one gigabyte 3.5" drives from several vendors. Areal Technology is already shipping 2.5" drives with 60 megabytes per disk, and has announced a two disk version. Considering the high production levels for drives in this group,

combined with the difficulties head, media and other component vendors typically experience in ramping up production of new high density components, the industry faces many interesting challenges as users' appetites for storage continue to grow.

It is not yet clear which interfaces will prevail with 3.5" drives in this range. But there are design advantages in masking a file organization optimized for high density behind an intelligent interface, so PC/AT and SCSI and embedded controllers compatible with specific personal computers will probably continue to predominate.

Forecasting assumptions

1. Growth in IBM's shipments of 3.5" drives in this group will continue to increase, with a transition to 1" high models starting in 1991, with 2.5" drives to be added in 1992.

2. 3.5" drives will continue to dominate non-captive drive shipments until 1994 due to their wide acceptance in the high-end personal computer market.

3. 2.5" drives for other captive and non-captive applications will be in volume production by 1992, and 1.8" drives will be in volume production for the OEM market in 1994.

TABLE 36

FIXED DISK DRIVES, 100 - 300 MEGABYTES

REVENUE SUMMARY

	DISK DRIVE REVENUES, BY SHIPMENT DESTINATION ($M)									
	1990 Revenues		Forecast 1991		1992		1993		1994	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM Captive	668.3	936.1	997.8	1,422.9	1,273.1	1,844.0	1,368.1	2,003.0	1,232.5	1,848.0
Other U.S. Captive	20.3	53.6	7.0	18.5	7.0	15.7	6.8	14.5	7.5	16.5
TOTAL U.S. CAPTIVE	688.6	989.7	1,004.8	1,441.4	1,280.1	1,859.7	1,374.9	2,017.5	1,240.0	1,864.5
PCM/Reseller	311.2	426.5	342.9	531.8	298.5	467.7	278.3	426.2	244.8	369.7
OEM/Integrator	551.7	763.7	628.2	934.0	670.9	1,021.8	794.1	1,174.6	1,014.1	1,440.1
TOTAL U.S. NON-CAPTIVE	862.9	1,190.2	971.1	1,465.8	969.4	1,489.5	1,072.4	1,600.8	1,258.9	1,809.8
TOTAL U.S. REVENUES	1,551.5	2,179.9	1,975.9	2,907.2	2,249.5	3,349.2	2,447.3	3,618.3	2,498.9	3,674.3
Non-U.S. Manufacturers										
Captive	81.9	512.1	41.2	391.9	35.3	355.5	39.2	330.8	56.4	351.8
PCM/Reseller	43.8	76.7	16.0	34.2	9.7	25.4	13.5	32.4	14.7	37.2
OEM/Integrator	107.0	375.9	53.3	325.9	60.7	332.0	76.8	373.0	103.8	459.3
TOTAL NON-U.S. REVENUES	232.7	964.7	110.5	752.0	105.7	712.9	129.5	736.2	174.9	848.3
Worldwide Recap										
TOTAL WORLDWIDE REVENUES	1,784.2	3,144.6	2,086.4	3,659.2	2,355.2	4,062.1	2,576.8	4,354.5	2,673.8	4,522.6
OEM Average Price ($000)		.531		.392		.290		.250		.228

TABLE 37

FIXED DISK DRIVES, 100 - 300 MEGABYTES

UNIT SHIPMENT SUMMARY

	DISK DRIVE UNIT SHIPMENTS, BY SHIPMENT DESTINATION (000)									
	1990		Forecast							
	Shipments		1991		1992		1993		1994	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM Captive	441.5	614.0	759.0	1,083.0	1,173.0	1,695.0	1,491.0	2,180.0	1,581.0	2,370.0
Other U.S. Captive	5.2	13.6	2.0	5.0	6.3	13.0	8.0	17.0	10.0	22.0
TOTAL U.S. CAPTIVE	446.7	627.6	761.0	1,088.0	1,179.3	1,708.0	1,499.0	2,197.0	1,591.0	2,392.0
PCM/Reseller	537.9	749.2	888.2	1,405.6	1,009.0	1,574.0	1,098.0	1,678.0	1,076.0	1,625.0
OEM/Integrator	1,030.2	1,456.3	1,523.3	2,330.3	2,273.0	3,499.0	3,180.0	4,706.0	4,500.0	6,365.0
TOTAL U.S. NON-CAPTIVE	1,568.1	2,205.5	2,411.5	3,735.9	3,282.0	5,073.0	4,278.0	6,384.0	5,576.0	7,990.0
TOTAL U.S. SHIPMENTS	2,014.8	2,833.1	3,172.5	4,823.9	4,461.3	6,781.0	5,777.0	8,581.0	7,167.0	10,382.0
Non-U.S. Manufacturers										
Captive	22.7	160.6	15.6	161.1	29.0	233.0	40.0	278.0	72.0	385.0
PCM/Reseller	91.6	150.8	45.0	84.6	34.0	82.0	54.0	132.0	65.0	163.0
OEM/Integrator	201.5	690.0	147.7	880.2	212.0	1,172.0	306.0	1,495.0	448.0	1,985.0
TOTAL NON-U.S. SHIPMENTS	315.8	1,001.4	208.3	1,125.9	275.0	1,487.0	400.0	1,905.0	585.0	2,533.0
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	2,330.6	3,834.5	3,380.8	5,949.8	4,736.3	8,268.0	6,177.0	10,486.0	7,752.0	12,915.0
Total Capacity (Terabytes)	413.8	660.1	591.7	1,002.7	655.9	1,132.9	1,188.6	2,026.7	1,954.0	3,284.9
Cumulative Shipments (Units in thousands)										
IBM	1,013.3	1,383.5	1,772.3	2,466.5	2,945.3	4,161.5	4,436.3	6,341.5	6,017.3	8,711.5
Non-IBM	4,048.1	6,654.6	6,669.9	11,521.4	10,233.2	18,094.4	14,919.2	26,400.4	21,090.2	36,945.4
WORLDWIDE TOTAL	5,061.4	8,038.1	8,442.2	13,987.9	13,178.5	22,255.9	19,355.5	32,741.9	27,107.5	45,656.9

TABLE 38

FIXED DISK DRIVES, 100 - 300 MEGABYTES

WORLDWIDE REVENUES ($M)

BREAKDOWN BY DISK DIAMETER

	1990 Revenues			Forecast												
				1991				1992			1993			1994		
	8"	5.25"	3.5"	8"	5.25"	3.5"	2.5"	5.25"	3.5"	2.5"	5.25"	3.5"	2.5"	3.5"	2.5"	1.8"
U.S. MANUFACTURERS																
IBM Captive	34.1	96.0	806.0	--	6.9	1,416.0	--	--	1,799.0	45.0	--	1,883.0	120.0	1,680.0	168.0	--
Other U.S. Captive	--	53.6	--	--	18.5	--	--	4.3	11.4	--	--	14.5	--	16.5	--	--
PCM/Reseller	--	99.2	327.3	--	79.7	450.5	1.6	25.2	436.8	5.7	9.3	397.7	19.2	333.7	36.0	--
OEM/Integrator	1.4	113.5	648.8	.6	42.2	877.3	13.9	10.8	803.1	207.9	4.0	707.5	463.1	610.3	711.0	118.8
TOTAL U.S. REVENUES	35.5	362.3	1,782.1	.6	147.3	2,743.8	15.5	40.3	3,050.3	258.6	13.3	3,002.7	602.3	2,640.5	915.0	118.8
NON-U.S. MANUFACTURERS																
Captive	22.6	256.0	233.5	6.6	104.0	281.3	--	25.0	272.0	58.5	6.0	236.8	88.0	190.8	161.0	--
PCM/Reseller	--	25.0	51.7	--	13.4	20.8	--	6.4	18.4	.6	1.0	28.8	2.6	30.4	6.8	--
OEM/Integrator	7.1	53.2	315.6	3.2	23.6	299.1	--	9.5	300.9	21.6	2.5	294.2	76.3	263.3	173.9	22.1
TOTAL NON-U.S. REVENUES	29.7	334.2	600.8	9.8	141.0	601.2	--	40.9	591.3	80.7	9.5	559.8	166.9	484.5	341.7	22.1
WORLDWIDE RECAP																
Captive	56.7	405.6	1,039.5	6.6	129.4	1,697.3	--	29.3	2,082.4	103.5	6.0	2,134.3	208.0	1,887.3	329.0	--
	-24.8%	-36.9%	+72.9%	-88.4%	-68.1%	+63.3%	--	-77.4%	+22.7%	--	-79.5%	+2.5%	+101.0%	-11.6%	+58.2%	--
PCM/Reseller	--	124.2	379.0	--	93.1	471.3	1.6	31.6	455.2	6.3	10.3	426.5	21.8	364.1	42.8	--
	--	+53.9%	--	--	-25.0%	+24.4%	--	-66.1%	-3.4%	+293.7%	-67.4%	-6.3%	+246.0%	-14.6%	+96.3%	--
OEM/Integrator	8.5	166.7	964.4	3.8	65.8	1,176.4	13.9	20.3	1,104.0	229.5	6.5	1,001.7	539.4	873.6	884.9	140.9
	-49.7%	-58.1%	+183.6%	-55.3%	-60.5%	+22.0%	--	-69.1%	-6.2%	--	-68.0%	-9.3%	+135.0%	-12.8%	+64.1%	--
Total Revenues	65.2	696.5	2,382.9	10.4	288.3	3,345.0	15.5	81.2	3,641.6	339.3	22.8	3,562.5	769.2	3,125.0	1,256.7	140.9
	-29.4%	-37.9%	+145.2%	-84.0%	-58.6%	+40.4%	--	-71.8%	+8.9%	--	-71.9%	-2.2%	+126.7%	-12.3%	+63.4%	--
ANNUAL SHARE, BY DIAMETER	2.1%	22.2%	75.7%	.3%	7.9%	91.5%	.3%	2.0%	89.7%	8.3%	.5%	81.9%	17.6%	69.2%	27.8%	3.0%

Note: Note: 8 inch totals include 9 inch drives.

TABLE 39

FIXED DISK DRIVES, 100 - 300 MEGABYTES

WORLDWIDE SHIPMENTS (000)

BREAKDOWN BY DISK DIAMETER

	1990 Shipments			Forecast												
				1991				1992			1993			1994		
	8"	5.25"	3.5"	8"	5.25"	3.5"	2.5"	5.25"	3.5"	2.5"	5.25"	3.5"	2.5"	3.5"	2.5"	1.8"
U.S. MANUFACTURERS																
IBM Captive	4.0	40.0	570.0	--	3.0	1,080.0	--	--	1,645.0	50.0	--	2,030.0	150.0	2,130.0	240.0	--
Other U.S. Captive	--	13.6	--	--	5.0	--	--	1.0	12.0	--	--	17.0	--	22.0	--	--
PCM/Reseller	--	135.4	613.8	--	119.5	1,282.1	4.0	44.0	1,510.0	20.0	18.0	1,585.0	75.0	1,465.0	160.0	--
OEM/Integrator	.5	143.3	1,312.5	.2	61.1	2,234.0	35.0	18.0	2,725.0	756.0	6.0	2,810.0	1,890.0	2,658.0	3,232.0	475.0
TOTAL U.S. SHIPMENTS	4.5	332.3	2,496.3	.2	188.6	4,596.1	39.0	63.0	5,892.0	826.0	24.0	6,442.0	2,115.0	6,275.0	3,632.0	475.0
NON-U.S. MANUFACTURERS																
Captive	1.9	65.1	93.6	.6	31.2	129.3	--	8.0	160.0	65.0	2.0	166.0	110.0	155.0	230.0	--
PCM/Reseller	--	27.8	123.0	--	19.3	65.3	--	10.0	70.0	2.0	2.0	120.0	10.0	135.0	28.0	--
OEM/Integrator	3.7	78.1	608.2	1.4	36.6	842.2	--	15.0	1,080.0	77.0	5.0	1,185.0	305.0	1,160.0	740.0	85.0
TOTAL NON-U.S. SHIPMENTS	5.6	171.0	824.8	2.0	87.1	1,036.8	--	33.0	1,310.0	144.0	9.0	1,471.0	425.0	1,450.0	998.0	85.0
WORLDWIDE RECAP																
Captive	5.9	118.7	663.6	.6	39.2	1,209.3	--	9.0	1,817.0	115.0	2.0	2,213.0	260.0	2,307.0	470.0	--
	-13.2%	-38.2%	+99.6%	-89.8%	-67.0%	+82.2%	--	-77.0%	+50.3%	--	-77.8%	+21.8%	+126.1%	+4.2%	+80.8%	--
PCM/Reseller	--	163.2	736.8	--	138.8	1,347.4	4.0	54.0	1,580.0	22.0	20.0	1,705.0	85.0	1,600.0	188.0	--
	--	+83.8%	--	--	-15.0%	+82.9%	--	-61.1%	+17.3%	+450.0%	-63.0%	+7.9%	+286.4%	-6.2%	+121.2%	--
OEM/Integrator	4.2	221.4	1,920.7	1.6	97.7	3,076.2	35.0	33.0	3,805.0	833.0	11.0	3,995.0	2,195.0	3,818.0	3,972.0	560.0
	-42.5%	-54.3%	+208.2%	-61.9%	-55.9%	+60.2%	--	-66.2%	+23.7%	--	-66.7%	+5.0%	+163.5%	-4.4%	+81.0%	--
Total Shipments	10.1	503.3	3,321.1	2.2	275.7	5,632.9	39.0	96.0	7,202.0	970.0	33.0	7,913.0	2,540.0	7,725.0	4,630.0	560.0
	-28.4%	-34.3%	+232.5%	-78.2%	-45.2%	+69.6%	--	-65.2%	+27.9%	--	-65.6%	+9.9%	+161.9%	-2.4%	+82.3%	--
ANNUAL SHARE, BY DIAMETER	.3%	13.1%	86.6%	--	4.6%	94.8%	.6%	1.2%	87.2%	11.6%	.3%	75.6%	24.1%	59.9%	35.8%	4.3%
TOTAL CAPACITY (Terabytes)	2.1	83.7	574.4	.4	47.0	949.9	5.5	16.3	980.6	136.0	5.6	1,521.5	499.6	1,942.8	1,263.8	78.4

Note: Note: 8 inch totals include 9 inch drives.

TABLE 40

FIXED DISK DRIVES, 100 - 300 MEGABYTES

APPLICATIONS SUMMARY
Percentage of Worldwide Shipments

APPLICATION	1990 Estimate Units (000)	1990 Estimate %	1994 Projection Units (000)	1994 Projection %
MAINFRAME/SUPERMINI General purpose	--	--	--	--
MINICOMPUTERS AND MULTI-USER MICROS Business and professional, including networks	338.2	8.8	904.1	7.0
PERSONAL COMPUTERS Business and professional, single user	3,010.8	78.5	11,068.2	85.7
OFFICE SYSTEMS AND WORKSTATIONS Dedicated application	175.2	4.6	129.2	1.0
NON-OFFICE SYSTEMS AND WORKSTATIONS Technical, distribution, medical, other specialized	290.3	7.6	774.9	6.0
CONSUMER AND HOBBY COMPUTERS	16.1	.4	25.8	.2
OTHER APPLICATIONS	2.7	.1	12.8	.1
Total	3,834.5	100.0	12,915.0	100.0

TABLE 41

FIXED DISK DRIVES, 100 - 300 MEGABYTES

MARKET SHARE SUMMARY
Worldwide Shipments of Non-Captive Disk Drives

	1990 Net Shipments									
	To United States Destinations					Worldwide				
	Units (000)				%	Units (000)				%
Drive Manufacturers	8"	5.25"	3.5"	Total		8"	5.25"	3.5"	Total	
Conner Peripherals	--	--	564.0	564.0	30.3	--	--	913.0	913.0	30.0
Seagate Technology	--	45.0	405.0	450.0	24.2	--	67.0	508.0	575.0	18.9
Quantum	--	--	225.3	225.3	12.1	--	--	310.0	310.0	10.2
Fujitsu	.8	1.6	71.0	73.4	3.9	2.0	7.2	278.5	287.7	9.4
Maxtor	--	70.2	118.7	188.9	10.1	--	86.4	143.0	229.4	7.5
Toshiba	--	5.0	105.0	110.0	5.9	1.0	14.0	189.0	204.0	6.7
NEC	--	25.0	3.0	28.0	1.5	--	45.0	76.0	121.0	4.0
Rodime	--	--	69.0	69.0	3.7	--	--	115.0	115.0	3.8
Micropolis	--	91.5	--	91.5	4.9	--	100.9	--	100.9	3.3
Other U.S.	.2	13.1	41.3	54.6	2.9	.5	24.4	68.1	93.0	3.1
Other Non-U.S.	.1	9.1	3.5	12.7	.8	.7	39.7	72.7	113.1	3.6
TOTAL	1.1	260.5	1599.6	1861.2	100.0	4.2	384.6	2657.5	3046.3	100.0

Note: 8 inch totals include 9 inch drives.

FIXED DISK DRIVES, 300-500 MEGABYTES

1991 DISK/TREND REPORT

FIXED DISK DRIVES, 300-500 MEGABYTES

Coverage

Examples of disk drives in this group include:

14" disk diameter

DZU	EC 5063

10.5" disk diameter

Fujitsu	M2350A, F6421

9" disk diameter

Seagate Technology	ST6344J

8" disk diameter

Fujitsu	M2333K
Hitachi	DK-814S-34
Sequel	807

5.25" disk diameter

Atasi Technology	638, 738
Digital Equipment	RA70, RF71
Edisa	ED 71408
Fujitsu	M2249E/S
Hewlett-Packard	7959S, 97544P
Hitachi	DK514-38
IBM	5363-520, 0671-387
Magtron	Mt5400E/S
Maxtor	XT-4380E/S, XT-8380E/S
Micropolis	1558-15, 1664-7*
Microscience International	FH-3414
Miltope	RDS-3800
NEC	D5662
Seagate Technology	ST4385N, ST2383N*

3.5" disk diameter

Conner Peripherals	CP-3360*
Fujitsu	M2622S*
Hewlett-Packard	C2235S*
IBM	0661-371*, 0661-467*
Maxtor	LXT-340*
Microscience International	7400*
NEC	D3872*, D3881*

3.5" disk diameter (continued)

Orca Technology	OT304S/A*
Quantum	425S/AT ProDrive*
Seagate Technology	ST1480A/N*, ST3500A/N**
Zentek	ZH 3490*

*Indicates drives with maximum 41.3 mm height, or less.
**Indicates drives with maximum 25.4 mm height, or less.

The original disk drives in this group were patterned after IBM's 3350 -- typically 317.5 megabyte floor-standing drives intended for use with mainframes. These drives, and the rack-mounted 14", 10.5", 9" and 8" drives which followed, are now mostly gone, as improving areal density continually reduces drive packaging to smaller sizes.

A wave of 380 megabyte 5.25" drives, following the lead of Maxtor, has provided major shipments for many producers for several years, with more than 20 companies active, at various times, in the market. The half high Wren 5.25" drives (pioneered by Control Data, now part of Seagate's product line), were followed with half high 5.25" models from only one other company, Micropolis.

In 1989, IBM became the first company to announce and ship 3.5" drives in this capacity range, but numerous other drive manufacturers also introduced 3.5" drives in 1990. In 1991, Seagate announced 426 megabyte models only 1" high.

Market status

DISK/TREND estimate of total market size:

Worldwide sales ($M)	1990	1991	1992	1993	1994
U.S. manufacturers	2,023.2	2,471.8	1,881.2	1,701.5	1,833.7
All manufacturers	2,544.8	2,804.9	2,291.1	2,212.3	2,473.8

Unit shipments of drives in the 300-500 megabyte range have grown in 1990 and 1991 more than twice as fast as revenues, as the product group feels the effects of declining prices on older drive models and the shift to drives with smaller disk diameters. 1990's $2,544.8 in revenues, up 10.8%, was overmatched by shipments of 1 million drives, up 21.4%. 1991's revenues are expected to increase another 10.2%, but unit shipments are forecasted to increase 31.0%.

The major depressing influence in revenues is now the rapid drop in shipments of 5.25" drives, following the same pattern as the decline in 8" and 14" drives which occurred previously. The peak in shipments for 5.25" drives was in 1989, earlier than expected. 5.25" drives are expected to decline 31.9% in worldwide shipments in 1991.

After many competitors expressed initial skepticism regarding the Maxtor 380 megabyte 5.25" drive, which was first shipped in 1984, thirteen firms had started production by 1988 -- and a playing field that was initially too empty had become overcrowded, despite a 700% shipment increase in 1988.

3.5" drive shipments in this product group have been dominated since 1989 by IBM's shipments of the "Lightning/Turbo" series, but major non-captive shipments of 3.5" drives are under way in 1991 from several drive manufacturers. 1991's estimated total shipments of 841,800 3.5"drives represents an increase of 221.4% over 1990.

IBM still has a major impact on this product group. Although the company's shipments of 14" and 8" drives stopped in 1990, production of the IBM "Lee" 5.25" drive, with formatted capacity of 315 megabytes, continued after its 1989 peak and isn't expected to end until this year.

But IBM's emphasis has shifted to the "Lightning" 3.5" series, first offered as a 320 megabyte drive in mid-1989 to distributors, and added as a standard drive on several major IBM systems in the Spring of 1990.

The Lightning introduction represented an interesting change in IBM sales strategy for the noncaptive market. After unsuccessful attempts to sell earlier small diameter disk drives to major system manufacturers on an OEM basis, a different sales program was established for the Lightning. The drive was offered for resale through Western Digital on an OEM basis and through WD's distributors, through System Industries with DEC compatible subsystems, and through CMS Enhancements for the PC aftermarket.

Although IBM enjoyed a full year head start in shipments of 3.5" drives in the 300-500 megabyte range, they now face more than enough competition in the noncaptive marketplace. 3.5" drives in this capacity range have been announced by eleven other drive manufacturers, and more are expected.

Minicomputer and multiuser micro applications, including network file servers, continued to lead with 35.4% of all unit shipments for the product group in 1990, and further growth to 42.0% in 1994 is expected. Usage of 300-500 megabyte drives with personal computers is rising quickly, however, with 27.7% of shipments in 1990, expected to grow to 33.9% in 1994. Technical workstations will also secure a growing share, but the share for mainframes and superminis will drop as older drives are discontinued.

Seagate increased its lead in noncaptive shipments in 1990, with 241,000 drives, mostly 5.25", for 37.4% of the worldwide total. Micropolis moved up to second position with 22.9%, and Maxtor retained 22.1%.

Marketing trends

Total revenues for 300-500 megabyte drives are expected to follow an up and down pattern through 1994, even though constant growth in shipments is expected, due to continuing changes in product mix.

The 14" and 8/9" drives which provided two thirds of this group's revenue in 1988 have reached end of life, with the last 14" shipments in 1990, and 8" drive shipments expected to end in 1992. Even 5.25" drive shipments are now forecasted to end in 1993, with both 3.5" and 2.5" sharing the product group in 1994:

Worldwide total Unit shipments (000)	1990	1991	1992	1993	1994
14"	4.5	1.2	--	--	--
	.4%	.1%	--	--	--
8"	34.7	5.5	2.0	--	--
	3.4%	.4%	.1%	--	--
5.25" full size	616.8	311.7	126.0	30.0	--
	60.3%	23.3%	7.3%	1.4%	--
5.25" half high	105.5	180.0	120.0	55.0	--
	10.3%	13.4%	6.9%	2.5%	--
3.5" 1.625" high	261.9	841.8	1,249.0	1,039.0	757.0
	25.6%	62.8%	72.2%	47.4%	27.5%
3.5" 1" high	--	--	113.0	586.0	933.0
	--	--	6.5%	26.8%	33.9%
2.5"	--	--	120.0	480.0	1,060.0
	--	--	6.9%	21.9%	38.5%
	1,023.4	1,340.2	1,730.0	2,190.0	2,750.0

One result of these product mix changes will be lower average prices, given the constant progression to smaller drives and higher shipment levels. With the movement to 2.5" drives for desktop personal computers noted in other product sections, 300-500 megabyte drives are expected to

be affected also, with the first 2.5" models expected next year. By 1994 2.5" drives are expected to share the shipment lead in this product group with 1" high 3.5" drives.

IBM had production problems with the 3.5" Lightning series in 1990 which held its planned shipment level to an estimated 240,000 drives, but IBM's 3.5" shipments in this group are expected to reach 450,000 in 1991. That is expected to be the peak, however, as IBM transitions to the 1 gigabyte "Corsair" 3.5" drive for a large share of its AS/400 and RS/6000 requirements.

Technical trends

Packaging for smaller form factors and refinements in performance will continue to receive priority in development activities for this product group. The only product development activities now under way are devoted to 3.5" and smaller drives.

Only two companies, Seagate and Micropolis, produce 5.25" half high 380 megabyte drives, using the same areal density now being employed with 770 megabyte 5.25" drives. The significant costs for tooling and the declining 5.25" market will limit participation in the half high field to firms which already have products.

Most drive manufacturers intending to participate in the 3.5" market for 300-500 megabyte drives have diverted earlier projects at the 320 megabyte level to the 425 megabyte range, and the first 1" high drives in the group have been announced. The first 2.5" drives, using more than the two disks to which lower capacity 2.5" drives have been limited, are expected in 1992.

The demand for more capacity in small spaces will continue. Expect to see extensive use of MIG and thin film heads, sputtered disks using thinner substrates, advanced encoding methods, intelligent interfaces, and extensive use of VLSI in drive electronics. IBM's Lightning drive was a pathfinder for the industry in disk substrate thickness and in drive packaging. It was an impressive usage of 8 disks in the standard 41.3 millimeter height for 3.5" drives, a design made possible by reducing the normal 50 mil disk substrate thickness to only 31.5 mils, which is now a de facto standard. Today, of course, most other firms are using fewer disks for drives in the 300-500 megabyte range.

In 1987, limited availability of thin film heads for 5.25" drives in this group caused severe problems for several companies, and head vendors sharply expanded production capacity. That shortage also inspired most drive manufacturers to substitute MIG heads in many drive designs as a competitive alternative. In 1990-91, however, extremely rapid shipment growth and the continuing movement to higher areal densities have again made availability of high performance heads a key issue for those drive manufacturers on a fast growth curve. Manufacturers of both thin film and MIG heads have installed additional production capacity and improved yields in existing facilities.

Forecasting assumptions

1. Shipments of 8" drives will end in 1992 and shipments of 5.25" drives will end in 1993.
2. Sustained growth for technical workstations, LANs, office systems and specialized systems will create significant growth for both captive and noncaptive 3.5" drives.
3. First shipments of 2.5" drives in this capacity range will start in 1992.

TABLE 42

FIXED DISK DRIVES, 300 - 500 MEGABYTES

REVENUE SUMMARY

	DISK DRIVE REVENUES, BY SHIPMENT DESTINATION ($M)									
	1990 Revenues		Forecast 1991		1992		1993		1994	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM Captive	977.4	1,257.0	1,350.5	1,817.5	720.0	1,000.0	424.0	593.0	463.5	631.0
Other U.S. Captive	82.3	177.0	28.2	58.1	13.0	30.0	86.2	179.6	137.0	289.1
TOTAL U.S. CAPTIVE	1,059.7	1,434.0	1,378.7	1,875.6	733.0	1,030.0	510.2	772.6	600.5	920.1
PCM/Reseller	89.3	110.9	145.5	197.4	147.0	199.8	146.5	206.2	138.1	204.3
OEM/Integrator	367.8	478.3	301.5	398.8	509.7	651.4	544.4	722.7	505.8	709.3
TOTAL U.S. NON-CAPTIVE	457.1	589.2	447.0	596.2	656.7	851.2	690.9	928.9	643.9	913.6
TOTAL U.S. REVENUES	1,516.8	2,023.2	1,825.7	2,471.8	1,389.7	1,881.2	1,201.1	1,701.5	1,244.4	1,833.7
Non-U.S. Manufacturers										
Captive	34.2	402.0	17.9	187.2	26.4	235.6	32.8	258.8	60.0	327.4
PCM/Reseller	--	.5	--	.4	2.3	10.4	7.4	25.4	10.5	38.6
OEM/Integrator	30.2	119.1	50.1	145.5	66.9	163.9	101.8	226.6	124.8	274.1
TOTAL NON-U.S. REVENUES	64.4	521.6	68.0	333.1	95.6	409.9	142.0	510.8	195.3	640.1
Worldwide Recap										
TOTAL WORLDWIDE REVENUES	1,581.2	2,544.8	1,893.7	2,804.9	1,485.3	2,291.1	1,343.1	2,212.3	1,439.7	2,473.8
OEM Average Price ($000)		1.114		.880		.711		.619		.526

TABLE 43

FIXED DISK DRIVES, 300 - 500 MEGABYTES

UNIT SHIPMENT SUMMARY

	DISK DRIVE UNIT SHIPMENTS, BY SHIPMENT DESTINATION (000)									
	1990		Forecast							
	Shipments		1991		1992		1993		1994	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM Captive	227.6	289.0	338.0	455.0	180.0	250.0	130.0	180.0	170.0	230.0
Other U.S. Captive	15.2	34.6	5.6	11.7	3.0	7.0	27.0	56.0	49.0	103.0
TOTAL U.S. CAPTIVE	242.8	323.6	343.6	466.7	183.0	257.0	157.0	236.0	219.0	333.0
PCM/Reseller	87.0	107.4	165.8	224.5	193.0	262.0	220.0	309.0	246.0	363.0
OEM/Integrator	351.7	459.2	360.7	474.2	735.0	938.0	905.0	1,201.0	990.0	1,388.0
TOTAL U.S. NON-CAPTIVE	438.7	566.6	526.5	698.7	928.0	1,200.0	1,125.0	1,510.0	1,236.0	1,751.0
TOTAL U.S. SHIPMENTS	681.5	890.2	870.1	1,165.4	1,111.0	1,457.0	1,282.0	1,746.0	1,455.0	2,084.0
Non-U.S. Manufacturers										
Captive	5.3	56.1	3.1	30.3	6.0	51.0	10.0	75.0	22.0	118.0
PCM/Reseller	--	.1	--	.1	3.0	13.2	11.0	37.1	18.0	66.0
OEM/Integrator	20.4	77.0	57.2	144.4	89.0	208.8	149.0	331.9	212.0	482.0
TOTAL NON-U.S. SHIPMENTS	25.7	133.2	60.3	174.8	98.0	273.0	170.0	444.0	252.0	666.0
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	707.2	1,023.4	930.4	1,340.2	1,209.0	1,730.0	1,452.0	2,190.0	1,707.0	2,750.0
Total Capacity (Terabytes)	272.3	394.3	401.6	572.6	545.9	775.4	694.9	1,043.0	834.3	1,342.1
Cumulative Shipments (Units in thousands)										
IBM	541.6	753.8	879.6	1,208.8	1,059.6	1,458.8	1,189.6	1,638.8	1,359.6	1,868.8
Non-IBM	1,714.8	2,656.6	2,307.2	3,541.8	3,336.2	5,021.8	4,658.2	7,031.8	6,195.2	9,551.8
WORLDWIDE TOTAL	2,256.4	3,410.4	3,186.8	4,750.6	4,395.8	6,480.6	5,847.8	8,670.6	7,554.8	11,420.6

TABLE 44

FIXED DISK DRIVES, 300 - 500 MEGABYTES

WORLDWIDE REVENUES ($M)

BREAKDOWN BY DISK DIAMETER

	1990 Revenues				Forecast											
	1991				1992				1993			1994	
	14"	8"	5.25"	3.5"	14"	8"	5.25"	3.5"	8"	5.25"	3.5"	2.5"	5.25"	3.5"	2.5"	3.5"	2.5"
U.S. MANUFACTURERS																	
IBM Captive	17.0	96.0	160.0	984.0	--	--	17.5	1,800.0	--	--	1,000.0	--	--	468.0	125.0	256.0	375.0
Other U.S. Captive	10.0	--	167.0	--	--	--	57.5	.6	--	10.0	20.0	--	--	129.6	50.0	185.6	103.5
PCM/Reseller	--	--	95.3	15.6	--	--	98.3	99.1	--	48.2	151.6	--	18.0	173.2	15.0	166.8	37.5
OEM/Integrator	--	37.5	434.4	6.4	--	3.0	249.4	146.4	--	96.5	494.9	60.0	25.6	545.8	151.3	467.0	242.3
TOTAL U.S. REVENUES	27.0	133.5	856.7	1,006.0	--	3.0	422.7	2,046.1	--	154.7	1,666.5	60.0	43.6	1,316.6	341.3	1,075.4	758.3
NON-U.S. MANUFACTURERS																	
Captive	18.0	86.2	297.8	--	10.0	26.9	147.6	2.7	14.0	93.6	128.0	--	35.0	181.8	42.0	202.4	125.0
PCM/Reseller	--	--	.5	--	--	--	.4	--	--	.6	9.8	--	.3	22.1	3.0	29.6	9.0
OEM/Integrator	16.1	23.5	78.7	.8	5.1	8.8	64.0	67.6	3.5	38.5	108.8	13.1	16.1	156.5	54.0	168.1	106.0
TOTAL NON-U.S. REVENUES	34.1	109.7	377.0	.8	15.1	35.7	212.0	70.3	17.5	132.7	246.6	13.1	51.4	360.4	99.0	400.1	240.0
WORLDWIDE RECAP																	
Captive	45.0	182.2	624.8	984.0	10.0	26.9	222.6	1,803.3	14.0	103.6	1,148.0	--	35.0	779.4	217.0	644.0	603.5
	-36.0%	-56.7%	-31.5%	--	-77.8%	-85.2%	-64.4%	+83.3%	-48.0%	-53.5%	-36.3%	--	-66.2%	-32.1%	--	-17.4%	+178.1%
PCM/Reseller	--	--	95.8	15.6	--	--	98.7	99.1	--	48.8	161.4	--	18.3	195.3	18.0	196.4	46.5
	--	-100.0%	-31.9%	+62.5%	--	--	+3.0%	+535.3%	--	-50.6%	+62.9%	--	-62.5%	+21.0%	--	+.6%	+158.3%
OEM/Integrator	16.1	61.0	513.1	7.2	5.1	11.8	313.4	214.0	3.5	135.0	603.7	73.1	41.7	702.3	205.3	635.1	348.3
	-66.2%	-47.5%	-11.2%	--	-68.3%	-80.7%	-38.9%	--	-70.3%	-56.9%	+182.1%	--	-69.1%	+16.3%	+180.8%	-9.6%	+69.7%
Total Revenues	61.1	243.2	1,233.7	1,006.8	15.1	38.7	634.7	2,116.4	17.5	287.4	1,913.1	73.1	95.0	1,677.0	440.3	1,475.5	998.3
	-48.2%	-54.9%	-24.3%	--	-75.3%	-84.1%	-48.6%	+110.2%	-54.8%	-54.7%	-9.6%	--	-66.9%	-12.3%	+502.3%	-12.0%	+126.7%
ANNUAL SHARE, BY DIAMETER	2.4%	9.6%	48.6%	39.4%	.5%	1.4%	22.7%	75.4%	.8%	12.5%	83.6%	3.1%	4.3%	75.9%	19.8%	59.7%	40.3%

Note: Note: 14 inch totals include 10.5 inch drives.
8 inch totals include 9 inch drives.

TABLE 45

FIXED DISK DRIVES, 300 - 500 MEGABYTES

WORLDWIDE SHIPMENTS (000)

BREAKDOWN BY DISK DIAMETER

	1990 Shipments				Forecast												
					1991				1992				1993			1994	
	14"	8"	5.25"	3.5"	14"	8"	5.25"	3.5"	8"	5.25"	3.5"	2.5"	5.25"	3.5"	2.5"	3.5"	2.5"
U.S. MANUFACTURERS																	
IBM Captive	1.0	8.0	40.0	240.0	--	--	5.0	450.0	--	--	250.0	--	--	130.0	50.0	80.0	150.0
Other U.S. Captive	.4	--	34.2	--	--	--	11.5	.2	--	2.0	5.0	--	--	36.0	20.0	58.0	45.0
PCM/Reseller	--	--	93.2	14.2	--	--	106.2	118.3	--	58.0	204.0	--	24.0	260.0	25.0	288.0	75.0
OEM/Integrator	--	13.6	438.9	6.7	--	1.2	282.0	191.0	--	125.0	713.0	100.0	37.0	889.0	275.0	878.0	510.0
TOTAL U.S. SHIPMENTS	1.4	21.6	606.3	260.9	--	1.2	404.7	759.5	--	185.0	1,172.0	100.0	61.0	1,315.0	370.0	1,304.0	780.0
NON-U.S. MANUFACTURERS																	
Captive	.9	5.5	49.7	--	.5	1.8	27.1	.9	1.0	18.0	32.0	--	7.0	53.0	15.0	68.0	50.0
PCM/Reseller	--	--	.1	--	--	--	.1	--	--	.2	13.0	--	.1	32.0	5.0	48.0	18.0
OEM/Integrator	2.2	7.6	66.2	1.0	.7	2.5	59.8	81.4	1.0	42.8	145.0	20.0	16.9	225.0	90.0	270.0	212.0
TOTAL NON-U.S. SHIPMENTS	3.1	13.1	116.0	1.0	1.2	4.3	87.0	82.3	2.0	61.0	190.0	20.0	24.0	310.0	110.0	386.0	280.0
WORLDWIDE RECAP																	
Captive	2.3	13.5	123.9	240.0	.5	1.8	43.6	451.1	1.0	20.0	287.0	--	7.0	219.0	85.0	206.0	245.0
	-39.5%	-53.1%	-25.5%	--	-78.3%	-86.7%	-64.8%	+88.0%	-44.4%	-54.1%	-36.4%	--	-65.0%	-23.7%	--	-5.9%	+188.2%
PCM/Reseller	--	--	93.3	14.2	--	--	106.3	118.3	--	58.2	217.0	--	24.1	292.0	30.0	336.0	93.0
	--	-100.0%	-20.2%	+77.5%	--	--	+13.9%	+733.1%	--	-45.2%	+83.4%	--	-58.6%	+34.6%	--	+15.1%	+210.0%
OEM/Integrator	2.2	21.2	505.1	7.7	.7	3.7	341.8	272.4	1.0	167.8	858.0	120.0	53.9	1,114.0	365.0	1,148.0	722.0
	-64.5%	-45.6%	+6.8%	--	-68.2%	-82.5%	-32.3%	--	-73.0%	-50.9%	+215.0%	--	-67.9%	+29.8%	+204.2%	+3.1%	+97.8%
Total Shipments	4.5	34.7	722.3	261.9	1.2	5.5	491.7	841.8	2.0	246.0	1,362.0	120.0	85.0	1,625.0	480.0	1,690.0	1,060.0
	-55.0%	-49.2%	-4.5%	--	-73.3%	-84.1%	-31.9%	+221.4%	-63.6%	-50.0%	+61.8%	--	-65.4%	+19.3%	+300.0%	+4.0%	+120.8%
ANNUAL SHARE, BY DIAMETER	.4%	3.4%	70.7%	25.5%	.1%	.4%	36.8%	62.7%	.1%	14.2%	78.8%	6.9%	3.9%	74.3%	21.8%	61.6%	38.4%
TOTAL CAPACITY (Terabytes)	1.9	13.7	278.4	100.4	.5	2.1	190.2	379.7	.9	96.2	630.4	48.0	33.4	795.6	213.9	831.1	511.1

Note: Note: 14 inch totals include 10.5 inch drives.
8 inch totals include 9 inch drives.

TABLE 46

FIXED DISK DRIVES, 300 - 500 MEGABYTES

APPLICATIONS SUMMARY
Percentage of Worldwide Shipments

APPLICATION	1990 Estimate Units (000)	1990 Estimate %	1994 Projection Units (000)	1994 Projection %
MAINFRAME/SUPERMINI General purpose	21.7	2.1	27.5	1.0
MINICOMPUTERS AND MULTI-USER MICROS Business and professional, including networks	362.5	35.4	1,155.0	42.0
PERSONAL COMPUTERS Business and professional, single user	282.4	27.7	932.3	33.9
OFFICE SYSTEMS AND WORKSTATIONS Dedicated application	156.0	15.2	82.5	3.0
NON-OFFICE SYSTEMS AND WORKSTATIONS Technical, distribution, medical, other specialized	192.4	18.8	522.5	19.0
CONSUMER AND HOBBY COMPUTERS	7.4	.7	27.5	1.0
OTHER APPLICATIONS	1.0	.1	2.7	.1
Total	1,023.4	100.0	2,750.0	100.0

TABLE 47

FIXED DISK DRIVES, 300 - 500 MEGABYTES

MARKET SHARE SUMMARY
Worldwide Shipments of Non-Captive Disk Drives

	1990 Net Shipments											
	To United States Destinations						Worldwide					
	Units (000)					%	Units (000)					%
Drive Manufacturers	14"	8"	5.25"	3.5"	Total		14"	8"	5.25"	3.5"	Total	
Seagate Technology	--	9.0	155.0	3.0	167.0	36.4	--	12.0	224.0	5.0	241.0	37.4
Micropolis	--	--	139.0	--	139.0	30.3	--	--	147.1	--	147.1	22.9
Maxtor	--	--	104.2	1.6	105.8	23.0	--	--	140.6	1.9	142.5	22.1
Fujitsu	--	3.1	6.0	--	9.1	2.0	.5	7.3	29.0	1.0	37.8	5.9
Other U.S.	--	.3	14.6	12.0	26.9	5.9	--	1.6	20.4	14.0	36.0	5.6
Other Non-U.S.	--	.3	11.0	--	11.3	2.4	1.7	.3	37.3	--	39.3	6.1
TOTAL	--	12.7	429.8	16.6	459.1	100.0	2.2	21.2	598.4	21.9	643.7	100.0

Note: 14 inch totals include 10.5 inch drives.
8 inch totals include 9 inch drives.

FIXED DISK DRIVES, 500 MEGABYTES-1 GIGABYTE

1991 DISK/TREND REPORT

FIXED DISK DRIVES, 500 MEGABYTES TO 1 GIGABYTE

Coverage

Examples of disk drives in this group include:

14" disk diameter

Alpha Data	Atlas 520
DZU	EC 5065
Hitachi	DKU-97S, DKU-85I-D14

10.5" disk diameter

Fujitsu	F6425G, M2361A

9-9.5" disk diameter

Elebra	W950
Hitachi	DK815-5, DKU-86I
Mitsubishi Electric	E1880B
NEC	D2366, N7757
Seagate Technology	ST6515

8" disk diameter

Fujitsu	M2344K/KS
Hewlett-Packard	7937S
IBM	9332-600
Seagate Technology	ST8851
Toshiba	MK-288FC

5.25" disk diameter

Digital Equipment	RF31
Edisa	ED 71793
Fujitsu	M2263E
Hewlett-Packard	97548P
Hitachi	DK711S-60D, DK515-78
IBM	0681-500, 9336-10
Magtron	MT5760E/S
Maxtor	XT-8760E/S
Micropolis	1568-15, 1624*
Microscience International	FH-2777
NEC	D5682
Orca Technology	OT506S
Seagate Technology	ST2502N*, ST4766N
Toshiba	MK-358FA

3.5" disk diameter

Conner Peripherals	CP-3540*
Fujitsu	M2624S*
Maxtor	LXT-535*
Seagate Technology	ST3600A/N**

*Indicates drives with maximum 41.3 mm height, or less.
**Indicates drives with maximum 25.4 mm height, or less.

Until recent years, disk drives in this group consisted mostly of PCM, IBM and other captive floor-standing 14" drives intended for use with mainframe systems.

Control Data's 9" FSD was the pioneer product among drives with disk diameters less than 10.5", but in the mid-1980s several 8" drives with capacities above 500 megabytes entered the market.

Maxtor's introduction of a 768 megabyte 5.25" drive precipitated a flurry of announcements from many of the same companies already competing for the 380 megabyte 5.25" market. Micropolis has announced a half high 5.25" drive with 668 megabytes capacity for delivery in 1991.

Maxtor was also the first company to announce a 3.5" drive in this product group, in 1990, but was quickly followed by several major competitors. Seagate has announced that it will ship a 1" high 3.5 drive with 525 megabytes capacity in early 1992.

Market status

DISK/TREND estimate of total market size:

Worldwide sales ($M)	1990	1991	1992	1993	1994
U.S. manufacturers	1,681.4	1,016.0	653.4	671.1	678.9
All manufacturers	2,671.9	1,961.5	1,405.0	1,269.8	1,170.4

As the pace of the movement to smaller disk diameters and higher capacities picks up speed, it is affecting this product group deeply. Total revenues declined slightly in 1990 and the estimated 1991 revenue total of $1.9 billion for 1991 represents another drop of 26.6%. In contrast, 1990 unit shipments were up 73.4% and the 1991 estimated total of 661,400 drives is a further increase of 10.7%.

Product mix changes have caused the current decline in total revenues. 14" drives have declined to insignificant levels and 8" drives are dropping quickly in all distribution channels. 5.25" drives are also topping out in the 1990-91 period, and intense price competition in noncaptive markets is severely depressing revenues. Overall average unit prices for OEM drives, mostly 5.25" models, are dropping an estimated 27.3% in 1991.

Mainframe and supermini applications dropped to 22.3% of unit shipments in 1990, headed down to an estimated 6% in 1994. Minicomputers and multiuser microcomputers, including file server applications, had become the leading applications by 1990 with 37.3% of shipments, and are projected to climb to 66% in 1994.

Seagate continued to hold the lead in noncaptive shipments with 149,000 drives, mostly 5.25" models, for 32.8% of the worldwide total. Maxtor held a 25.5% share, the same as last year, by leading in the 760 megabyte 5.25" market, and Micropolis increased its position to third place with 15.1%.

Marketing trends

Total shipments for this product group are expected to continually increase during the 1992-94 period, up an average of 18.4% per year,

reaching a worldwide total of 1,095,000 drives in 1994. Unfortunately, total revenues are expected to continue to drop, with a projected average decline of 15.2% per year through 1994.

As with other DISK/TREND product groups, the relentless shift to smaller disk diameters, combined with continually higher production levels, has meant lower prices. The overall average price for OEM drives, will continue down -- from $1,213 in 1991 to an estimated $686 in 1994, as the product mix continues to evolve:

Worldwide total Unit shipments (000)	1990	1991	1992	1993	1994
14"	14.0	6.9	3.0	--	--
	2.3%	1.0%	.4%	--	--
8"	125.1	63.3	14.0	4.0	--
	20.9%	9.6%	1.7%	.4%	--
5.25" full size	436.9	399.2	231.0	121.0	38.0
	73.1%	60.4%	28.3%	12.6%	3.5%
5.25" half high	15.0	49.0	73.0	72.0	35.0
	2.5%	7.4%	8.9%	7.5%	3.2%
3.5" 1.625" high	6.7	143.0	457.0	652.0	771.0
	1.1%	21.6%	56.0%	67.9%	70.4%
3.5" 1" high	--	--	38.0	111.0	211.0
	--	--	4.7%	11.6%	19.3%
2.5"	--	--	--	--	40.0
	--	--	--	--	3.7%
	597.7	661.4	816.0	960.0	1,095.0

Although shipments of half high 5.25" drives are expected to start in 1992, and 2.5" models are projected for 1994, much of the potential growth once considered likely for this product group will probably be diverted to drives with high capacities. The rapid buildup of shipments for 5.25" drives with over 1 gigabyte capacity during the last year is expected to

be matched by steeply rising shipments of 3.5" drives over 1 gigabyte, as ready availability of drives over 1 gigabyte persuades many system manufacturers to skip over the 500 megabyte - 1 gigabyte range.

Technical trends

It is believed that the technical developments in this product group during the next few years will consist primarily of performance refinements and capacity improvements to drives already introduced. The basic problem in reducing the physical size of high capacity drives, notably to the 3.5" form factor, has already been accomplished by several drive manufacturers -- with more VLSI, thinner disks, higher density heads and more advanced motors.

The next steps for small drives in this group are expected to be mostly evolutionary. Average head positioning times of 11-14 milliseconds for 3.5" drives in this group will be improved even further. And motor speed for 3.5" drives, now in the 4,400-4,500 RPM range for the newer drives, will go substantially higher.

Forecasting assumptions

1. IBM will stop production of 8" drives in this product group in 1991, and will not introduce 3.5" drives.
2. Shipments of 3.5" drives by other noncaptive and captive drive manufacturers will continue to increase through 1994.
3. First shipments of 2.5" drives in this product group will commence in 1994.

TABLE 48

FIXED DISK DRIVES, 500 MEGABYTES TO 1 GIGABYTE

REVENUE SUMMARY

	DISK DRIVE REVENUES, BY SHIPMENT DESTINATION ($M)									
	1990		Forecast							
	Revenues		1991		1992		1993		1994	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM Captive	375.0	675.0	156.0	300.0	--	--	--	--	--	--
Other U.S. Captive	206.2	488.6	143.6	304.6	113.2	246.9	116.4	249.6	111.0	244.0
TOTAL U.S. CAPTIVE	581.2	1,163.6	299.6	604.6	113.2	246.9	116.4	249.6	111.0	244.0
PCM/Reseller	54.8	68.8	67.6	105.1	45.7	61.5	50.0	66.3	40.0	55.0
OEM/Integrator	381.9	449.0	238.4	306.3	265.8	345.0	264.9	355.2	261.3	379.9
TOTAL U.S. NON-CAPTIVE	436.7	517.8	306.0	411.4	311.5	406.5	314.9	421.5	301.3	434.9
TOTAL U.S. REVENUES	1,017.9	1,681.4	605.6	1,016.0	424.7	653.4	431.3	671.1	412.3	678.9
Non-U.S. Manufacturers										
Captive	3.2	764.3	26.6	707.3	36.8	514.2	41.0	362.7	33.4	267.6
PCM/Reseller	2.6	4.4	--	--	3.6	12.6	5.1	17.9	6.4	21.6
OEM/Integrator	83.0	221.8	70.9	238.2	62.4	224.8	62.6	218.1	59.1	202.3
TOTAL NON-U.S. REVENUES	88.8	990.5	97.5	945.5	102.8	751.6	108.7	598.7	98.9	491.5
Worldwide Recap										
TOTAL WORLDWIDE REVENUES	1,106.7	2,671.9	703.1	1,961.5	527.5	1,405.0	540.0	1,269.8	511.2	1,170.4
OEM Average Price ($000)		1.669		1.213		.909		.781		.686

TABLE 49

FIXED DISK DRIVES, 500 MEGABYTES TO 1 GIGABYTE

UNIT SHIPMENT SUMMARY

	DISK DRIVE UNIT SHIPMENTS, BY SHIPMENT DESTINATION (000)									
	1990 Shipments		Forecast							
	1991		1992		1993		1994			
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM Captive	25.0	45.0	13.0	25.0	--	--	--	--	--	--
Other U.S. Captive	22.0	54.1	24.1	51.1	25.0	54.0	29.0	62.0	33.0	72.0
TOTAL U.S. CAPTIVE	47.0	99.1	37.1	76.1	25.0	54.0	29.0	62.0	33.0	72.0
PCM/Reseller	40.8	50.7	59.3	91.2	46.0	61.0	60.0	79.0	57.0	78.0
OEM/Integrator	259.1	302.6	203.7	262.0	297.0	382.0	347.0	463.0	394.0	568.0
TOTAL U.S. NON-CAPTIVE	299.9	353.3	263.0	353.2	343.0	443.0	407.0	542.0	451.0	646.0
TOTAL U.S. SHIPMENTS	346.9	452.4	300.1	429.3	368.0	497.0	436.0	604.0	484.0	718.0
Non-U.S. Manufacturers										
Captive	.2	43.8	2.1	45.2	5.0	60.0	7.0	64.0	8.0	69.0
PCM/Reseller	1.2	2.2	--	--	4.0	14.0	6.0	21.0	8.0	27.0
OEM/Integrator	40.9	99.3	53.1	186.9	68.0	245.0	77.0	271.0	81.0	281.0
TOTAL NON-U.S. SHIPMENTS	42.3	145.3	55.2	232.1	77.0	319.0	90.0	356.0	97.0	377.0
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	389.2	597.7	355.3	661.4	445.0	816.0	526.0	960.0	581.0	1,095.0
Total Capacity (Terabytes)	287.4	435.8	256.2	470.9	301.7	552.4	391.2	715.7	475.8	906.8
Cumulative Shipments (Units in thousands)										
IBM	188.6	376.2	201.6	401.2	201.6	401.2	201.6	401.2	201.6	401.2
Non-IBM	917.1	1,535.0	1,259.4	2,171.4	1,704.4	2,987.4	2,230.4	3,947.4	2,811.4	5,042.4
WORLDWIDE TOTAL	1,105.7	1,911.2	1,461.0	2,572.6	1,906.0	3,388.6	2,432.0	4,348.6	3,013.0	5,443.6

TABLE 50

FIXED DISK DRIVES, 500 MEGABYTES TO 1 GIGABYTE

WORLDWIDE REVENUES ($M)

BREAKDOWN BY DISK DIAMETER

	1990 Revenues				Forecast													
	1991				1992				1993			1994		
	14"	8"	5.25"	3.5"	14"	8"	5.25"	3.5"	14"	8"	5.25"	3.5"	8"	5.25"	3.5"	5.25"	3.5"	2.5"
U.S. MANUFACTURERS																		
IBM Captive	--	675.0	--	--	--	300.0	--	--	--	--	--	--	--	--	--	--	--	--
Other U.S. Captive	65.1	130.3	293.2	--	1.6	--	303.0	--	--	--	192.5	54.4	--	140.8	108.8	70.0	174.0	--
PCM/Reseller	--	--	68.8	--	--	--	103.0	2.1	--	--	53.1	8.4	--	33.9	32.4	5.6	49.4	--
OEM/Integrator	--	71.4	372.1	5.5	--	28.0	245.1	33.2	--	10.8	152.7	181.5	--	79.5	275.7	26.9	330.0	23.0
TOTAL U.S. REVENUES	65.1	876.7	734.1	5.5	1.6	328.0	651.1	35.3	--	10.8	398.3	244.3	--	254.2	416.9	102.5	553.4	23.0
NON-U.S. MANUFACTURERS																		
Captive	181.0	367.3	216.0	--	130.0	241.4	335.9	--	60.0	105.0	234.0	115.2	43.5	156.0	163.2	66.0	201.6	--
PCM/Reseller	--	.8	3.6	--	--	--	--	--	--	--	--	12.6	--	--	17.9	--	21.6	--
OEM/Integrator	9.2	105.6	105.0	2.0	.2	52.1	85.2	100.7	--	12.0	57.6	155.2	4.0	33.3	180.8	15.4	186.9	--
TOTAL NON-U.S. REVENUES	190.2	473.7	324.6	2.0	130.2	293.5	421.1	100.7	60.0	117.0	291.6	283.0	47.5	189.3	361.9	81.4	410.1	--
WORLDWIDE RECAP																		
Captive	246.1	1,172.6	509.2	--	131.6	541.4	638.9	--	60.0	105.0	426.5	169.6	43.5	296.8	272.0	136.0	375.6	--
	-53.5%	-27.0%	--	--	-46.5%	-53.8%	+25.5%	--	-54.4%	-80.6%	-33.2%	--	-58.6%	-30.4%	+60.4%	-54.2%	+38.1%	--
PCM/Reseller	--	.8	72.4	--	--	--	103.0	2.1	--	--	53.1	21.0	--	33.9	50.3	5.6	71.0	--
	--	-73.3%	+80.1%	--	--	-100.0%	+42.3%	--	--	--	-48.4%	+900.0%	--	-36.2%	+139.5%	-83.5%	+41.2%	--
OEM/Integrator	9.2	177.0	477.1	7.5	.2	80.1	330.3	133.9	--	22.8	210.3	336.7	4.0	112.8	456.5	42.3	516.9	23.0
	-71.8%	-34.2%	+125.8%	--	-97.8%	-54.7%	-30.8%	--	-100.0%	-71.5%	-36.3%	+151.5%	-82.5%	-46.4%	+35.6%	-62.5%	+13.2%	--
Total Revenues	255.3	1,350.4	1,058.7	7.5	131.8	621.5	1,072.2	136.0	60.0	127.8	689.9	527.3	47.5	443.5	778.8	183.9	963.5	23.0
	-54.5%	-28.1%	+312.1%	--	-48.4%	-54.0%	+1.3%	--	-54.5%	-79.4%	-35.7%	+287.7%	-62.8%	-35.7%	+47.7%	-58.5%	+23.7%	--
ANNUAL SHARE, BY DIAMETER	9.6%	50.6%	39.6%	.2%	6.7%	31.8%	54.7%	6.8%	4.3%	9.1%	49.2%	37.4%	3.7%	35.0%	61.3%	15.7%	82.4%	1.9%

Note: Note: 14 inch totals include 10.5 inch drives.
8 inch totals include 9 inch drives.

TABLE 51

FIXED DISK DRIVES, 500 MEGABYTES TO 1 GIGABYTE

WORLDWIDE SHIPMENTS (000)

BREAKDOWN BY DISK DIAMETER

	1990 Shipments				Forecast													
	1991				1992				1993			1994		
	14"	8"	5.25"	3.5"	14"	8"	5.25"	3.5"	14"	8"	5.25"	3.5"	8"	5.25"	3.5"	5.25"	3.5"	2.5"
U.S. MANUFACTURERS																		
IBM Captive	--	45.0	--	--	--	25.0	--	--	--	--	--	--	--	--	--	--	--	--
Other U.S. Captive	4.2	10.7	39.2	--	.1	--	51.0	--	--	--	38.0	16.0	--	28.0	34.0	14.0	58.0	--
PCM/Reseller	--	--	50.7	--	--	--	89.2	2.0	--	--	51.0	10.0	--	37.0	42.0	7.0	71.0	--
OEM/Integrator	--	21.3	276.3	5.0	--	10.0	217.0	35.0	--	4.0	149.0	229.0	--	86.0	377.0	32.0	496.0	40.0
TOTAL U.S. SHIPMENTS	4.2	77.0	366.2	5.0	.1	35.0	357.2	37.0	--	4.0	238.0	255.0	--	151.0	453.0	53.0	625.0	40.0
NON-U.S. MANUFACTURERS																		
Captive	9.0	21.3	13.5	--	6.5	14.9	23.8	--	3.0	7.0	18.0	32.0	3.0	13.0	48.0	6.0	63.0	--
PCM/Reseller	--	.2	2.0	--	--	--	--	--	--	--	--	14.0	--	--	21.0	--	27.0	--
OEM/Integrator	.8	26.6	70.2	1.7	.3	13.4	67.2	106.0	--	3.0	48.0	194.0	1.0	29.0	241.0	14.0	267.0	--
TOTAL NON-U.S. SHIPMENTS	9.8	48.1	85.7	1.7	6.8	28.3	91.0	106.0	3.0	10.0	66.0	240.0	4.0	42.0	310.0	20.0	357.0	--
WORLDWIDE RECAP																		
Captive	13.2	77.0	52.7	--	6.6	39.9	74.8	--	3.0	7.0	56.0	48.0	3.0	41.0	82.0	20.0	121.0	--
	-56.9%	-20.0%	--	--	-50.0%	-48.2%	+41.9%	--	-54.5%	-82.5%	-25.1%	--	-57.1%	-26.8%	+70.8%	-51.2%	+47.6%	--
PCM/Reseller	--	.2	52.7	--	--	--	89.2	2.0	--	--	51.0	24.0	--	37.0	63.0	7.0	98.0	--
	--	-75.0%	+192.8%	--	--	-100.0%	+69.3%	--	--	--	-42.8%	--	--	-27.5%	+162.5%	-81.1%	+55.6%	--
OEM/Integrator	.8	47.9	346.5	6.7	.3	23.4	284.2	141.0	--	7.0	197.0	423.0	1.0	115.0	618.0	46.0	763.0	40.0
	-50.0%	-34.4%	+179.2%	--	-62.5%	-51.1%	-18.0%	--	-100.0%	-70.1%	-30.7%	+200.0%	-85.7%	-41.6%	+46.1%	-60.0%	+23.5%	--
Total Shipments	14.0	125.1	451.9	6.7	6.9	63.3	448.2	143.0	3.0	14.0	304.0	495.0	4.0	193.0	763.0	73.0	982.0	40.0
	-56.5%	-26.5%	+217.3%	--	-50.7%	-49.4%	-.8%	--	-56.5%	-77.9%	-32.2%	+246.2%	-71.4%	-36.5%	+54.1%	-62.2%	+28.7%	--
ANNUAL SHARE, BY DIAMETER	2.3%	21.0%	75.6%	1.1%	1.0%	9.6%	67.9%	21.5%	.4%	1.7%	37.4%	60.5%	.4%	20.2%	79.4%	6.7%	89.8%	3.5%
TOTAL CAPACITY (Terabytes)	10.4	87.3	333.8	4.3	4.8	44.8	329.0	92.4	2.1	10.1	220.3	320.0	2.9	145.2	567.5	56.7	826.1	24.0

Note: Note: 14 inch totals include 10.5 inch drives.
8 inch totals include 9 inch drives.

TABLE 52

FIXED DISK DRIVES, 500 MEGABYTES TO 1 GIGABYTE

APPLICATIONS SUMMARY
Percentage of Worldwide Shipments

APPLICATION	1990 Estimate Units (000)	1990 Estimate %	1994 Projection Units (000)	1994 Projection %
MAINFRAME/SUPERMINI General purpose	133.3	22.3	65.7	6.0
MINICOMPUTERS AND MULTI-USER MICROS Business and professional, including networks	222.3	37.3	722.6	66.0
PERSONAL COMPUTERS Business and professional, single user	63.6	10.6	98.6	9.0
OFFICE SYSTEMS AND WORKSTATIONS Dedicated application	33.5	5.6	32.9	3.0
NON-OFFICE SYSTEMS AND WORKSTATIONS Technical, distribution, medical, other specialized	144.3	24.1	175.2	16.0
CONSUMER AND HOBBY COMPUTERS	--	--	--	--
OTHER APPLICATIONS	.7	.1	--	--
Total	597.7	100.0	1,095.0	100.0

TABLE 53

FIXED DISK DRIVES, 500 MEGABYTES TO 1 GIGABYTE

MARKET SHARE SUMMARY
Worldwide Shipments of Non-Captive Disk Drives

	1990 Net Shipments											
	To United States Destinations						Worldwide					
	Units (000)					%	Units (000)					%
Drive Manufacturers	14"	8"	5.25"	3.5"	Total		14"	8"	5.25"	3.5"	Total	
Seagate Technology	--	16.0	99.0	--	115.0	33.6	--	21.0	128.0	--	149.0	32.8
Maxtor	--	--	100.8	--	100.8	29.5	--	--	115.9	--	115.9	25.5
Micropolis	--	--	66.4	--	66.4	19.4	--	--	68.5	--	68.5	15.1
Fujitsu	--	2.2	17.0	--	19.2	5.6	.5	15.0	37.0	1.7	54.2	11.9
Other U.S.	--	.3	12.4	5.0	17.7	5.2	--	.3	14.6	5.0	19.9	4.3
Other Non-U.S.	--	7.2	15.7	--	22.9	6.7	.3	11.8	35.2	--	47.3	10.4
TOTAL	--	25.7	311.3	5.0	342.0	100.0	.8	48.1	399.2	6.7	454.8	100.0

Note: 14 inch totals include 10.5 inch drives.
8 inch totals include 9 inch drives.

FIXED DISK DRIVES, 1-2 GIGABYTES

1991 DISK/TREND REPORT

FIXED DISK DRIVES, 1 - 2 GIGABYTES

Coverage

Examples of disk drives in this group include:

14" disk diameter

Hitachi	DKU-85I, DKU-98I
IBM	3380-J, 9335

10.8" disk diameter

IBM	3390-1

10.5" disk diameter

Fujitsu	F6425M4, F6425H

9" disk diameter

Hitachi	DKU-86I

9" disk diameter

Digital Equipment	RA90, RA92
Hitachi	DK815-10
Mitsubishi Electric	E1880E
NEC	D2367, D2377

8" disk diameter

Fujitsu	M2391K
Seagate Technology	ST81236

5.25" disk diameter

Digital Equipment	RF72
Fujitsu	M2266
Hewlett-Packard	97560E/P
Hitachi	DK516C-16
IBM	0681-1000, 9336-20, 9345-1/2
Magtron	MT51200S
Maxtor	P0-12E, P1-17S
Micropolis	1518-15, 1528-15
Microscience International	FH-31200
NEC	D5892
Orca Technology	OT510S
Seagate Technology	ST41600N, ST41200N

3.5" disk diameter

Digital Equipment	DSP3080*
IBM	0663-11/12*
Micropolis	2112*
Seagate Technology	ST11200N*
Toshiba	MK-438FB*

*Indicates drives with maximum 41.3 mm height, or less

DISK/TREND Reports in recent years have grouped all drives with more than 1 gigabyte capacity in a single product group, but that group is being split this year at the 2 gigabyte level, in recognition of the diverging nature of the products and markets, both above and below that level.

There are still drives in this product group which are intended solely for mainframe computer applications, but they are now the minority. IBM's 3380 was the core of this product group during the first half of the 1980s. The original 3380 was first shipped in late 1981, after an extremely expensive (to IBM) delay of over a year from the announced delivery schedule. However, IBM increased the capacity to 2.5 gigabytes with mid-life enhancements to the 3380 family in 1985, and most of the mainframe drive activity moved up to higher capacities, leaving the 3390-1, first shipped in 1989, and newer 5.25" drives (9336 and 9345) as the remaining IBM mainframe drives in this product group.

As shipments of the older 10.5", 9.5", 9" and 8" drives for captive and non-captive markets fade, 5.25" drives currently available from 12 companies are the major products in the 1-2 gigabyte range. Joining them in late 1991 are 3.5" drives from 5 firms, with more expected in the near future. 3.5" drives are expected to provide a major challenge to 5.25" drives in this capacity range during the next three years.

Market status

DISK/TREND estimate of total market size:

Worldwide sales ($M)	1990	1991	1992	1993	1994
U.S. manufacturers	2,814.4	2,645.8	5,733.5	7,106.0	7,054.8
All manufacturers	4,014.7	4,163.6	7,039.5	8,179.6	7,957.7

The modest revenue increases for 1-2 gigabyte drives in 1990 and 1991 mask rapid growth in total unit shipments for the same period. As in the rest of the disk drive industry, older drives using large diameter disks are being replaced by newer small drives.

In this product group, unit shipments of 14" drives started to decline in 1990, and 8/9" drives joined them in 1991. Underlying these product mix changes is the availability of 5.25" drives in this capacity range from numerous vendors. After shipments of only a few 5.25" drives in 1989, 1990 saw worldwide shipments of 127,200 drives, and the 1991 total is expected to be up another 238.4%, at 430,400 units.

The movement to 5.25" drives has been driven by the usual reasons. The smaller drives require less power, generate less heat and noise, and most significantly, have much lower prices. The average price for all OEM drives in the 1-2 gigabyte range was already down to $3,654 in 1990 and in 1991 is estimated at $2,168. The net result is a 77% estimated increase in total unit shipments for the product group in 1991, compared with an increase in revenues of only 3.7%.

Mainframe and supermini applications used to provide the primary market for drives in this group, but these applications were down to only 37% of the unit shipment total for 1990, with a further decline to 21% forecasted for 1994. Minicomputers and multiuser micros, including file

servers, were the leading application in 1990 with 48% of unit shipments and are forecasted to climb to 61.9% in 1994.

Seagate's combination of 9", 8" and 5.25" drives, a total of 59,000 units in 1990, provided 43.2% of the worldwide non-captive total for that year. Fujitsu held second place with 23.3%, followed by NEC in third position with 12.4%.

Marketing trends

The 55.5% average annual growth in unit shipments of 1-2 gigabyte drives is expected to be higher than for any other DISK/TREND product group in the 1992-94 period. The existing momentum of 5.25" drive shipments, combined with immediate acceptance of the 3.5" drives now coming into the market, are projected to almost completely replace larger drives by 1994.

Worldwide total Unit shipments (000)	1990	1991	1992	1993	1994
14"	70.1	28.4	4.0	--	--
	21.7%	5.0%	.3%	--	--
8"	125.1	108.7	61.0	34.0	13.0
	38.8%	19.1%	5.1%	2.1%	.7%
5.25"	127.2	430.4	646.0	666.0	493.0
	39.5%	75.4%	54.5%	41.4%	25.0%
3.5"	--	3.0	475.0	910.0	1,469.0
	--	.5%	40.1%	56.5%	74.4%
	322.4	570.5	1,186.0	1,610.0	1,975.0

The 1-2 gigabyte group is the beneficiary of growing demand for more capacity in file server and other applications and the ready availability of 5.25" and 3.5" drives in this capacity range. As a result many system manufacturers are expected to skip over the 500 megabyte - 1 gigabyte

capacity range, as they move from 300-500 megabyte drives directly up to drives in the 1-2 gigabyte group.

Technical trends

Drive designers have been faced with all of the usual head, disk, actuator and electronics issues as they plan and design drives for this product group. It has been mostly a question of availability, in most cases. Will disks of proper coercivity and surface characteristics be available in the right quantities? Will 50% sliders be available or are 70% sliders the best choice? Are chips available for zoned recording, or digital signal processing, or for the higher transfer rates? In most cases, the answer has been yes.

For many drive manufacturers the myriad of details associated with packaging as many as eight or more disks in a small drive have been a formidable challenge. IBM helped by setting an industry standard for 31.5 mil disks with its Lightning series of 3.5" drives, and head suspensions have been modified for the narrow disk spacing required. The problems are difficult but they are being solved.

Forecasting assumptions

1. IBM will concentrate its 3.5" drive programs in this capacity range, passing up the 500 megabyte-1 gigabyte range.
2. Last production of 14" drives will be in 1992, and shipments of 8" drives will continue a rapid decline.
3. 3.5" drives will assume shipment leadership of this product group in 1993, with 1993 the peak year for shipments of 5.25" drives.

TABLE 54

FIXED DISK DRIVES, 1 - 2 GIGABYTES

REVENUE SUMMARY

	DISK DRIVE REVENUES, BY SHIPMENT DESTINATION ($M)									
	1990		Forecast							
	Revenues		1991		1992		1993		1994	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM Captive	1,079.0	1,759.5	901.4	1,379.0	3,099.8	4,213.5	4,023.9	5,627.0	3,861.0	5,606.0
Other U.S. Captive	488.6	834.6	444.5	823.0	426.4	872.0	348.0	735.2	305.7	651.3
TOTAL U.S. CAPTIVE	1,567.6	2,594.1	1,345.9	2,202.0	3,526.2	5,085.5	4,371.9	6,362.2	4,166.7	6,257.3
PCM/Reseller	22.5	22.5	65.6	82.9	135.4	172.2	197.6	256.1	178.9	239.0
OEM/Integrator	162.6	197.8	267.2	360.9	365.8	475.8	378.7	487.7	414.2	558.5
TOTAL U.S. NON-CAPTIVE	185.1	220.3	332.8	443.8	501.2	648.0	576.3	743.8	593.1	797.5
TOTAL U.S. REVENUES	1,752.7	2,814.4	1,678.7	2,645.8	4,027.4	5,733.5	4,948.2	7,106.0	4,759.8	7,054.8
Non-U.S. Manufacturers										
Captive	1.7	877.9	--	1,291.5	18.0	1,091.8	39.2	849.8	56.2	636.5
PCM/Reseller	15.5	66.4	3.2	9.0	7.2	14.4	26.4	47.2	36.6	60.9
OEM/Integrator	105.6	256.0	93.5	217.3	90.7	199.8	94.2	176.6	117.7	205.5
TOTAL NON-U.S. REVENUES	122.8	1,200.3	96.7	1,517.8	115.9	1,306.0	159.8	1,073.6	210.5	902.9
Worldwide Recap										
TOTAL WORLDWIDE REVENUES	1,875.5	4,014.7	1,775.4	4,163.6	4,143.3	7,039.5	5,108.0	8,179.6	4,970.3	7,957.7
OEM Average Price ($000)		3.654		2.168		1.488		1.151		.949

TABLE 55

FIXED DISK DRIVES, 1 - 2 GIGABYTES

UNIT SHIPMENT SUMMARY

	DISK DRIVE UNIT SHIPMENTS, BY SHIPMENT DESTINATION (000)									
	1990		Forecast							
	Shipments		1991		1992		1993		1994	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM Captive	71.5	111.0	90.6	135.0	314.0	425.0	423.0	590.0	450.0	650.0
Other U.S. Captive	21.6	37.6	33.5	64.0	49.0	101.0	54.0	115.0	60.0	130.0
TOTAL U.S. CAPTIVE	93.1	148.6	124.1	199.0	363.0	526.0	477.0	705.0	510.0	780.0
PCM/Reseller	8.6	8.6	34.8	43.6	93.0	118.0	158.0	204.0	173.0	231.0
OEM/Integrator	57.1	67.8	137.1	185.4	264.0	340.0	343.0	436.0	442.0	595.0
TOTAL U.S. NON-CAPTIVE	65.7	76.4	171.9	229.0	357.0	458.0	501.0	640.0	615.0	826.0
TOTAL U.S. SHIPMENTS	158.8	225.0	296.0	428.0	720.0	984.0	978.0	1,345.0	1,125.0	1,606.0
Non-U.S. Manufacturers										
Captive	.1	37.1	--	60.4	3.0	82.0	8.0	95.0	13.0	112.0
PCM/Reseller	.9	3.9	.3	.8	3.0	6.0	16.0	29.0	28.0	47.0
OEM/Integrator	27.3	56.4	38.5	81.3	58.0	114.0	80.0	141.0	124.0	210.0
TOTAL NON-U.S. SHIPMENTS	28.3	97.4	38.8	142.5	64.0	202.0	104.0	265.0	165.0	369.0
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	187.1	322.4	334.8	570.5	784.0	1,186.0	1,082.0	1,610.0	1,290.0	1,975.0
Total Capacity (Terabytes)	244.5	425.5	444.6	754.5	1,020.5	1,562.3	1,559.1	2,323.4	2,052.2	3,134.0
Cumulative Shipments (Units in thousands)										
IBM	279.4	479.3	370.0	614.3	684.0	1,039.3	1,107.0	1,629.3	1,557.0	2,279.3
Non-IBM	279.2	554.5	523.4	990.0	993.4	1,751.0	1,652.4	2,771.0	2,492.4	4,096.0
WORLDWIDE TOTAL	558.6	1,033.8	893.4	1,604.3	1,677.4	2,790.3	2,759.4	4,400.3	4,049.4	6,375.3

TABLE 56

FIXED DISK DRIVES, 1 - 2 GIGABYTES

WORLDWIDE REVENUES ($M)

BREAKDOWN BY DISK DIAMETER

	1990 Revenues			Forecast													
	1991				1992				1993			1994		
	14"	8"	5.25"	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	1,063.5	--	696.0	320.0	--	1,041.0	18.0	--	--	1,333.5	2,880.0	--	1,377.0	4,250.0	--	966.0	4,640.0
Other U.S. Captive	--	756.0	78.6	--	380.0	443.0	--	--	80.0	739.2	52.8	--	568.0	167.2	--	352.5	298.8
PCM/Reseller	--	10.8	11.7	--	--	82.9	--	--	--	157.5	14.7	--	228.8	27.3	--	159.5	79.5
OEM/Integrator	9.0	79.2	109.6	--	17.8	341.9	1.2	--	6.8	364.5	104.5	--	273.0	214.7	--	126.5	432.0
TOTAL U.S. REVENUES	1,072.5	846.0	895.9	320.0	397.8	1,908.8	19.2	--	86.8	2,594.7	3,052.0	--	2,446.8	4,659.2	--	1,604.5	5,450.3
NON-U.S. MANUFACTURERS																	
Captive	442.8	435.1	--	207.5	1,066.0	18.0	--	96.0	760.0	222.0	13.8	513.0	280.8	56.0	198.0	331.2	107.3
PCM/Reseller	13.7	52.7	--	1.5	7.5	--	--	--	--	14.4	--	--	32.2	15.0	--	28.6	32.3
OEM/Integrator	37.5	197.9	20.6	--	133.7	83.6	--	--	64.0	99.0	36.8	27.3	66.3	83.0	7.6	34.1	163.8
TOTAL NON-U.S. REVENUES	494.0	685.7	20.6	209.0	1,207.2	101.6	--	96.0	824.0	335.4	50.6	540.3	379.3	154.0	205.6	393.9	303.4
WORLDWIDE RECAP																	
Captive	1,506.3	1,191.1	774.6	527.5	1,446.0	1,502.0	18.0	96.0	840.0	2,294.7	2,946.6	513.0	2,225.8	4,473.2	198.0	1,649.7	5,046.1
	-28.1%	+38.0%	--	-65.0%	+21.4%	+93.9%	--	-81.8%	-41.9%	+52.8%	--	-38.9%	-3.0%	+51.8%	-61.4%	-25.9%	+12.8%
PCM/Reseller	13.7	63.5	11.7	1.5	7.5	82.9	--	--	--	171.9	14.7	--	261.0	42.3	--	188.1	111.8
	+65.1%	-47.3%	--	-89.1%	-88.2%	+608.5%	--	-100.0%	-100.0%	+107.4%	--	--	+51.8%	+187.8%	--	-27.9%	+164.3%
OEM/Integrator	46.5	277.1	130.2	--	151.5	425.5	1.2	--	70.8	463.5	141.3	27.3	339.3	297.7	7.6	160.6	595.8
	-68.8%	-18.5%	--	-100.0%	-45.3%	+226.8%	--	--	-53.3%	+8.9%	--	-61.4%	-26.8%	+110.7%	-72.2%	-52.7%	+100.1%
Total Revenues	1,566.5	1,531.7	916.5	529.0	1,605.0	2,010.4	19.2	96.0	910.8	2,930.1	3,102.6	540.3	2,826.1	4,813.2	205.6	1,998.4	5,753.7
	-30.4%	+15.7%	--	-66.2%	+4.8%	+119.4%	--	-81.9%	-43.3%	+45.7%	--	-40.7%	-3.5%	+55.1%	-61.9%	-29.3%	+19.5%
ANNUAL SHARE, BY DIAMETER	39.1%	38.2%	22.7%	12.7%	38.6%	48.3%	.4%	1.4%	12.9%	41.7%	44.0%	6.6%	34.7%	58.7%	2.6%	25.2%	72.2%

Note: Notes: 14 inch totals include 10.5 inch drives.
8 inch totals include 9 inch drives.

TABLE 57

FIXED DISK DRIVES, 1 - 2 GIGABYTES

WORLDWIDE SHIPMENTS (000)

BREAKDOWN BY DISK DIAMETER

	1990 Shipments			Forecast													
	1991							1992				1993			1994		
	14"	8"	5.25"	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	51.0	--	60.0	20.0	--	113.0	2.0	--	--	105.0	320.0	--	90.0	500.0	--	70.0	580.0
Other U.S. Captive	--	31.5	6.1	--	20.0	44.0	--	--	5.0	84.0	12.0	--	71.0	44.0	--	47.0	83.0
PCM/Reseller	--	3.0	5.6	--	--	43.6	--	--	--	105.0	13.0	--	176.0	28.0	--	145.0	86.0
OEM/Integrator	.5	22.0	45.3	--	5.1	179.3	1.0	--	2.0	243.0	95.0	--	210.0	226.0	--	115.0	480.0
TOTAL U.S. SHIPMENTS	51.5	56.5	117.0	20.0	25.1	379.9	3.0	--	7.0	537.0	440.0	--	547.0	798.0	--	377.0	1,229.0
NON-U.S. MANUFACTURERS																	
Captive	16.4	20.7	--	8.3	50.6	1.5	--	4.0	38.0	37.0	3.0	27.0	54.0	14.0	11.0	72.0	29.0
PCM/Reseller	.7	3.2	--	.1	.7	--	--	--	--	6.0	--	--	14.0	15.0	--	13.0	34.0
OEM/Integrator	1.5	44.7	10.2	--	32.3	49.0	--	--	16.0	66.0	32.0	7.0	51.0	83.0	2.0	31.0	177.0
TOTAL NON-U.S. SHIPMENTS	18.6	68.6	10.2	8.4	83.6	50.5	--	4.0	54.0	109.0	35.0	34.0	119.0	112.0	13.0	116.0	240.0
WORLDWIDE RECAP																	
Captive	67.4	52.2	66.1	28.3	70.6	158.5	2.0	4.0	43.0	226.0	335.0	27.0	215.0	558.0	11.0	189.0	692.0
	-20.6%	+53.5%	--	-58.0%	+35.2%	+139.8%	--	-85.9%	-39.1%	+42.6%	--	-37.2%	-4.9%	+66.6%	-59.3%	-12.1%	+24.0%
PCM/Reseller	.7	6.2	5.6	.1	.7	43.6	--	--	--	111.0	13.0	--	190.0	43.0	--	158.0	120.0
	-22.2%	-42.6%	--	-85.7%	-88.7%	+678.6%	--	-100.0%	-100.0%	+154.6%	--	--	+71.2%	+230.8%	--	-16.8%	+179.1%
OEM/Integrator	2.0	66.7	55.5	--	37.4	228.3	1.0	--	18.0	309.0	127.0	7.0	261.0	309.0	2.0	146.0	657.0
	-69.7%	+1.7%	--	-100.0%	-43.9%	+311.4%	--	--	-51.9%	+35.3%	--	-61.1%	-15.5%	+143.3%	-71.4%	-44.1%	+112.6%
Total Shipments	70.1	125.1	127.2	28.4	108.7	430.4	3.0	4.0	61.0	646.0	475.0	34.0	666.0	910.0	13.0	493.0	1,469.0
	-24.1%	+13.3%	--	-59.5%	-13.1%	+238.4%	--	-85.9%	-43.9%	+50.1%	--	-44.3%	+3.1%	+91.6%	-61.8%	-26.0%	+61.4%
ANNUAL SHARE, BY DIAMETER	21.8%	38.8%	39.4%	5.0%	19.1%	75.5%	.4%	.3%	5.1%	54.6%	40.0%	2.1%	41.5%	56.4%	.7%	25.1%	74.2%
TOTAL CAPACITY (Terabytes)	86.4	180.8	158.3	33.3	148.6	569.0	3.6	5.9	87.6	898.8	570.0	47.6	1,001.8	1,274.0	18.2	765.4	2,350.4

Note: Notes: 14 inch totals include 10.5 inch drives.
8 inch totals include 9 inch drives.

TABLE 58

FIXED DISK DRIVES, 1 - 2 GIGABYTES

APPLICATIONS SUMMARY
Percentage of Worldwide Shipments

APPLICATION	1990 Estimate Units (000)	1990 Estimate %	1994 Projection Units (000)	1994 Projection %
MAINFRAME/SUPERMINI General purpose	119.3	37.0	414.8	21.0
MINICOMPUTERS AND MULTI-USER MICROS Business and professional, including networks	154.5	48.0	1,104.0	55.9
PERSONAL COMPUTERS Business and professional, single user	1.4	.4	118.5	6.0
OFFICE SYSTEMS AND WORKSTATIONS Dedicated application	14.5	4.5	39.5	2.0
NON-OFFICE SYSTEMS AND WORKSTATIONS Technical, distribution, medical, other specialized	32.0	9.9	296.2	15.0
CONSUMER AND HOBBY COMPUTERS	--	--	--	--
OTHER APPLICATIONS	.7	.2	2.0	.1
Total	322.4	100.0	1,975.0	100.0

TABLE 59

FIXED DISK DRIVES, 1 - 2 GIGABYTES

MARKET SHARE SUMMARY
Worldwide Shipments of Non-Captive Disk Drives

	1990 Net Shipments									
	To United States Destinations					Worldwide				
	Units (000)				%	Units (000)				%
Drive Manufacturers	14"	8"	5.25"	Total		14"	8"	5.25"	Total	
Seagate Technology	--	21.0	28.0	49.0	52.2	--	25.0	34.0	59.0	43.2
Fujitsu	.2	8.2	5.4	13.8	14.7	.7	22.0	9.1	31.8	23.3
NEC	--	13.0	--	13.0	13.8	--	17.0	--	17.0	12.4
Micropolis	--	--	14.1	14.1	15.0	--	--	14.3	14.3	10.5
Hitachi	--	--	1.1	1.1	1.2	1.5	8.6	1.1	11.2	8.2
Other U.S.	.3	--	2.3	2.6	2.8	.5	--	2.6	3.1	2.4
Other Non-U.S.	--	.3	--	.3	.3	--	.3	--	.3	.2
TOTAL	.5	42.5	50.9	93.9	100.0	2.7	72.9	61.1	136.7	100.0

Note: 14 inch totals include 10.5 inch drives.
8 inch totals include 9 and 9.5 inch drives.

FIXED DISK DRIVES, MORE THAN 2 GIGABYTES

1991 DISK/TREND REPORT

FIXED DISK DRIVES, MORE THAN 2 GIGABYTES

Coverage

Examples of disk drives in this group include:

14" disk diameter	
IBM	3380-K
Storage Technology	8380F
10.8" disk diameter	
IBM	3390-2, 3390-3
10.5" disk diameter	
Fujitsu	F6425H
9.5" disk diameter	
Hitachi	DKU-87I, H-6587
9" disk diameter	
Hitachi	DK816-20
NEC	D2387
8" disk diameter	
Fujitsu	M2392K
Seagate Technology	ST83220K, ST82500N/J
5.25" disk diameter	
Digital Equipment	DSP5200
Fujitsu	M2652S/P
Hewlett-Packard	C3010
Micropolis	1548, 1924
Seagate Technology	ST42100N, ST43400N

High performance disk drives intended for use with mainframe computers constitute most of this product group. Until this year, all disk drives with capacities more than 1 gigabyte were included in a single product group. However that group was becoming a diverse mixture of

drives, and the group is now split at the 2 gigabyte level, providing a high-end product group still dominated by drives for mainframe applications.

Disk drives with individual spindles, or head/disk assemblies, containing capacities above 2 gigabytes first appeared in 1985 with IBM's introduction of the 3380-E, the double capacity model in the 3380 series. That drive was replaced by the triple capacity 3380-K in 1987, which in turn has been made obsolete by the 3390 series. The 3390-2, with the same 3.7 gigabyte capacity as the 3380-K, but offering performance and price improvements, first shipped at the end of 1989. The 3390-3, with 50% more capacity per spindle and further price reductions per megabyte, became available in September, 1991.

The other 14", 10.5", and 9.5" drives in this group are intended for mainframe and supermini applications similar to IBM's, and most use technology similar to IBM's 3380 drives, relying on oxide coated disks and thin film heads, with the exception of a few drives using ferrite heads. The 8" and 9" drives now offer capacities over 3 gigabytes, and are used typically in small mainframe, supermini and imaging applications. Some are also finding their way into mainframe PCM applications, with Fujitsu 8" and Hitachi 9.5" drives now included in a plug compatible subsystems equivalent to IBM 3380 and 3390 drives.

5.25" drives above 2 gigabytes were available for the first time in 1991. Most 5.25" drives in the group follow the physical packaging of the original 8 disk Maxtor 5.25" drive configuration, except that individual models now include up to 12 disks.

Plug compatible drives sold by major mainframe PCM vendors such as Amdahl, Hitachi Data Systems, Comparex and Memorex Telex have been includ-

ed in the product specification section, in the interest of clarity. Currently, Fujitsu makes the drives sold by Amdahl, while Hitachi makes the drives sold by Hitachi Data Systems and Comparex. Drives currently offered in the plug compatible market by Memorex Telex are made by Fujitsu and Seagate Technology.

Market status

DISK/TREND estimate of total market size:

Worldwide sales ($M)	1990	1991	1992	1993	1994
U.S. manufacturers	5,941.7	4,901.0	4,930.2	5,233.6	6,059.4
All manufacturers	6,597.3	5,885.8	6,018.2	6,512.9	7,649.4

While total revenues for disk drives in this product group were up 27.9% in 1990, at $6.6 billion, unit shipments grew 45.6%. This phenomenon was the result of IBM's first full year of 3390-2 shipments, in replacement of the 3380-K, but at lower average unit prices.

It's a different situation in 1991. IBM transitioned to the higher priced 3390-3 in the last third of 1991, but mainframe customers had apparently held down their disk drive purchases for most of the year, due to the economic recession and in anticipation of IBM's announcement of the more cost-effective 3390-3.

Total unit shipments for the product group are expected to be up 33.7% in 1991, mostly on the strength of increased sales of plug compatible drives for mainframe computers and the start of shipments of 5.25" OEM drives. The result of IBM's revenue shortfall is an expected 10.8% reduction in worldwide revenues for the product group in 1991.

The strong start for 5.25" drives with more than 2 gigabytes capacity expected for this year, a total of 57,500 drives, is a signal of the major role projected for 5.25" and smaller drives in this capacity range. Despite the fact that drives in this group have traditionally been used mostly for mainframes and superminis, new applications in file servers are already emerging for the smaller drives.

In 1990, 94.6% of the unit shipments for the product group were used in mainframe and supermini applications, with a decline to 81% expected in 1994. Minicomputers and multiuser micros, including file servers, held only 4.3% of the 1990 total but are expected to gain 15% of the 1994 applications.

Hitachi held 33.6% of the 1990 worldwide non-captive unit shipments for the product group with 16,200 units (measured as IBM 3380 or 3390 equivalent spindles), all 9.5" models. Seagate Technology was second with 27%, all 8" drives, and Fujitsu was third with 26.3%, a mixture of 8" and 10.5" drives.

Marketing trends

An upward slope is projected for both revenues and unit shipments in this product group through 1994, but the product mix is going to look completely different by then. As it frequently happens in this industry, the average annual revenue increase in the 1992-94 period is projected to be a modest 9.2%, compared to a very robust average annual increase of 50.6% in unit shipments. The reason for the difference is in the rapid growth expected first for 5.25" drives, then for 3.5" drives, all at continually lower prices for each new generation.

OEM drives have become a major part of the industry's shipments in this product group in recent years, first with 8" drives, and starting in 1991 with 5.25" drives. 5.25" drives' share of total unit shipments for the product group are expected to continue growing only through 1993, peaking at 54% of the shipments for all drives in that year. The first 3.5" drive shipments are projected for 1993, and rapid growth is foreseen, for IBM captive mainframe applications as well as non-captive markets. In 1994 unit shipments for 3.5" drives are expected to be virtually tied with those for 5.25" drives.

Worldwide total Unit shipments (000)	1990	1991	1992	1993	1994
14"	129.1	115.1	93.0	93.0	62.0
	77.3%	51.6%	34.9%	23.4%	8.5%
8"	37.9	50.6	51.2	52.0	52.0
	22.7%	22.7%	19.2%	13.1%	7.1%
5.25"	--	57.5	122.0	215.0	308.0
	--	25.8%	45.8%	54.0%	42.2%
3.5"	--	--	--	38.0	307.0
	--	--	--	9.5%	42.1%
	167.0	223.2	266.2	398.0	729.0

IBM's pace in development and introduction of disk drives for its continually evolving family of mainframe computers has continued to make life difficult for companies which compete in the market for drives used with IBM mainframes. That's been true for twenty years, and the degree of difficulty is increasing, considering the rapidity of new model introductions and the higher level of investment required for each new disk drive generation.

Since 1985, IBM has introduced new disk drive models for its mainframe systems every two years, and we expect this pattern to continue,

with a new drive family to appear in 1993. The degree of technical difficulty will again be high, since we expect these to be 3.5" drives, utilizing extremely high areal density and presenting difficult challenges in packaging and electronic components.

In the meantime, plug compatible vendors may be able to provide logical duplicates of IBM's 3390-3 with no unusual delays, since the drive was expected for some time, and their existing PCM subsystems using 8" and 9.5" drives can be modified and extended. Hitachi announced its version shortly after IBM's 3390-3 announcement, for delivery in the second quarter of 1992.

A more creative approach is being followed by Storage Technology, with its array project code-named "Iceberg", also promised for general availability in second quarter of 1992. The Iceberg is expected to be a pathfinder for other arrays in the mainframe plug compatible market, with the potential to offer both improved reliability and cost.

Technical trends

The long-expected 3390-3 provided no technology surprises to the industry, and is probably noteworthy mostly for IBM's first use of sputtered disks in a large diameter drive. Nor does the long-overdue emergence of the Sutter/Sawmill 5.25" drive family, used both in RAID-3 arrays and in general mainframe computer disk subsystems, provide any surprises, except that its capacity has been limited to 1 and 1.5 gigabyte models.

IBM's options for the probable 1993 replacement of the 3390-3 can probably be listed as three basic choices: (1) A further enhancement to the 3390 family, to increase capacity and lower the price per megabyte; (2) a 5.25" drive designed to offer the same capacity and be the exact

logical equivalent of the 3390-3, offering lower price per megabyte; and (3) a 3.5" drive offering improved performance, packaging and price.

We currently assume that IBM will choose to utilize the 3.5" drive option discussed above for a 1993 introduction. The technical difficulty will be high, with the areal density twice that of today's latest drives, but IBM already has demonstrated active programs in several critical areas. Magnetoresistive heads in nanoslider configurations have already been announced in a new IBM 3.5" drive, PRML encoding is already being used by IBM, and the firm has established extensive production capacity for sputtered disks. Most important, the current management of IBM's Storage Systems Products Division has shown renewed tenacity in pursuing new technology programs for data storage.

Forecasting assumptions

1. IBM's next disk drive for the mainframe market will be a 3.5" model to be introduced in 1993.

2. PCM vendors will match IBM's 3390-3 starting in mid-1992, and other PCM subsystems using 5.25" drives, including array subsystems, will establish significant market shares.

3. Shipments of 5.25" drives in OEM/Integrator markets will grow rapidly in the 1990-94 period, supplemented by 3.5" drives starting in 1993.

TABLE 60

FIXED DISK DRIVES, MORE THAN 2 GIGABYTES

REVENUE SUMMARY

	DISK DRIVE REVENUES, BY SHIPMENT DESTINATION ($M)									
	1990		Forecast							
	Revenues		1991		1992		1993		1994	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM Captive	3,822.1	5,662.6	3,063.0	4,548.0	3,120.0	4,576.0	3,132.0	4,680.0	3,254.0	4,980.0
Other U.S. Captive	26.4	46.2	--	--	--	--	63.0	126.0	134.5	278.5
TOTAL U.S. CAPTIVE	3,848.5	5,708.8	3,063.0	4,548.0	3,120.0	4,576.0	3,195.0	4,806.0	3,388.5	5,258.5
PCM/Reseller	41.4	64.4	50.7	77.0	46.6	62.0	49.4	68.4	201.6	392.0
OEM/Integrator	90.5	168.5	167.0	276.0	174.2	292.2	226.1	359.2	246.0	408.9
TOTAL U.S. NON-CAPTIVE	131.9	232.9	217.7	353.0	220.8	354.2	275.5	427.6	447.6	800.9
TOTAL U.S. REVENUES	3,980.4	5,941.7	3,280.7	4,901.0	3,340.8	4,930.2	3,470.5	5,233.6	3,836.1	6,059.4
Non-U.S. Manufacturers										
Captive	--	12.0	--	90.0	--	290.0	--	420.0	--	518.0
PCM/Reseller	287.7	606.7	390.4	813.5	333.3	724.2	346.5	774.9	434.0	964.9
OEM/Integrator	27.4	36.9	68.2	81.3	52.4	73.8	48.6	84.4	56.3	107.1
TOTAL NON-U.S. REVENUES	315.1	655.6	458.6	984.8	385.7	1,088.0	395.1	1,279.3	490.3	1,590.0
Worldwide Recap										
TOTAL WORLDWIDE REVENUES	4,295.5	6,597.3	3,739.3	5,885.8	3,726.5	6,018.2	3,865.6	6,512.9	4,326.4	7,649.4
OEM Average Price ($000)		8.8		4.8		3.3		2.6		2.1

TABLE 61

FIXED DISK DRIVES, MORE THAN 2 GIGABYTES

UNIT SHIPMENT SUMMARY

	DISK DRIVE UNIT SHIPMENTS, BY SHIPMENT DESTINATION (000)									
	1990		Forecast							
	Shipments		1991		1992		1993		1994	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM Captive	79.3	117.0	70.7	105.0	60.0	88.0	81.0	120.0	173.0	260.0
Other U.S. Captive	.8	1.4	--	--	--	--	6.0	12.0	15.0	31.0
TOTAL U.S. CAPTIVE	80.1	118.4	70.7	105.0	60.0	88.0	87.0	132.0	188.0	291.0
PCM/Reseller	1.8	2.8	6.8	9.4	17.7	23.0	26.0	36.0	48.0	80.0
OEM/Integrator	12.3	16.5	39.3	51.8	62.0	84.0	93.0	128.0	132.0	189.0
TOTAL U.S. NON-CAPTIVE	14.1	19.3	46.1	61.2	79.7	107.0	119.0	164.0	180.0	269.0
TOTAL U.S. SHIPMENTS	94.2	137.7	116.8	166.2	139.7	195.0	206.0	296.0	368.0	560.0
Non-U.S. Manufacturers										
Captive	--	.4	--	3.0	--	10.0	--	20.0	--	42.0
PCM/Reseller	10.6	22.3	15.4	32.2	16.3	34.2	21.0	45.0	32.0	70.0
OEM/Integrator	4.9	6.6	18.0	21.8	18.5	27.0	21.0	37.0	30.0	57.0
TOTAL NON-U.S. SHIPMENTS	15.5	29.3	33.4	57.0	34.8	71.2	42.0	102.0	62.0	169.0
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	109.7	167.0	150.2	223.2	174.5	266.2	248.0	398.0	430.0	729.0
Total Capacity (Terabytes)	438.2	675.6	540.9	828.6	710.0	1,114.1	940.4	1,535.2	1,304.0	2,233.2
Cumulative Shipments (Units in thousands)										
IBM	247.4	388.0	318.1	493.0	378.1	581.0	459.1	701.0	632.1	961.0
Non-IBM	78.2	159.6	157.7	277.8	272.2	456.0	439.2	734.0	696.2	1,203.0
WORLDWIDE TOTAL	325.6	547.6	475.8	770.8	650.3	1,037.0	898.3	1,435.0	1,328.3	2,164.0

TABLE 62

FIXED DISK DRIVES, MORE THAN 2 GIGABYTES

WORLDWIDE REVENUES ($M)

BREAKDOWN BY DISK DIAMETER

	1990 Revenues		Forecast													
	1991					1992			1993				1994			
	14"	8"	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	5,662.6	--	4,548.0	--	--	4,576.0	--	--	4,320.0	--	--	360.0	2,580.0	--	--	2,400.0
Other U.S. Captive	46.2	--	--	--	--	--	--	--	--	--	126.0	--	--	--	142.5	136.0
PCM/Reseller	64.4	--	58.0	--	19.0	18.0	--	44.0	--	--	68.4	--	--	--	81.6	310.4
OEM/Integrator	110.0	58.5	115.6	26.4	134.0	108.0	12.6	171.6	96.0	4.0	247.8	11.4	60.0	--	294.5	54.4
TOTAL U.S. REVENUES	5,883.2	58.5	4,721.6	26.4	153.0	4,702.0	12.6	215.6	4,416.0	4.0	442.2	371.4	2,640.0	--	518.6	2,900.8
NON-U.S. MANUFACTURERS																
Captive	--	12.0	--	90.0	--	--	290.0	--	--	336.0	84.0	--	--	189.0	266.0	63.0
PCM/Reseller	121.0	485.7	81.6	731.9	--	23.0	694.6	6.6	--	756.0	18.9	--	--	855.0	32.3	77.6
OEM/Integrator	--	36.9	--	61.5	19.8	--	32.0	41.8	--	13.2	67.2	4.0	--	--	85.5	21.6
TOTAL NON-U.S. REVENUES	121.0	534.6	81.6	883.4	19.8	23.0	1,016.6	48.4	--	1,105.2	170.1	4.0	--	1,044.0	383.8	162.2
WORLDWIDE RECAP																
Captive	5,708.8	12.0	4,548.0	90.0	--	4,576.0	290.0	--	4,320.0	336.0	210.0	360.0	2,580.0	189.0	408.5	2,599.0
	+36.7%	-91.4%	-20.3%	+650.0%	--	+.6%	+222.2%	--	-5.6%	+15.9%	--	--	-40.3%	-43.7%	+94.5%	+621.9%
PCM/Reseller	185.4	485.7	139.6	731.9	19.0	41.0	694.6	50.6	--	756.0	87.3	--	--	855.0	113.9	388.0
	-36.6%	+36.3%	-24.7%	+50.7%	--	-70.6%	-5.1%	+166.3%	-100.0%	+8.8%	+72.5%	--	--	+13.1%	+30.5%	--
OEM/Integrator	110.0	95.4	115.6	87.9	153.8	108.0	44.6	213.4	96.0	17.2	315.0	15.4	60.0	--	380.0	76.0
	-40.0%	+808.6%	+5.1%	-7.9%	--	-6.6%	-49.3%	+38.8%	-11.1%	-61.4%	+47.6%	--	-37.5%	-100.0%	+20.6%	+393.5%
Total Revenues	6,004.2	593.1	4,803.2	909.8	172.8	4,725.0	1,029.2	264.0	4,416.0	1,109.2	612.3	375.4	2,640.0	1,044.0	902.4	3,063.0
	+29.1%	+17.2%	-20.0%	+53.4%	--	-1.6%	+13.1%	+52.8%	-6.5%	+7.8%	+131.9%	--	-40.2%	-5.9%	+47.4%	+715.9%
ANNUAL SHARE, BY DIAMETER	91.1%	8.9%	81.7%	15.5%	2.8%	78.6%	17.1%	4.3%	67.9%	17.0%	9.4%	5.7%	34.6%	13.6%	11.8%	40.0%

Note: Notes: 14 inch totals include 10.5 inch drives.
8 inch totals include 9 inch drives.

TABLE 63

FIXED DISK DRIVES, MORE THAN 2 GIGABYTES

WORLDWIDE SHIPMENTS (000)

BREAKDOWN BY DISK DIAMETER

	1990 Shipments		1991			1992			Forecast 1993				1994			
	14"	8"	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	117.0	--	105.0	--	--	88.0	--	--	90.0	--	--	30.0	60.0	--	--	200.0
Other U.S. Captive	1.4	--	--	--	--	--	--	--	--	--	12.0	--	--	--	15.0	16.0
PCM/Reseller	2.8	--	2.9	--	6.5	1.0	--	22.0	--	--	36.0	--	--	--	48.0	32.0
OEM/Integrator	3.5	13.0	3.8	6.0	42.0	3.0	3.0	78.0	3.0	1.0	118.0	6.0	2.0	--	155.0	32.0
TOTAL U.S. SHIPMENTS	124.7	13.0	111.7	6.0	48.5	92.0	3.0	100.0	93.0	1.0	166.0	36.0	62.0	--	218.0	280.0
NON-U.S. MANUFACTURERS																
Captive	--	.4	--	3.0	--	--	10.0	--	--	12.0	8.0	--	--	7.0	28.0	7.0
PCM/Reseller	4.4	17.9	3.4	28.8	--	1.0	30.2	3.0	--	36.0	9.0	--	--	45.0	17.0	8.0
OEM/Integrator	--	6.6	--	12.8	9.0	--	8.0	19.0	--	3.0	32.0	2.0	--	--	45.0	12.0
TOTAL NON-U.S. SHIPMENTS	4.4	24.9	3.4	44.6	9.0	1.0	48.2	22.0	--	51.0	49.0	2.0	--	52.0	90.0	27.0
WORLDWIDE RECAP																
Captive	118.4	.4	105.0	3.0	--	88.0	10.0	--	90.0	12.0	20.0	30.0	60.0	7.0	43.0	223.0
	+49.9%	-93.5%	-11.3%	+650.0%	--	-16.2%	+233.3%	--	+2.3%	+20.0%	--	--	-33.3%	-41.7%	+115.0%	+643.3%
PCM/Reseller	7.2	17.9	6.3	28.8	6.5	2.0	30.2	25.0	--	36.0	45.0	--	--	45.0	65.0	40.0
	-37.9%	+65.7%	-12.5%	+60.9%	--	-68.3%	+4.9%	+284.6%	-100.0%	+19.2%	+80.0%	--	--	+25.0%	+44.4%	--
OEM/Integrator	3.5	19.6	3.8	18.8	51.0	3.0	11.0	97.0	3.0	4.0	150.0	8.0	2.0	--	200.0	44.0
	-37.5%	--	+8.6%	-4.1%	--	-21.1%	-41.5%	+90.2%	--	-63.6%	+54.6%	--	-33.3%	-100.0%	+33.3%	+450.0%
Total Shipments	129.1	37.9	115.1	50.6	57.5	93.0	51.2	122.0	93.0	52.0	215.0	38.0	62.0	52.0	308.0	307.0
	+34.2%	+104.9%	-10.8%	+33.5%	--	-19.2%	+1.2%	+112.2%	--	+1.6%	+76.2%	--	-33.3%	--	+43.3%	+707.9%
ANNUAL SHARE, BY DIAMETER	77.4%	22.6%	51.7%	22.7%	25.6%	35.0%	19.2%	45.8%	23.5%	13.1%	54.0%	9.4%	8.5%	7.1%	42.3%	42.1%
TOTAL CAPACITY (Terabytes)	551.5	124.1	530.5	183.2	115.0	617.7	228.0	268.4	622.2	290.0	547.0	76.0	414.8	323.5	881.0	614.0

Note: Notes: 14 inch totals include 10.5 inch drives.
8 inch totals include 9 inch drives.

TABLE 64

WORLDWIDE SHIPMENTS OF IBM CAPTIVE AND PCM FIXED DISK DRIVES

USED WITH MAINFRAME COMPUTER APPLICATIONS

	DISK DRIVE SHIPMENTS, BY SHIPMENT DESTINATION (000 SPINDLES)									
	1990 Shipments		FORECAST 1991		1992		1993		1994	
	US	WW	US	WW	US	WW	US	WW	US	WW
IBM 9336 (857 MB)	45.0	60.0	77.0	110.0	45.0	70.0	--	--	--	--
3380J Type (1260 MB)										
IBM	3.5	6.0	--	--	--	--	--	--	--	--
PCM	.8	3.8	.3	.8	--	--	--	--	--	--
TOTAL	4.3	9.8	.3	.8	--	--	--	--	--	--
3380E Type (2520 MB)										
PCM	.8	2.0	--	--	--	--	--	--	--	--
3380K Type (3780 MB)										
IBM	20.5	33.0	6.7	11.0	--	--	--	--	--	--
PCM	11.6	23.1	6.5	13.5	1.0	1.7	--	--	--	--
TOTAL	32.1	56.1	13.2	24.5	1.0	1.7	--	--	--	--
3390-2 type (3784 MB)										
IBM	58.8	84.0	52.0	77.0	--	--	--	--	--	--
PCM	--	--	10.6	21.3	8.5	19.2	--	--	--	--
TOTAL	58.8	84.0	62.6	98.3	8.5	19.2	--	--	--	--
9390-3 type (5676 MB)										
IBM	--	--	12.0	17.0	60.0	88.0	60.0	90.0	38.0	60.0
PCM	--	--	--	--	7.0	13.0	20.0	36.0	25.0	45.0
TOTAL	--	--	12.0	17.0	67.0	101.0	80.0	126.0	63.0	105.0
9345 type (1500 MB)										
IBM	--	--	2.0	3.0	45.0	60.0	63.0	90.0	45.0	70.0
PCM	--	--	--	--	8.0	12.0	12.0	18.0	14.0	25.0
TOTAL	--	--	2.0	3.0	53.0	72.0	75.0	108.0	59.0	95.0
Not yet announced										
IBM 3.5 INCH (1700 MB)	--	--	--	--	--	--	21.0	30.0	135.0	200.0
PCM 3.5 INCH (1700 MB)	--	--	--	--	--	--	--	--	22.0	40.0
TOTAL 3.5 INCH	--	--	--	--	--	--	21.0	30.0	157.0	240.0
TOTAL SPINDLES	141.0	211.9	167.1	253.6	174.5	263.9	176.0	264.0	279.0	440.0
TOTAL FORMATTED CAPACITY (Terabytes)		598.7 +38%		660.9 +10%		760.4 +15%		928.2 +22%		1,146.5 +24%

NOTE: PCM Drives are counted in units equivalent in capacity to IBM individual spindles, even though different disk diameters and physical file organizations may be used. In some cases, an "equivalent" PCM spindle may be composed of two or more physical spindles in order to equal the capacity of a specific IBM spindle. This table includes drives with less than 2 gigabytes capacity which are used with IBM mainframe computers.

TABLE 65

FIXED DISK DRIVES, MORE THAN 2 GIGABYTES

APPLICATIONS SUMMARY
Percentage of Worldwide Shipments

APPLICATION	1990 Estimate Units (000)	1990 Estimate %	1994 Projection Units (000)	1994 Projection %
MAINFRAME/SUPERMINI General purpose	158.0	94.6	590.5	81.0
MINICOMPUTERS AND MULTI-USER MICROS Business and professional, including networks	7.2	4.3	109.4	15.0
PERSONAL COMPUTERS Business and professional, single user	--	--	3.6	.5
OFFICE SYSTEMS AND WORKSTATIONS Dedicated application	--	--	--	--
NON-OFFICE SYSTEMS AND WORKSTATIONS Technical, distribution, medical, other specialized	1.8	1.1	25.5	3.5
CONSUMER AND HOBBY COMPUTERS	--	--	--	--
OTHER APPLICATIONS	--	--	--	--
Total	167.0	100.0	729.0	100.0

TABLE 66

FIXED DISK DRIVES, MORE THAN 2 GIGABYTES

MARKET SHARE SUMMARY
Worldwide Shipments of Non-Captive Disk Drives

	1990 Net Shipments							
	To United States Destinations				Worldwide			
	Units (000)			%	Units (000)			%
Drive Manufacturers	14"	8"	Total		14"	8"	Total	
Hitachi	--	7.4	7.4	25.0	--	16.2	16.2	33.6
Seagate Technology	--	11.0	11.0	37.2	--	13.0	13.0	27.0
Fujitsu	2.6	5.5	8.1	27.4	4.4	8.3	12.7	26.3
Other U.S.	3.1	--	3.1	10.4	6.3	--	6.3	13.1
Other Non-U.S.	--	--	--	--	--	--	--	--
TOTAL	5.7	23.9	29.6	100.0	10.7	37.5	48.2	100.0

Note: 14 inch totals include 10.5 inch drives.
8 inch totals include 9 and 9.5 inch drives.

RIGID DISK DRIVE SPECIFICATIONS

1991 DISK/TREND REPORT

RIGID MAGNETIC DISK DRIVE SPECIFICATIONS

Coverage

This section includes most rigid 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. Also included are plug compatible drives sold by major mainframe PCM vendors such as Amdahl, Hitachi Data Systems, Comparex and Memorex Telex, but which are manufactured by other firms. Not listed in many cases are captive drives which are similar to OEM/Integrator models made by the same manufacturer.

Capacities

Capacities are listed as "U" for unformatted or "F" for formatted. In general, unformatted capacities are shown for OEM/Integrator and PCM/Reseller drives without embedded controllers, and formatted capacities are given for captive drives and non-captive drives with embedded controllers, such as SCSI or PC/AT.

Unformatted capacity is used to determine the appropriate DISK/TREND product group for each drive, except that some arbitrary decisions have been made in some cases to place certain drives in product groups that will appear logical to most users of the DISK/TREND Report. For example, all 3.5" drives of about 425 formatted megabytes have been placed in the 300-500 megabyte group, even though a few of these drives have unformatted capacities slightly above 500 megabytes. In addition, all 2.5" drives in

the 80-86 formatted megabyte range have been placed in the 60-100 megabyte product group, despite unformatted capacities for a few which exceed 100 megabytes.

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 non-captive drives, so please be alert to the need to check for manufacturers' latest information if you need precise data. In particular, there are many non-interchangeable forms of SCSI interfaces.

Accuracy

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

1991 DISK/TREND product groups for rigid magnetic disk drives

Removable magnetic media:	1.	Disk cartridge drives
Fixed magnetic media:	2.	Fixed disk drives, less than 30 megabytes
	3.	Fixed disk drives, 30-60 megabytes
	4.	Fixed disk drives, 60-100 megabytes
	5.	Fixed disk drives, 100-300 megabytes
	6.	Fixed disk drives, 300-500 megabytes
	7.	Fixed disk drives, 500 MB-1 gigabyte
	8.	Fixed disk drives, 1 - 2 gigabytes
	9.	Fixed disk drives, more than 2 gigabytes

MANUFACTURER	ALPHA DATA	ALPS ELECTRIC	ALPS ELECTRIC	ALPS ELECTRIC	ALPS ELECTRIC
DRIVE	Atlas 520	DRR040C	DRR040D	DRR040N	DRR050D
DISK/TREND GROUP	7	3	3	3	4
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	14"	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	Thin Film	Thin Film	Thin Film	Thin Film
DRIVE: Heads	Ferrite	MIG	MIG	MIG	MIG
Interface	ESMD	PC AT	SCSI	PC AT	SCSI
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	U: 520	F: 42.8	F: 45.34	F: 42.8	F: 52.5
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 30,240	F: 17,920	F: 17,920	F: 17,920	F: 17,920
Data surfaces per spindle	7.6	2	2	2	2
Heads per data surface	10	1	1	1	1
Tracks per surface	2250	1195	1265	1195	1465
Track density (TPI)	1000	1400	1740	1740	1740
Maximum linear density (BPI)	11700	33343 BPI 22229 FCI	33343 BPI 22229 FCI	27326 BPI 18217 FCI	33343 BPI 22229 FCI
Recording code	MFM	2,7 RLL	2,7 RLL	2,7 RLL	2,7 RLL
Rotational speed (RPM)	3600	3205	3205	3205	3205
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Dedicated Surf.	Embedded	Embedded	Embedded	Embedded
Average positioning time (msec)	18	19	19	19	19
Average rotational delay (msec)	8.3	9.4	9.4	9.4	9.4
Average access time (msec)	26.3	28.4	28.4	28.4	28.4
Data transfer rate (KBytes/sec)	1800	750	2000	750	2000
FIRST CUSTOMER SHIPMENT	2Q86	4Q89	1990	12/90	12/90
COMMENTS	8 parallel channel version available	20.8 mm high	20.8 mm high	16 mm high	20.8 mm high

MANUFACTURER	ALPS ELECTRIC	ALPS ELECTRIC	AMDAHL	AMDAHL	AMDAHL
DRIVE	DRR100C	DRR100D	6380-AJ4 6380-BJ4	6380-AK4 6380-BK4	6390-A/B24 6390-A/B28 6390-A/B2C 6390-A/B2F
DISK/TREND GROUP	5	5	7	8	8
MARKET	OEM	OEM	PCM	PCM	PCM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	95 mm OD 25 mm ID	95 mm OD 25 mm ID	10.5" OD 4.0" ID	10.5" OD 4.0" ID	210 mm OD 100 mm ID
Recording medium	Thin Film	Thin Film	Oxide Coated	Oxide Sputtered	Thin Film
DRIVE: Heads	MIG	MIG	Ferrite	Ferrite	Thin Film
Interface	PC AT	SCSI	IBM	IBM	IBM
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	F: 105.0	F: 105.0	F: 630	F: 1,890	F: 1,892
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 17,920	F: 17,920	F: 47,476	F: 47,476	F: 56,664
Data surfaces per spindle	4	4	8	15	15
Heads per data surface	1	1	2	2	1
Tracks per surface	1465	1465	1770	2656	2226
Track density (TPI)	1740	1740	1350	1350	2050
Maximum linear density (BPI)	33343 BPI 22229 FCI	33343 BPI 22229 FCI	21300 BPI 15975 FCI	24440 BPI 18330 FCI	32733 BPI 24550 FCI
Recording code	2,7 RLL	2,7 RLL	1,7 RLL	1,7 RLL	1,7 RLL
Rotational speed (RPM)	3205	3205	3620	3620	4348
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Embedded	Embedded	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.
Average positioning time (msec)	19	19	12	16	10.7
Average rotational delay (msec)	9.4	9.4	8.3	8.3	6.9
Average access time (msec)	28.4	28.4	20.3	24.3	17.6
Data transfer rate (KBytes/sec)	750	2000	3000	3000	4500
FIRST CUSTOMER SHIPMENT	1Q90	1990	1Q89	1Q89	4Q91
COMMENTS	25.4 mm high	25.4 mm high	PCM 3380J Drive has 4 spindles Manufactured by Fujitsu	PCM 3380K Drive has 4 spindles Manufactured by Fujitsu	PCM 3390 Drive has 4, 8, 12, or 16 spindles Manufactured by Fujitsu

MANUFACTURER	AREAL TECHNOLOGY	AREAL TECHNOLOGY	AREAL TECHNOLOGY	AREAL TECHNOLOGY	ATASI TECHNOLOGY
DRIVE	MD-2060	MD-2080	A120	A180	519
DISK/TREND GROUP	4	4	5	5	5
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	65 mm OD 20 mm ID	65 mm OD 20 mm ID	65 mm OD 20 mm ID	65 mm OD 20 mm ID	130 mm OD 40 mm ID
Recording medium	Thin Film*	Thin Film*	Thin Film*	Thin Film*	Thin Film
DRIVE: Heads	Thin Film	Thin Film	Thin Film	Thin Film	Ferrite
Interface	PC AT	PC AT	PC AT	PC AT	ST412
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	F: 62.4	F: 80.6	F: 124.8	F: 181.3	U: 191.2
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 30,464	F: 30,464	F: 30,464	F: 30,464	U: 10,416
Data surfaces per spindle	2	2	4	4	15
Heads per data surface	1	1	1	1	1
Tracks per surface	1024	1323	1024	1488	1224
Track density (TPI)	2083	2540	2005	2860	1070
Maximum linear density (BPI)	67322 BPI 44881 FCI	67222 BPI 44815 FCI	67234 BPI 44823 FCI	67234 BPI 44823 FCI	10924
Recording code	2,7 RLL	2,7 RLL	2,7 RLL	2,7 RLL	MFM
Rotational speed (RPM)	2087	2087	3130	3130	3600
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Linear, Voice Coil
Servo type	Embedded	Embedded	Embedded	Embedded	Dedicated Surf.
Average positioning time (msec)	19	19	15	17	22
Average rotational delay (msec)	14.37	14.37	9.6	9.6	8.3
Average access time (msec)	33.37	33.37	24.6	26.6	30.3
Data transfer rate (KBytes/sec)	1250	1250	1875	1875	625
FIRST CUSTOMER SHIPMENT	1/91	4Q91	1Q92	1Q92	1Q86
COMMENTS	14.9 mm high *Glass disk	14.9 mm high *Glass disk	14.9 mm high *Glass disk	14.9 mm high *Glass disk	

MANUFACTURER	ATASI TECHNOLOGY	ATASI TECHNOLOGY	BRAND TECHNOLOGIES	BRAND TECHNOLOGIES	BRAND TECHNOLOGIES
DRIVE	638	738	BT9220A	BT9220E	BT9220S
DISK/TREND GROUP	6	6	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	95 mm OD 25 mm ID
Recording medium	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
DRIVE: Heads	Ferrite	Ferrite	MIG	MIG	MIG
Interface	ESDI	SCSI	PC AT	ESDI	SCSI
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	U: 382.7	F: 353.5	F: 200	U: 226	F: 200
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 20,832	F: 19,456	F: 18,432	U: 20,850	F: 18,432
Data surfaces per spindle	15	15	9	9	9
Heads per data surface	1	1	1	1	1
Tracks per surface	1225	1225	1208	1208	1208
Track density (TPI)	1070	1070	1376	1376	1376
Maximum linear density (BPI)	21848 BPI 14565 FCI	21848 BPI 14565 FCI	29700 BPI 19800 FCI	29700 BPI 19800 FCI	29700 BPI 19800 FCI
Recording code	2,7 RLL	2,7 RLL	2,7 RLL	2,7 RLL	2,7 RLL
Rotational speed (RPM)	3600	3600	3565	3565	3565
PERFORMANCE					
Actuator type	Linear, Voice Coil	Linear, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.
Average positioning time (msec)	18	18	16.5	16.5	16.5
Average rotational delay (msec)	8.3	8.3	8.4	8.4	8.4
Average access time (msec)	26.3	26.3	24.9	24.9	24.9
Data transfer rate (KBytes/sec)	1250	1250	8000	1250	6670 synch. 3000 asynch.
FIRST CUSTOMER SHIPMENT	3Q86	4Q86	8/90	8/90	8/90
COMMENTS			41.3 mm high	41.3 mm high	41.3 mm high

MANUFACTURER	CERPLEX TECHNOLOGIES	CERPLEX TECHNOLOGIES	CERPLEX TECHNOLOGIES	COMPAREX	COMPAREX
DRIVE	7110	7130	PhD	6480AJ 6480BJ	6480AE 6480BE
DISK/TREND GROUP	1	1	1	7	8
MARKET	OEM	OEM	PCM	PCM	PCM
MEDIA: Generic type	8" Cartridge	8" Cartridge	8" Cartridge	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	9.5"	9.5"
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	SMD, SCSI	SMD, SCSI	SCSI, PC	IBM	IBM
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	U: 26.9	U: 80.9	U: 80.9	F: 630	F: 1,260
REMOVABLE	U: 26.9	U: 26.9	U: 26.9	--	--
Capacity per track (Bytes)	U: 20,928	U: 20,928	U: 20,928	F: 47,476	F: 47,476
Data surfaces per spindle	4	8	8	8	8
Heads per data surface	1	1	1	2	2
Tracks per surface	644	644	644	1327.5	2655
Track density (TPI)	555	555	555	*	*
Maximum linear density (BPI)	10986 BPI 7324 FCI	10986 BPI 7324 FCI	10986 BPI 7324 FCI	*	*
Recording code	2,7 RLL	2,7 RLL	2,7 RLL	2,7 RLL	2,7 RLL
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
Servo type	Embedded	Embedded	Embedded	Dedicated Surf.	Dedicated Surf.
Average positioning time (msec)	25	25	25	11	13
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	33.3	33.3	33.3	19.3	21.3
Data transfer rate (KBytes/sec)	1229	1229	1229	3000	3000
FIRST CUSTOMER SHIPMENT	1Q83	1/86	1/86	1988	1988
COMMENTS				PCM 3380J Drive has 2 or 4 spindles. *Not announced. Manufactured by Hitachi	PCM 3380E Drive has 2 or 4 spindles. *Not announced. Manufactured by Hitachi

MANUFACTURER	COMPAREX	COMPAREX	COMPAREX	CONNER PERIPHERALS	CONNER PERIPHERALS
DRIVE	6490-A14 6490-A18 6490-B14 6490-B18 6490-B1C	6480AK 6480BK	6490-A24 6490-A28 6490-B24 6490-B28 6490-B2C	CP-2020 Kato	CP-2024 Kato
DISK/TREND GROUP	8	9	9	2	2
MARKET	PCM	PCM	PCM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	9.5"	9.5"	9.5"	65 mm OD 20 mm ID	65 mm OD 20 mm ID
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Thin Film	Thin Film
DRIVE: Heads	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
Interface	IBM	IBM	IBM	SCSI	PC AT/XT
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	F: 946	F: 1,890	F: 1,892	F: 21	F: 21.4
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 56,664	F: 47,476	F: 56,664	F: 16,384	F: 16,384
Data surfaces per spindle	15	8	15	2	2
Heads per data surface	2	4	2	1	1
Tracks per surface	1113	2655	2226	653	653
Track density (TPI)	*	*	*	1700	1700
Maximum linear density (BPI)	*	*	*	34000 BPI 22666 FCI	34000 BPI 22666 FCI
Recording code	1,7 RLL	2,7 RLL	1,7 RLL	2,7 RLL	2,7 RLL
Rotational speed (RPM)	4260	3600	4260	3433	3433
PERFORMANCE					
Actuator type	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Embedded	Embedded
Average positioning time (msec)	8.5	12.5	10	23	23
Average rotational delay (msec)	7.1	8.3	7.1	8.7	8.7
Average access time (msec)	15.6	20.8	17.1	31.7	31.7
Data transfer rate (KBytes/sec)	4200	3000	4200	3000 synch. 1250 asynch.	1250
FIRST CUSTOMER SHIPMENT	4Q90	1988	4Q90	1Q90	1Q90
COMMENTS	PCM 3390-1 Drive has 4, 8, or 12 spindles. *Not announced. Manufactured by Hitachi	PCM 3380K Drive has 2 or 4 spindles. *Not announced. Manufactured by Hitachi	PCM 3390-2 Drive has 4, 8, or 12 spindles. *Not announced. Manufactured by Hitachi	17.5 mm high	17.5 mm high

MANUFACTURER	CONNER PERIPHERALS	CONNER PERIPHERALS	CONNER PERIPHERALS	CONNER PERIPHERALS	CONNER PERIPHERALS
DRIVE	CP-3020	CP-3024	CP-4024 Stubby	CP-2034 Pancho	CP-2044 Pancho
DISK/TREND GROUP	2	2	2	3	3
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	65 mm OD 20 mm ID	65 mm OD 20 mm ID
Recording medium	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
DRIVE: Heads	Ferrite	Ferrite	Thin Film		
Interface	SCSI	PC AT	PC AT/XT	PC AT	PC AT
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	F: 21.5	F: 21.5	F: 21.6	F: 32	F: 42.6
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 16,896	F: 16,896	F: 17,408	F: 19,456	F: 19,456
Data surfaces per spindle	2	2	2	2	4
Heads per data surface	1	1	1	1	1
Tracks per surface	636	636	620	823	552
Track density (TPI)	1150	1150	1150	2100	1700
Maximum linear density (BPI)	21594 BPI 14396 FCI	21594 BPI 14396 FCI	23148 BPI 15432 FCI	39222 BPI 26148 FCI	36789 BPI 24526 FCI
Recording code	2,7 RLL	2,7 RLL	2,7 RLL	2,7 RLL	2,7 RLL
Rotational speed (RPM)	3575	3575	2913	3486	3486
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Embedded	Embedded	Embedded	Embedded	Embedded
Average positioning time (msec)	27	27	29	19	19
Average rotational delay (msec)	8.4	8.4	10.3	8.7	8.7
Average access time (msec)	35.4	35.4	39.3	27.7	27.7
Data transfer rate (KBytes/sec)	4000 synch. 1250 asynch.	1250	1125	1500	1500
FIRST CUSTOMER SHIPMENT	2Q88	2Q88	4Q89	4Q90	4Q90
COMMENTS	25.4 mm high	25.4 mm high	19.8 mm high	19 mm high	19 mm high

MANUFACTURER	CONNER PERIPHERALS	CONNER PERIPHERALS	CONNER PERIPHERALS	CONNER PERIPHERALS	CONNER PERIPHERALS
DRIVE	CP-3000 Allegheny	CP-3040 Sierra	CP-3044 Sierra	CP-4044 Stubby	CP-2064 Pancho
DISK/TREND GROUP	3	3	3	3	4
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	65 mm OD 20 mm ID
Recording medium	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
DRIVE: Heads	MIG	Thin Film, MIG	Thin Film, MIG	MIG	MIG
Interface	PC AT	SCSI	PC AT	PC AT/XT	PC AT
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	F: 42.6	F: 40.10	F: 42.65	F: 42.6	F: 64
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 20,480	F: 20,480	F: 20,480	F: 19,456	F: 19,456
Data surfaces per spindle	1	2	2	2	4
Heads per data surface	1	1	1	1	1
Tracks per surface	1045	1026	1047	1096	823
Track density (TPI)	1400	1400	1400	1400	2100
Maximum linear density (BPI)	30871 BPI 20581 FCI	30871 BPI 20581 FCI	30871 BPI 20581 FCI	32729 BPI 21819 FCI	39222 BPI 26148 FCI
Recording code	2,7 RLL	2,7 RLL	2,7 RLL	2,7 RLL	2,7 RLL
Rotational speed (RPM)	3557	3557	3557	2905	3486
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Embedded	Embedded	Embedded	Embedded	Embedded
Average positioning time (msec)	28	25	25	29	19
Average rotational delay (msec)	8.4	8.4	8.4	10.3	8.6
Average access time (msec)	36.4	33.4	33.4	39.3	27.6
Data transfer rate (KBytes/sec)	1500	4000 synch. 1500 asynch.	1500	1250	1500
FIRST CUSTOMER SHIPMENT	3Q90	4Q88	4Q88	4Q89	4Q90
COMMENTS	25.4 mm high	25.4 mm high	25.4 mm high	19.8 mm high	19 mm high

MANUFACTURER	CONNER PERIPHERALS	CONNER PERIPHERALS	CONNER PERIPHERALS	CONNER PERIPHERALS	CONNER PERIPHERALS
DRIVE	CP-2084 Pancho	CP-30060 Hopi	CP-30064 Hopi	CP-30069 Hopi	CP-30080 Hopi
DISK/TREND GROUP	4	4	4	4	4
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	65 mm OD 20 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	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
DRIVE: Heads	MIG	MIG	MIG	MIG	MIG
Interface	PC AT	SCSI	PC AT, EISA	MCA	SCSI
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	F: 85.0	F: 60	F: 60	F: 60	F: 84.1
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 19,456	F: 19,968	F: 19,968	F: 19,968	F: 19,968
Data surfaces per spindle	4	1	1	1	4
Heads per data surface	1	1	1	1	1
Tracks per surface	1097	1522	1522	1522	1058
Track density (TPI)	2300	1850	1850	1850	1400
Maximum linear density (BPI)	43866 BPI 32900 FCI	33184 BPI 24888 FCI	33184 BPI 24888 FCI	33184 BPI 24888 FCI	33184 BPI 24888 FCI
Recording code	1,7 RLL	1,7 RLL	1,7 RLL	1,7 RLL	1,7 RLL
Rotational speed (RPM)	3486	3399	3399	3399	3400
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Embedded	Embedded	Embedded	Embedded	Embedded
Average positioning time (msec)	19	19	19	19	19
Average rotational delay (msec)	8.6	8.8	8.8	8.8	8.8
Average access time (msec)	27.6	27.8	27.8	27.8	27.8
Data transfer rate (KBytes/sec)	6500 max.	4000 synch. 1500 asynch.	1500	1500	4000 synch. 1500 asynch.
FIRST CUSTOMER SHIPMENT	3Q91	4Q90	4Q90	4Q90	4Q90
COMMENTS	19 mm high	25.4 mm high	25.4 mm high	25.4 mm high	25.4 mm high

MANUFACTURER	CONNER PERIPHERALS	CONNER PERIPHERALS	CONNER PERIPHERALS	CONNER PERIPHERALS	CONNER PERIPHERALS
DRIVE	CP-30080E Jaguar	CP-30084 Hopi	CP-30084E Jaguar	CP-3180	CP-3184
DISK/TREND GROUP	4	4	4	4	4
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	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
DRIVE: Heads	MIG	MIG	MIG	Ferrite	Ferrite
Interface	SCSI	PC AT, EISA	PC AT	SCSI	PC AT
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	F: 85.0	F: 84.1	F: 85.0	F: 84.3	F: 84.3
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 23,552	F: 19,968	F: 23,552	F: 16,896	F: 16,896
Data surfaces per spindle	2	4	2	6	6
Heads per data surface	1	1	1	1	1
Tracks per surface	1806	1058	1806	832	832
Track density (TPI)	2150	1400	2150	1150	1150
Maximum linear density (BPI)	42173 BPI 31630 FCI	33184 BPI 24888 FCI	42173 BPI 31630 FCI	24437 BPI 16291 FCI	24437 BPI 16291 FCI
Recording code	1,7 RLL	1,7 RLL	1,7 RLL	2,7 RLL	2,7 RLL
Rotational speed (RPM)	3833	3400	3833	3575	3575
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Embedded	Embedded	Embedded	Embedded	Embedded
Average positioning time (msec)	17	19	17	25	25
Average rotational delay (msec)	7.8	8.8	7.8	8.4	8.4
Average access time (msec)	24.8	27.8	24.8	33.4	33.4
Data transfer rate (KBytes/sec)	5000 synch. 2000 asynch.	1500	6000 max.	2500 synch. 1250 asynch.	1250
FIRST CUSTOMER SHIPMENT	3Q91	4Q90	3Q91	4Q87	4Q87
COMMENTS	25.4 mm high	25.4 mm high	25.4 mm high	41.3 mm high	41.3 mm high

MANUFACTURER	CONNER PERIPHERALS	CONNER PERIPHERALS	CONNER PERIPHERALS	CONNER PERIPHERALS	CONNER PERIPHERALS
DRIVE	CP-30100 Hopi	CP-30104 Hopi	CP-30109 Hopi	CP-30170E Jaguar	CP-30174E Jaguar
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	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
DRIVE: Heads	MIG	MIG	MIG	MIG	MIG
Interface	SCSI	PC AT/XT, EISA	MCA	SCSI	PC AT
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	F: 120	F: 120	F: 120	F: 170.0	F: 170.0
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 19,968	F: 19,968	F: 19,968	F: 23,552	F: 23,552
Data surfaces per spindle	4	4	4	4	4
Heads per data surface	1	1	1	1	1
Tracks per surface	1522	1522	1522	1806	1806
Track density (TPI)	1850	1850	1850	2150	2150
Maximum linear density (BPI)	33184 BPI 24888 FCI	33184 BPI 24888 FCI	33184 BPI 24888 FCI	42173 BPI 31630 FCI	42173 BPI 31630 FCI
Recording code	1,7 RLL	1,7 RLL	1,7 RLL	1,7 RLL	1,7 RLL
Rotational speed (RPM)	3399	3399	3399	3833	3833
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Embedded	Embedded	Embedded	Embedded	Embedded
Average positioning time (msec)	19	19	19	17	17
Average rotational delay (msec)	8.8	8.8	8.8	7.8	7.8
Average access time (msec)	27.8	27.8	27.8	24.8	24.8
Data transfer rate (KBytes/sec)	4000 synch. 1500 asynch.	1500	1500	5000 synch. 2000 asynch.	6000 max.
FIRST CUSTOMER SHIPMENT	1Q90	1Q90	1Q90	3Q91	3Q91
COMMENTS	25.4 mm high	25.4 mm high	25.4 mm high	25.4 mm high	25.4 mm high

MANUFACTURER	CONNER PERIPHERALS	CONNER PERIPHERALS	CONNER PERIPHERALS	CONNER PERIPHERALS	CONNER PERIPHERALS
DRIVE	CP-30200 Cougar	CP-30204 Cougar	CP-3100	CP-3104	CP-3114
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	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
DRIVE: Heads	Thin Film	Thin Film	Ferrite	Ferrite	Ferrite
Interface	SCSI	PC AT	SCSI	PC AT	PC AT
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	F: 212.6	F: 212.6	F: 104.9	F: 104.9	F: 112
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 25,088	F: 25,088	F: 16,896	F: 16,896	F: 16,896
Data surfaces per spindle	4	4	8	8	8
Heads per data surface	1	1	1	1	1
Tracks per surface	2119	2119	776	776	833
Track density (TPI)	2484	2484	1150	1150	1150
Maximum linear density (BPI)	45610 BPI 30407 FCI	45610 BPI 30407 FCI	23441 BPI 15627 FCI	23441 BPI 15627 FCI	23441 BPI 15627 FCI
Recording code	2,7 RLL	2,7 RLL	2,7 RLL	2,7 RLL	2,7 RLL
Rotational speed (RPM)	4500	4500	3575	3575	3575
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Embedded	Embedded	Embedded	Embedded	Embedded
Average positioning time (msec)	12	12	25	25	25
Average rotational delay (msec)	6.7	6.7	8.4	8.4	8.4
Average access time (msec)	18.7	18.7	33.4	33.4	33.4
Data transfer rate (KBytes/sec)	5000 synch. 2500 asynch.	2500	2500 synch. 1250 asynch.	1250	1250
FIRST CUSTOMER SHIPMENT	3Q91	3Q91	4Q87	4Q87	1988
COMMENTS	25.4 mm high	25.4 mm high	41.3 mm high	41.3 mm high	41.3 mm high

MANUFACTURER	CONNER PERIPHERALS	CONNER PERIPHERALS	CONNER PERIPHERALS	CONNER PERIPHERALS	CONNER PERIPHERALS
DRIVE	CP-3200F	CP-3204F	CP-3209F	CP-3360 Summit	CP-3364 Summit
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	95 mm OD 25 mm ID	95 mm OD 25 mm ID	95 mm OD 25 mm ID
Recording medium	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
DRIVE: Heads	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
Interface	SCSI	PC AT	MCA	SCSI-2	PC AT
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	F: 212.6	F: 212.6	F: 212.6	F: 362.5	F: 362.5
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 19,456	F: 19,456	F: 19,456	F: 25,088	F: 25,088
Data surfaces per spindle	8	8	8	8	8
Heads per data surface	1	1	1	1	1
Tracks per surface	1366	1366	1366	1806	1806
Track density (TPI)	1700	1700	1700	2100	2100
Maximum linear density (BPI)	31800 BPI 23850 FCI	31800 BPI 23850 FCI	31800 BPI 23850 FCI	44325 BPI 29550 FCI	44325 BPI 29550 FCI
Recording code	1,7 RLL	2,7 RLL	1,7 RLL	2,7 RLL	2,7 RLL
Rotational speed (RPM)	3485	3485	3485	4500	4500
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Embedded	Embedded	Embedded	Embedded	Embedded
Average positioning time (msec)	16	16	16	12	12
Average rotational delay (msec)	8.6	8.6	8.6	6.7	6.7
Average access time (msec)	24.6	24.6	24.6	18.7	18.7
Data transfer rate (KBytes/sec)	5000 synch. 1500 asynch.	1500	1500	5000 synch. 2500 asynch.	2500
FIRST CUSTOMER SHIPMENT	4Q89	4Q89	4Q89	3Q91	3Q91
COMMENTS	41.3 mm high	41.3 mm high	41.3 mm high	41.3 mm high	41.3 mm high

MANUFACTURER	CONNER PERIPHERALS	CONNER PERIPHERALS	DIGIREDE	DIGIREDE	DIGIREDE
DRIVE	CP-3540 Summit	CP-3544 Summit	W525/50	W525/85	W525/140
DISK/TREND GROUP	7	7	3	4	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	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: Heads	Thin Film	Thin Film	Ferrite	Ferrite	Ferrite
Interface	SCSI-2	PC AT	ST412	ST412	ST412
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	F: 543.7	F: 543.7	U: 50	U: 85.3	U: 140.2
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 25,088	F: 25,088	U: 10,416	U: 10,416	U: 10,416
Data surfaces per spindle	12	12	5	9	11
Heads per data surface	1	1	1	1	1
Tracks per surface	1806	1806	1024	1024	1224
Track density (TPI)	2150	2150	1022	1022	1022
Maximum linear density (BPI)	44325 BPI 29550 FCI	44325 BPI 29550 FCI	9934	11555	11555
Recording code	2,7 RLL	2,7 RLL	MFM	MFM	MFM
Rotational speed (RPM)	4500	4500	3600	3600	3600
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Embedded	Embedded	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.
Average positioning time (msec)	12	12	27	28	30
Average rotational delay (msec)	6.7	6.7	8.3	8.3	8.3
Average access time (msec)	18.7	18.7	35.3	36.3	38.3
Data transfer rate (KBytes/sec)	5000 synch. 2500 asynch.	2500	625	625	625
FIRST CUSTOMER SHIPMENT	3Q91	4Q90	1987	1987	1987
COMMENTS	41.3 mm high	41.3 mm high			

MANUFACTURER	DIGIREDE	DIGIREDE	DIGIREDE	DIGITAL EQUIPMENT CORPORATION	DIGITAL EQUIPMENT CORPORATION
DRIVE	W525/190	W525R/125	W525R/240	RF31F	RA70
DISK/TREND GROUP	5	5	5	5	6
MARKET	OEM	OEM	OEM	Captive	Captive
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: Heads	Ferrite	Ferrite	Ferrite	MIG	Ferrite
Interface	ST412	ST412	ST412	DEC, DSSI	DEC, SDI
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	U: 191.2	U: 127.99	U: 239.98	F: 200	U: 350 F: 280
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 10,416	U: 15,624	U: 15,624	F: 25,600	F: 17,408
Data surfaces per spindle	15	8	15	8	11
Heads per data surface	1	1	1	1	1
Tracks per surface	1224	1024	1024	984	1507
Track density (TPI)	1022	1070	1070	1875	1355
Maximum linear density (BPI)	11555	14901 BPI 9934 FCI	14901 BPI 9934 FCI	30064 BPI 22548 FCI	22437 BPI 14958 FCI
Recording code	MFM	2,7 RLL	2,7 RLL	1,7 RLL	2,7 RLL
Rotational speed (RPM)	3600	3600	3600	3600	4000
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Linear, Voice Coil
Servo type	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Embedded	Dedicated Surf.
Average positioning time (msec)	30	28	28	12.2	19.5
Average rotational delay (msec)	8.3	8.3	8.3	8.3	7.5
Average access time (msec)	38.3	36.3	36.3	20.5	27.0
Data transfer rate (KBytes/sec)	625	937.5	937.5	2000	1450
FIRST CUSTOMER SHIPMENT	1987	1989	1989	2/91	4/88
COMMENTS		For use with RLL controller	For use with RLL controller	41.3 mm high	

MANUFACTURER	DIGITAL EQUIPMENT CORPORATION	DIGITAL EQUIPMENT CORPORATION	DIGITAL EQUIPMENT CORPORATION	DIGITAL EQUIPMENT CORPORATION	DMA TECHNOLOGIES
DRIVE	RF31	RA90	RA92	RF72	360
DISK/TREND GROUP	7	8	8	8	1
MARKET	Captive	Captive	Captive	Captive	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	--
Nominal disk diameter	130 mm OD 40 mm ID	9"	9"	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: Heads	Ferrite	Thin Film	Thin Film	MIG	Ferrite
Interface	DEC, DSSI	DEC, SDI	DEC, SDI	DEC, DSSI	ST412
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	U: 508 F: 381	U: 1,607 F: 1,216	U: 1,987 F: 1,506	U: 1,370 F: 1,000	--
REMOVABLE	--	--	--	--	U: 12.75
Capacity per track (Bytes)	F: 25,600	F: 35,328	F: 35,328	F: 25,600	U: 10,416
Data surfaces per spindle	8	13	13	21	2
Heads per data surface	1	1	1	1	1
Tracks per surface	1861	2649	3099	1861	612
Track density (TPI)	1875	1750	2045	1875	612
Maximum linear density (BPI)	30520 BPI 22890 FCI	22839 BPI 15226 FCI	22839 BPI 15226 FCI	30064 BPI 22548 FCI	10894
Recording code	1,7 RLL	2,7 RLL	2,7 RLL	1,7 RLL	MFM
Rotational speed (RPM)	3600	3600	3400	3600	3473
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rack & Pinion, Stepping Motor
Servo type	Embedded	Dedicated Surf.	Dedicated Surf.	Embedded	Open Loop
Average positioning time (msec)	16	18.5	16	13.3	98 (including settling)
Average rotational delay (msec)	8.3	8.3	8.8	8.9	8.6
Average access time (msec)	24.3	26.8	24.8	22.2	106.6
Data transfer rate (KBytes/sec)	2000	2800	2800	5000	625
FIRST CUSTOMER SHIPMENT	6/90	8/88	3/90	11/90	5/84
COMMENTS	41.3 mm high	SA600 consists of 4 or 8 spindles, up to 9,728 MB	SA800 consists of up to 16 spindles (in 2 cabinets),up to 24,096 MB	"Hispeed" mode with 10.3 msec. average seek	41.3 mm high

MANUFACTURER	DMA TECHNOLOGIES	DMA TECHNOLOGIES	DZU	DZU	DZU
DRIVE	370	371	ISOT 5502C	SM 5509	EC 5063
DISK/TREND GROUP	1	1	3	3	6
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	--	--	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	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	ST412	SCSI	ST412	ST412	IBM
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	--	--	U: 50.88	U: 44.84	F: 317
REMOVABLE	U: 25.0	F: 21.2	--	--	--
Capacity per track (Bytes)	U: 10,416	F: 8,704	U: 10,416	U: 10,416	F:
Data surfaces per spindle	2	2	5	7	15
Heads per data surface	1	1	1	1	2
Tracks per surface	1224	1224	977	615	1122
Track density (TPI)	1222	1222	625	625	475
Maximum linear density (BPI)	10894	10894	9617	9617	6248
Recording code	MFM	MFM	MFM	MFM	MFM
Rotational speed (RPM)	3473	3473	3600	3600	3600
PERFORMANCE					
Actuator type	Rack & Pinion, Stepping Motor	Rack & Pinion, Stepping Motor	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil
Servo type	Open Loop	Open Loop	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.
Average positioning time (msec)	85 (including settling)	85 (including settling)	40	45	25
Average rotational delay (msec)	8.6	8.6	8.3	8.3	8.3
Average access time (msec)	93.6	93.6	48.3	53.3	33.3
Data transfer rate (KBytes/sec)	625	625	625	625	1198
FIRST CUSTOMER SHIPMENT	5/88	5/88	1989		1985
COMMENTS	41.3 mm high	41.3 mm high			

MANUFACTURER	DZU	DZU	ECOL.2	ECOL.2	ECOL.2
DRIVE	EC 5063 C	EC 5065	EC-50	EC-100	EC3-100
DISK/TREND GROUP	6	7	3	5	5
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	14"	14"	95 mm OD 25 mm ID	95 mm OD 25 mm ID	95 mm OD 25 mm ID
Recording medium	Oxide Coated	Oxide Coated	Thin Film*	Thin Film*	Thin Film*
DRIVE: Heads	Ferrite	Ferrite	Thin Film	Thin Film	Thin Film
Interface	SMD	IBM	SCSI, IDE	SCSI, IDE	SCSI, IDE
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	U: 337.7	F: 635	F: 50	F: 100	F: 100
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 20,160	F:	F: 30,720	F: 30,720	F: 43,520
Data surfaces per spindle	15	15	1	2	1
Heads per data surface	2	2	1	1	1
Tracks per surface	1120	2242	1720	1720	2300
Track density (TPI)	475	960	1731	1731	2300
Maximum linear density (BPI)	6248	6248	57000 BPI 38000 FCI	57000 BPI 38000 FCI	
Recording code	MFM	MFM	2,7 RLL	2,7 RLL	
Rotational speed (RPM)	3600	3600	1565	1565	3200
PERFORMANCE					
Actuator type	Linear, Voice Coil	Linear, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Dedicated Surf.	Dedicated Surf.	Embedded	Embedded	Embedded
Average positioning time (msec)	22	25	35	35	20
Average rotational delay (msec)	8.3	8.3	19.25	19.25	9.37
Average access time (msec)	30.3	33.3	54.25	54.25	29.37
Data transfer rate (KBytes/sec)	1209	1198	937.5	937.5	2500
FIRST CUSTOMER SHIPMENT	1989	1989	3Q91	3Q91	1992
COMMENTS			25.4 mm high *Glass Disk	25.4 mm high *Glass Disk	17 mm high *Glass Disk

MANUFACTURER	ECOL.2	EDISA INFORMATICA	EDISA INFORMATICA	EDISA INFORMATICA	EDISA INFORMATICA
DRIVE	EC3-200	ED 71204	ED 71396	ED 71408	ED 71793
DISK/TREND GROUP	5	5	6	6	7
MARKET	OEM	Captive, OEM	Captive, OEM	Captive, OEM	Captive, 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	Thin Film*	Thin Film	Thin Film	Thin Film	Thin Film
DRIVE: Heads	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
Interface	SCSI, IDE	SCSI	SCSI	SCSI	SCSI
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	F: 200	F: 162	F: 332	F: 323	F: 664
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 43,520	F: 16,384	F: 28,672	F: 16,384	F: 28,672
Data surfaces per spindle	2	6	8	12	16
Heads per data surface	1	1	1	1	1
Tracks per surface	2300	1643	1447	1643	1447
Track density (TPI)	2300	1590	1667	1590	1667
Maximum linear density (BPI)		20745 BPI 13830 FCI	30552 BPI 20368 FCI	20745 BPI 13830 FCI	30552 BPI 20368 FCI
Recording code		2,7 RLL	2,7 RLL	2,7 RLL	2,7 RLL
Rotational speed (RPM)	3200	3348	4002	3348	4002
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Embedded	Embedded	Embedded	Embedded	Embedded
Average positioning time (msec)	20	17.5	16.5	17.5	16.5
Average rotational delay (msec)	9.37	8.96	7.49	8.96	7.49
Average access time (msec)	29.37	26.46	23.99	26.46	23.99
Data transfer rate (KBytes/sec)	2500	2000 synch. 1500 asynch.	4000 synch. 1500 asynch.	2000 synch. 1500 asynch.	4000 synch. 1500 asynch.
FIRST CUSTOMER SHIPMENT	1992	3Q90	1Q92	3Q90	3Q91
COMMENTS	17 mm high *Glass Disk				

MANUFACTURER	ELEBRA	ELEBRA	ELEBRA	ELEBRA	ELEBRA
DRIVE	W320	W530	W540	W560	W570
DISK/TREND GROUP	2	3	3	4	4
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	Thin Film	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	ST412	ST412	ST412	ST412	ST412
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	U: 25	U: 30	U: 48	U: 67	U: 77.26*
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 10,416	U: 10,416	U: 10,416	U: 10,416	U: 15,624*
Data surfaces per spindle	4	3	5	7	5
Heads per data surface	1	1	1	1	1
Tracks per surface	612	925	925	925	989
Track density (TPI)	600	960	960	960	960
Maximum linear density (BPI)	18800	9274	9274	9274	14302 BPI* 9535 FCI
Recording code	MFM	MFM	MFM	MFM	2,7 RLL
Rotational speed (RPM)	3600	3600	3600	3600	3597
PERFORMANCE					
Actuator type	Band, Stepping Motor	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Open Loop	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.
Average positioning time (msec)	65 (including settling)	28	28	28	28
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	73.3	36.3	36.3	36.3	36.3
Data transfer rate (KBytes/sec)	625	625	625	625	937.5*
FIRST CUSTOMER SHIPMENT	1Q89	2Q85	2Q85	2Q85	3Q91
COMMENTS	Usable with RLL controller	Usable with RLL controller	Usable with RLL controller	Usable with RLL controller	41.3 mm high *With RLL controller

MANUFACTURER	ELEBRA	ELEBRA	ELEBRA	ESPERT	EZI
DRIVE	W570-ST	W580	W950	EP-340A	1300
DISK/TREND GROUP	4	4	7	3	6
MARKET	OEM, PCM	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	230 mm OD 100 mm ID	95 mm OD 25 mm ID	130 mm OD 40 mm ID
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Thin Film	Thin Film
DRIVE: Heads	Ferrite	Ferrite	Thin Film	Ferrite	Thin Film
Interface	ST412	ST412	Modified SMD	PC AT	ESDI
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	U: 77.26*	U: 86	U: 516	F: 41.5	U: 310
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 15,624*	U: 10,416	U: 30,240	F: 13,312	U: 21,280
Data surfaces per spindle	5	9	12	3	12
Heads per data surface	1	1	2	1	1
Tracks per surface	989	925	1422	1040	1216
Track density (TPI)	960	960	960	1200	1207
Maximum linear density (BPI)	14100 BPI* 9400 FCI	9274	15159 BPI 10106 FCI	21122 BPI 14082 FCI	19331 BPI 12887 FCI
Recording code	2,7 RLL/MFM	MFM	2,7 RLL	2,7 RLL	2,7 RLL
Rotational speed (RPM)	3600	3600	3600	3600	3524
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Linear, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.
Average positioning time (msec)	28	28	18	25	25
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.5
Average access time (msec)	36.3	36.3	26.3	33.3	33.5
Data transfer rate (KBytes/sec)	937.5*	625	1825	4000 max.	1250
FIRST CUSTOMER SHIPMENT	2Q91	2Q85	1986	1990	1991
COMMENTS	41.3 mm high *With RLL controller	Usable with RLL controller	Similar to Seagate FSD	41.3 mm high	Previously manufactured by Siemens

MANUFACTURER	EZI	EZI	EZI	FUJI ELECTRIC	FUJI ELECTRIC
DRIVE	2300	4410	4420	FK309-26	FK309S-26R
DISK/TREND GROUP	6	6	6	2	2
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	95 mm OD 25 mm ID	95 mm OD 25 mm ID
Recording medium	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
DRIVE: Heads	Thin Film	Thin Film	Thin Film	Ferrite	Ferrite
Interface	SCSI	ESDI	SCSI	ST412	SCSI
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	F: 261.4	U: 382.55	F: 334.54	U: 25.6	F: 22.5
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 17,920	U: 31,616	F: 27,648	U: 10,416	F: 9,216
Data surfaces per spindle	12	11	11	4	4
Heads per data surface	1	1	1	1	1
Tracks per surface	1216	1100	1100	615	615
Track density (TPI)	1207	1207	1207	753	880
Maximum linear density (BPI)	19331 BPI 12887 FCI	29607 BPI 19736 FCI	29607 BPI 19736 FCI	15600	14200 BPI 9466 FCI
Recording code	2,7 RLL	2,7 RLL	2,7 RLL	MFM	2,7 RLL
Rotational speed (RPM)	3524	3558	3558	3350	3350
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Band, Stepping Motor	Band, Stepping Motor
Servo type	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Embedded	Embedded
Average positioning time (msec)	25	16.5	16.5	65 (including settling)	47 (including settling)
Average rotational delay (msec)	8.5	8.43	8.43	8.96	8.95
Average access time (msec)	33.5	24.93	24.93	73.96	55.95
Data transfer rate (KBytes/sec)	1250	1875	4000 synch. 2000 asynch.	625	645
FIRST CUSTOMER SHIPMENT	1991	1991	1991	4/87	1Q88
COMMENTS	Previously manufactured by Siemens	Previously manufactured by Siemens	Previously manufactured by Siemens	41.3 mm high	41.3 mm high

MANUFACTURER	FUJI ELECTRIC	FUJI ELECTRIC	FUJI ELECTRIC	FUJI ELECTRIC	FUJI ELECTRIC
DRIVE	FK309X-26	FK311A-26R	FK201-43R	FK303-52	FK309S-50R
DISK/TREND GROUP	2	2	3	3	3
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	65 mm OD 20 mm ID	95 mm OD 25 mm ID	95 mm OD 25 mm ID
Recording medium	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
DRIVE: Heads	Ferrite	Ferrite	MIG	Ferrite	Ferrite
Interface	PC XT	PC AT	SCSI	ST412	SCSI
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	F: 21.4	F: 21.4	F: 43	U: 51.2	F: 42.5
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 8,704	F: 17,408	F:	U: 10,416	F: 16,896
Data surfaces per spindle	4	2	4	8	4
Heads per data surface	1	1	1	1	1
Tracks per surface	615	615	618	615	615
Track density (TPI)	753	910	1341	753	880
Maximum linear density (BPI)	15600 BPI 10400 FCI	26600 BPI 17733 FCI	37780 BPI 28335 FCI	15600	25600 BPI 17066 FCI
Recording code	2,7 RLL	2,7 RLL	1,7 RLL	MFM	2,7 RLL
Rotational speed (RPM)	3350	3050	3414	3350	3150
PERFORMANCE					
Actuator type	Band, Stepping Motor	Rotary, Stepping Motor	Voice Coil	Band, Stepping Motor	Band, Stepping Motor
Servo type	Embedded	Embedded		Embedded	Embedded
Average positioning time (msec)	65 (including settling)	28 (including settling)	25	40 (including settling)	47 (including settling)
Average rotational delay (msec)	8.95	9.84	8.79	8.96	9.52
Average access time (msec)	73.95	37.84	33.79	48.96	56.52
Data transfer rate (KBytes/sec)	645	1093	1250	625	1093
FIRST CUSTOMER SHIPMENT	1Q88	2/89	3/91	8/87	1Q88
COMMENTS	41.3 mm high	25.4 mm high	19.05 mm high	41.3 mm high	41.3 mm high

MANUFACTURER	FUJI ELECTRIC	FUJI ELECTRIC	FUJI ELECTRIC	FUJITSU	FUJITSU
DRIVE	FK311A-50R	FK312S-53R	FK314S-90R	M2225D2	M2235AS
DISK/TREND GROUP	3	3	5	2	2
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	130 mm OD 40 mm ID
Recording medium	Thin Film	Thin Film	Thin Film	Oxide Coated	Oxide Coated
DRIVE: Heads	Ferrite	Ferrite	MIG	Ferrite	Ferrite
Interface	PC AT	SCSI	SCSI	ST412	ST412
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	F: 42.8	F: 40.3	F: 91.4	U: 25.62	U: 26.66
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 17,408	F: 15,360	F: 20,400	U: 10,416	U: 10,416
Data surfaces per spindle	4	4	4	4	8
Heads per data surface	1	1	1	1	1
Tracks per surface	615	652	1116	615	320
Track density (TPI)	910	1053	1400	834	300
Maximum linear density (BPI)	26600 BPI 17733 FCI	27000 BPI 18000 FCI	34000 BPI 25500 FCI	14845	10200
Recording code	2,7 RLL	2,7 RLL	1,7 RLL	MFM	MFM
Rotational speed (RPM)	3050	3051	3540	3600	3600
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Encoder Motor	Rotary, Voice Coil
Servo type	Embedded	Embedded	Embedded	Open Loop	Open Loop
Average positioning time (msec)	28	28	25	35	83
Average rotational delay (msec)	9.84	9.83	8.5	8.3	8.3
Average access time (msec)	37.84	37.83	33.5	43.3	91.3
Data transfer rate (KBytes/sec)	1093	1041	1500	625	625
FIRST CUSTOMER SHIPMENT	4Q89	2/89	4Q90	2Q87	10/83
COMMENTS	25.4 mm high	25.4 mm high	25.4 mm high	41.3 mm high	

MANUFACTURER	FUJITSU	FUJITSU	FUJITSU	FUJITSU	FUJITSU
DRIVE	M2226D2	M2227D2	M2241AS2 M2241B	M2242AS2 M2242B	M2611S/SA/SB
DISK/TREND GROUP	3	3	3	3	3
MARKET	OEM	OEM	Captive, OEM	Captive, 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	Thin Film
DRIVE: Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	ST412	ST412	ST412, SA4000	ST412, SA4000	SCSI
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	U: 38.43	U: 51.24	U: 31.4	U: 54.9	F: 45.07
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 10,416	U: 10,416	U: 10,416	U: 10,416	F: 17,408
Data surfaces per spindle	6	8	4	7	2
Heads per data surface	1	1	1	1	1
Tracks per surface	615	615	754	754	1334
Track density (TPI)	834	834	760	760	1681
Maximum linear density (BPI)	14845	14845	10200	10200	29571 BPI 22178 FCI
Recording code	MFM	MFM	MFM	MFM	1,7 RLL
Rotational speed (RPM)	3600	3600	3600	3600	3490
PERFORMANCE					
Actuator type	Rotary, Encoder Motor	Rotary, Encoder Motor	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Open Loop	Open Loop	Dedicated Surf.	Dedicated Surf.	Embedded
Average positioning time (msec)	35	35	30	30	25
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.6
Average access time (msec)	43.3	43.3	38.3	38.3	33.6
Data transfer rate (KBytes/sec)	625	625	625	625	2500 synch. 1500 asynch.
FIRST CUSTOMER SHIPMENT	1Q87	1Q87	5/84	5/84	4Q88
COMMENTS	41.3 mm high	41.3 mm high			25.4 mm high

MANUFACTURER	FUJITSU	FUJITSU	FUJITSU	FUJITSU	FUJITSU
DRIVE	M2611T	M2631S	M2631T	M2243AS2 M2243B	M2243T
DISK/TREND GROUP	3	3	3	4	4
MARKET	OEM	OEM	OEM	Captive, OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	95 mm OD 25 mm ID	65 mm OD 20 mm ID	65 mm OD 20 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: Heads	Ferrite	MIG	MIG	Ferrite	Ferrite
Interface	PC AT	SCSI-2	PC AT	ST412, SA4000	ST412
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	F: 45.07	U: 58 F: 45	U: 58 F: 45	U: 86.3	U: 86.4
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 16,896	*	*	U: 10,416	U: 10,416
Data surfaces per spindle	2	2	2	11	7
Heads per data surface	1	1	1	1	1
Tracks per surface	1334	916	916	754	1185
Track density (TPI)	1681	2000	2000	760	1226
Maximum linear density (BPI)	29571 BPI 22178 FCI	42500 BPI 31875 FCI	42500 BPI 31875 FCI	10200	10200
Recording code	1,7 RLL	1,7 RLL	1,7 RLL	MFM	MFM
Rotational speed (RPM)	3490	3600	3600	3600	3600
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Embedded	Embedded	Embedded	Dedicated Surf.	Dedicated Surf.
Average positioning time (msec)	25	18	18	30	25
Average rotational delay (msec)	8.6	8.3	8.3	8.3	8.3
Average access time (msec)	33.6	26.3	26.3	38.3	33.3
Data transfer rate (KBytes/sec)	7400 max.	5000 synch. 3000 asynch.	6300 max.	625	625
FIRST CUSTOMER SHIPMENT	3Q89	4Q91	4Q91	5/84	3Q87
COMMENTS	25.4 mm high	17 mm high *Varies by zone	17 mm high *Varies by zone		41.3 mm high

MANUFACTURER	FUJITSU	FUJITSU	FUJITSU	FUJITSU	FUJITSU
DRIVE	M2244C/E	M2244S/SA/SB	M2633S	M2633T	M2243R
DISK/TREND GROUP	4	4	4	4	5
MARKET	Captive, OEM	Captive, 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	65 mm OD 20 mm ID	65 mm OD 20 mm ID	130 mm OD 40 mm ID
Recording medium	Oxide Coated	Oxide Coated	Thin Film	Thin Film	Oxide Coated
DRIVE: Heads	Ferrite	Ferrite	MIG	MIG	Ferrite
Interface	ESDI	SCSI	SCSI-2	PC AT	ST412
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	U: 85.8	F: 67.2	U: 116 F: 90	U: 116 F: 90	U: 129.6*
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 20,864	F: 16,640	*	*	U: 15,624*
Data surfaces per spindle	5	5	4	4	7
Heads per data surface	1	1	1	1	1
Tracks per surface	823	823	916	916	1185
Track density (TPI)	850	850	2000	2000	1226
Maximum linear density (BPI)	20400 BPI 13600 FCI	20400 BPI 13600 FCI	42500 BPI 31875 FCI	42500 BPI 31875 FCI	15300 BPI 10200 FCI
Recording code	2,7 RLL	2,7 RLL	1,7 RLL	1,7 RLL	2,7 RLL*
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
Servo type	Dedicated Surf.	Dedicated Surf.	Embedded	Embedded	Dedicated Surf.
Average positioning time (msec)	25	25	18	18	25
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	33.3	33.3	26.3	26.3	33.3
Data transfer rate (KBytes/sec)	1250	2500 synch. 1500 asynch.	5000 synch. 3000 asynch.	6300 max.	937.5*
FIRST CUSTOMER SHIPMENT	3Q85	2Q87	4Q91	4Q91	3Q87
COMMENTS			17 mm high *Varies by zone	17 mm high *Varies by zone	41.3 mm high *With RLL controller

MANUFACTURER	FUJITSU	FUJITSU	FUJITSU	FUJITSU	FUJITSU
DRIVE	M2245C/E	M2245S/SA/SB	M2246C/E	M2246S/SA/SB	M2247E
DISK/TREND GROUP	5	5	5	5	5
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	130 mm OD 40 mm ID
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	ESDI	SCSI	ESDI	SCSI	ESDI
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	U: 120.2	F: 97.1	U: 171.7	F: 140.8	U: 181.5
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 20,864	F: 16,640	U: 20,864	F: 16,640	U: 20,864
Data surfaces per spindle	7	7	10	10	7
Heads per data surface	1	1	1	1	1
Tracks per surface	823	823	823	823	1243
Track density (TPI)	850	850	850	850	1267
Maximum linear density (BPI)	20400 BPI 13600 FCI	20400 BPI 13600 FCI	20400 BPI 13600 FCI	20400 BPI 13600 FCI	19295 BPI 14471 FCI
Recording code	2,7 RLL	2,7 RLL	2,7 RLL	2,7 RLL	1,7 RLL
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
Servo type	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.
Average positioning time (msec)	25	25	25	25	18
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	33.3	33.3	33.3	33.3	26.3
Data transfer rate (KBytes/sec)	1250	2500 synch. 1500 asynch.	1250	2500 synch. 1500 asynch.	1250
FIRST CUSTOMER SHIPMENT	3Q85	2Q87	3Q85	2Q87	3Q87
COMMENTS					

MANUFACTURER	FUJITSU	FUJITSU	FUJITSU	FUJITSU	FUJITSU
DRIVE	M2247S/SA/SB	M2248E	M2248S/SA/SB	M2322K	M2331K
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	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: Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	SCSI	ESDI	SCSI	SMD	SMD
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	F: 153.1	U: 285.3	F: 244.6	U: 168.5	U: 168.5
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 16,640	U: 20,864	F: 16,640	U: 20,480	U: 40,960
Data surfaces per spindle	7	11	11	10	5
Heads per data surface	1	1	1	1	1
Tracks per surface	1243	1243	1243	823	823
Track density (TPI)	1267	1267	1267	683	683
Maximum linear density (BPI)	19295 BPI 14471 FCI	19295 BPI 14471 FCI	19295 BPI 14471 FCI	9867	19734 BPI 13156 FCI
Recording code	1,7 RLL	1,7 RLL	1,7 RLL	MFM	2,7 RLL
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
Servo type	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.
Average positioning time (msec)	18	18	18	20	20
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	26.3	26.3	26.3	28.3	28.3
Data transfer rate (KBytes/sec)	2500 synch. 1500 asynch.	1250	2500 synch. 1500 asynch.	1229	2458
FIRST CUSTOMER SHIPMENT	1Q88	3Q87	1Q88	11/83	11/84
COMMENTS					

MANUFACTURER	FUJITSU	FUJITSU	FUJITSU	FUJITSU	FUJITSU
DRIVE	M2612ES/ESA/ESB M2612S/SA/SB	M2612ET/T	M2613ES/ESA/ESB M2613S/SA/SB	M2613ET/T	M2614ES/ESA/ESB M2614S/SA/SB
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	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
DRIVE: Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	SCSI	PC AT	SCSI	PC AT	SCSI
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	F: 90.84	F: 90.15	F: 136.6	F: 135.23	F: 182.36
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 17,408	F: 16,896	F: 17,408	F: 16,896	F: 17,408
Data surfaces per spindle	4	4	6	6	8
Heads per data surface	1	1	1	1	1
Tracks per surface	1334	1334	1334	1334	1334
Track density (TPI)	1681	1681	1681	1681	1681
Maximum linear density (BPI)	29571 BPI 22178 FCI	29571 BPI 22178 FCI	29571 BPI 22178 FCI	29571 BPI 22178 FCI	29571 BPI 22178 FCI
Recording code	1,7 RLL	1,7 RLL	1,7 RLL	1,7 RLL	1,7 RLL
Rotational speed (RPM)	3490	3490	3490	3490	3490
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Embedded	Embedded	Embedded	Embedded	Embedded
Average positioning time (msec)	20/25*	20/25	20/25*	20/25	20/25*
Average rotational delay (msec)	8.6	8.6	8.6	8.6	8.6
Average access time (msec)	28.6/33.6*	28.6/33.6	28.6/33.6*	28.6/33.6	28.6/33.6*
Data transfer rate (KBytes/sec)	2500 synch. 1500 asynch.	7400 max.	2500 synch. 1500 asynch.	7400 max.	2500 synch. 1500 asynch.
FIRST CUSTOMER SHIPMENT	4Q88	3Q89	4Q88	3Q89	4Q88
COMMENTS	41.3 mm high *ESA/S/SA/SB	41.3 mm high	41.3 mm high *ESA/S/SA/SB	41.3 mm high	41.3 mm high *ESA/S/SA/SB

MANUFACTURER	FUJITSU	FUJITSU	FUJITSU	FUJITSU	FUJITSU
DRIVE	M2614ET/T	M2616ES/ESA/ESB M2616SA	M2616ET/T	F6421	M2249E
DISK/TREND GROUP	5	5	5	6	6
MARKET	OEM	OEM	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	10.5" OD 4.0" ID	130 mm OD 40 mm ID
Recording medium	Thin Film	Thin Film	Thin Film	Oxide Coated	Oxide Coated
DRIVE: Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	PC AT	SCSI	PC AT	Fujitsu	ESDI
CAPACITY/RECORDING DENSITY				1.607 or 1.144 MB Fixed Head Option	
Total capacity (Mbytes) FIXED	F: 180.31	F: 105	F: 105	F: 446/317.5	U: 389
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 16,896	F: 17,408	F: 16,896	F: 26,793/ 19,069	U: 20,864
Data surfaces per spindle	8	4	4	10	15
Heads per data surface	1	1	1	2	1
Tracks per surface	1334	1542	1542	1680	1243
Track density (TPI)	1681	1681	1681	880	1267
Maximum linear density (BPI)	29571 BPI 22178 FCI	32069 BPI 24052 FCI	32069 BPI 24052 FCI	12790	19295 BPI 14471 FCI
Recording code	1,7 RLL	1,7 RLL	1,7 RLL	MFM	1,7 RLL
Rotational speed (RPM)	3490	3490	3490	3961	3600
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Embedded	Embedded	Embedded	Dedicated Surf.	Dedicated Surf.
Average positioning time (msec)	20/25	20	20	18	18
Average rotational delay (msec)	8.6	8.6	8.6	7.5	8.3
Average access time (msec)	28.6/33.6	28.6	28.6	25.5	26.3
Data transfer rate (KBytes/sec)	7400 max.	2500 synch. 1500 asynch.	7400 max.	1859	1250
FIRST CUSTOMER SHIPMENT	3Q89	1Q90	1Q90	3Q81	3Q87
COMMENTS	41.3 mm high	25.4 mm high	25.4 mm high	Drive has 4 spindles	

MANUFACTURER	FUJITSU	FUJITSU	FUJITSU	FUJITSU	FUJITSU
DRIVE	M2249S/SA/SB	M2261E	M2261H/HA/HB M2261S/SA/SB	M2333K/KS/P	M2343K/KS
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	210 mm OD 100 mm ID	210 mm OD 100 mm ID
Recording medium	Oxide Coated	Thin Film	Thin Film	Oxide Coated	Oxide Coated
DRIVE: Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	SCSI	ESDI	SCSI	Modified SMD	Modified SMD
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	F: 333.6	U: 415.1	F: 357.1*	U: 337.1	U: 383.38
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 16,640	U: 31,296	F: 27,136	U: 40,960	U: 40,960
Data surfaces per spindle	15	8	8	10	7.5
Heads per data surface	1	1	1	1	2/1
Tracks per surface	1243	1658	1658	823	1248
Track density (TPI)	1267	1712	1712	683	846
Maximum linear density (BPI)	19295 BPI 14471 FCI	28816 BPI 21612 FCI	28816 BPI 21612 FCI	19734 BPI 13156 FCI	20767 BPI 13844 FCI
Recording code	1,7 RLL	1,7 RLL	1,7 RLL	2,7 RLL	2,7 RLL
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
Servo type	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.
Average positioning time (msec)	18	16	16	20	16
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	26.3	24.3	24.3	28.3	24.3
Data transfer rate (KBytes/sec)	2500 synch. 1500 asynch.	1875	4000 synch. 1750 asynch.	2458	2458
FIRST CUSTOMER SHIPMENT	1Q88	2Q88	2Q88	11/84	4Q87
COMMENTS			*512 byte sector		

MANUFACTURER	FUJITSU	FUJITSU	FUJITSU	FUJITSU	FUJITSU
DRIVE	M2350A	M2351A	M2622F/FA/FB	M2622S/SA/SB	M2622T
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	10.5" OD 4.0" ID	10.5" OD 4.0" 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	Thin Film	Thin Film	Thin Film
DRIVE: Heads	Ferrite	Ferrite	MIG	MIG	MIG
Interface	Modified SMD	Modified SMD	SCSI-1/2	SCSI-1/2	PC AT
CAPACITY/RECORDING DENSITY		1.69 MB Fixed Head Option			
Total capacity (Mbytes) FIXED	U: 474.2	U: 474.2	F: 330.17	F: 330.17	F: 326.7
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 28,160	U: 28,160	*	*	*
Data surfaces per spindle	10	10	7	7	7
Heads per data surface	2	2	1	1	1
Tracks per surface	1682	1684	1435	1435	1435
Track density (TPI)	880	880	1751	1751	1751
Maximum linear density (BPI)	12790	12790	46383 BPI 34787 FCI	46383 BPI 34787 FCI	46383 BPI 34787 FCI
Recording code	MFM	MFM	1,7 RLL	1,7 RLL	1,7 RLL
Rotational speed (RPM)	3961	3961	4400	4400	4400
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.
Average positioning time (msec)	18	18	12	12	12
Average rotational delay (msec)	7.5	7.5	6.8	6.8	6.8
Average access time (msec)	25.5	25.5	18.8	18.8	18.8
Data transfer rate (KBytes/sec)	1859/7436/9295	1859	10000 synch. 3000 asynch.	5000 synch. 3000 asynch.	7400 max.
FIRST CUSTOMER SHIPMENT	2/84	3/82	1Q91	1Q91	3Q91
COMMENTS	Parallel data transfer, 4 or 5 channels		41.3 mm high *Varies by zone	41.3 mm high *Varies by zone	41.3 mm high *Varies by zone

MANUFACTURER	FUJITSU	FUJITSU	FUJITSU	FUJITSU	FUJITSU
DRIVE	M2623F/FA/FB	M2623S/SA/SB	M2623T	F6423B	F6425G
DISK/TREND GROUP	6	6	6	7	7
MARKET	OEM	OEM	OEM	Captive	Captive
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	210 mm OD 100 mm ID	10.5" OD 4.0" ID
Recording medium	Thin Film	Thin Film	Thin Film	Oxide Coated	Oxide Coated
DRIVE: Heads	MIG	MIG	MIG	Ferrite	Ferrite
Interface	SCSI-1/2	SCSI-1/2	PC AT	Fujitsu	Fujitsu
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	F: 425.1	F: 425.1	F: 420.1	F: 630.0	F: 630.0
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	*	*	*	F: 47,476	F: 47,476
Data surfaces per spindle	9	9	9	8	8
Heads per data surface	1	1	1	2	2
Tracks per surface	1435	1435	1435	988	1770
Track density (TPI)	1751	1751	1751	1193	1370
Maximum linear density (BPI)	46383 BPI 34787 FCI	46383 BPI 34787 FCI	46383 BPI 34787 FCI	25300 BPI 18975 FCI	21300 BPI 15975 FCI
Recording code	1,7 RLL	1,7 RLL	1,7 RLL	1,7 RLL	1,7 RLL
Rotational speed (RPM)	4400	4400	4400	3620	3620
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.
Average positioning time (msec)	12	12	12	13	12
Average rotational delay (msec)	6.8	6.8	6.8	8.3	8.3
Average access time (msec)	18.8	18.8	18.8	21.3	20.3
Data transfer rate (KBytes/sec)	10000 synch. 3000 asynch.	5000 synch. 3000 asynch.	7400 max.	3000	3000
FIRST CUSTOMER SHIPMENT	1Q91	1Q91	3Q91	8/88	12/88
COMMENTS	41.3 mm high *Varies by zone	41.3 mm high *Varies by zone	41.3 mm high *Varies by zone	Drive has 4 spindles	Drive has 4 spindles

MANUFACTURER	FUJITSU	FUJITSU	FUJITSU	FUJITSU	FUJITSU
DRIVE	F6425K4/L4	M2262E	M2262H/HA/HB M2262S/SA/SB	M2263E	M2263H/HA/HB M2263S/SA/SB
DISK/TREND GROUP	7	7	7	7	7
MARKET	Captive	OEM	OEM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	10.5" OD 4.0" 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: Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	Fujitsu	ESDI	SCSI	ESDI	SCSI
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	F: 630.0	U: 570.8	F: 492*	U: 778.3	F: 671.9*
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 47,476	U: 31,296	F: 27,136	U: 31,296	F: 27,136
Data surfaces per spindle	8	11	11	15	15
Heads per data surface	2	1	1	1	1
Tracks per surface	1770	1658	1658	1658	1658
Track density (TPI)	910	1712	1712	1712	1712
Maximum linear density (BPI)	24420 BPI 16280 FCI	28816 BPI 21612 FCI	28816 BPI 21612 FCI	28816 BPI 21612 FCI	28816 BPI 21612 FCI
Recording code	2,7 RLL	1,7 RLL	1,7 RLL	1,7 RLL	1,7 RLL
Rotational speed (RPM)	3620	3600	3600	3600	3600
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.
Average positioning time (msec)	15	16	16	16	16
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	23.3	24.3	24.3	24.3	24.3
Data transfer rate (KBytes/sec)	3000	1875	4000 synch. 1750 asynch.	1875	4000 synch. 1750 asynch.
FIRST CUSTOMER SHIPMENT	3Q86	2Q88	2Q88	2Q88	4Q88
COMMENTS	Drive has 4 spindles		*512 byte sector		*512 byte sector

MANUFACTURER	FUJITSU	FUJITSU	FUJITSU	FUJITSU	FUJITSU
DRIVE	M2344K/KS	M2360A	M2361A	M2372K/KS	M2381K/KP
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	210 mm OD 100 mm ID	10.5" OD 4.0" ID	10.5" OD 4.0" 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: Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	Mod. SMD, SCSI	Modified SMD	Modified SMD	Mod. SMD, SCSI	Mod. SMD, IPI-2
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	U: 690.1	U: 689.8	U: 689.8	U: 823.9	U: 555.7
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 40,960	U: 40,960	U: 40,960	U: 40,960	U: 49,728
Data surfaces per spindle	13.5	10	10	13.5	7.5
Heads per data surface	2/1	2	2	2/1	2/1
Tracks per surface	1248	1684	1682	1490	1490
Track density (TPI)	846	880	880	1193	1193
Maximum linear density (BPI)	20767 BPI 13844 FCI	18620 BPI 12413 FCI	18620 BPI 12413 FCI	20766 BPI 13844 FCI	25211 BPI 18908 FCI
Recording code	2,7 RLL	2,7 RLL	2,7 RLL	2,7 RLL	1,7 RLL
Rotational speed (RPM)	3600	3673	3600	3600	3620
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.
Average positioning time (msec)	16	18	18	16	16
Average rotational delay (msec)	8.3	8.17	8.3	8.3	8.3
Average access time (msec)	24.3	26.17	26.3	24.3	24.3
Data transfer rate (KBytes/sec)	2458	2507-12537	2458	2458	3000
FIRST CUSTOMER SHIPMENT	2Q87	3Q86	2Q85	9/87	1Q88
COMMENTS		Parallel data transfer, 4 or 5 channels			

MANUFACTURER	FUJITSU	FUJITSU	FUJITSU	FUJITSU	FUJITSU
DRIVE	M2391D	M2624F/FA/FB	M2624S/SA/SB	M2624T	F6425M4/N4
DISK/TREND GROUP	7	7	7	7	8
MARKET	OEM	OEM	OEM	OEM	Captive
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	210 mm OD 100 mm ID	95 mm OD 25 mm ID	95 mm OD 25 mm ID	95 mm OD 25 mm ID	10.5" OD 4.0" ID
Recording medium	Oxide Coated	Thin Film	Thin Film	Thin Film	Oxide Sputtered
DRIVE: Heads	Thin Film	MIG	MIG	MIG	Ferrite
Interface	Modified SMD	SCSI-1/2	SCSI-1/2	PC AT	Fujitsu
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	U: 965	F: 520.1	F: 520.1	F: 513.5	F: 1,260
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 45,792	*	*	*	F: 47,476
Data surfaces per spindle	11	11	11	11	12
Heads per data surface	1	1	1	1	2
Tracks per surface	1916	1435	1435	1435	2360
Track density (TPI)	1456	1751	1751	1751	1160
Maximum linear density (BPI)	22764 BPI 17073 FCI	46383 BPI 34787 FCI	46383 BPI 34787 FCI	46383 BPI 34787 FCI	24425 BPI 16283 FCI
Recording code	1,7 RLL	1,7 RLL	1,7 RLL	1,7 RLL	2,7 RLL
Rotational speed (RPM)	3600	4400	4400	4400	3620
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.
Average positioning time (msec)	12	12	12	12	17
Average rotational delay (msec)	8.3	6.8	6.8	6.8	8.3
Average access time (msec)	20.3	18.8	18.8	18.8	25.3
Data transfer rate (KBytes/sec)	2750	10000 synch. 3000 asynch.	5000 synch. 3000 asynch.	7400 max.	3000
FIRST CUSTOMER SHIPMENT	1Q90	1Q91	1Q91	3Q91	3Q86
COMMENTS		41.3 mm high *Varies by zone	41.3 mm high *Varies by zone	41.3 mm high *Varies by zone	Drive has 4 spindles

MANUFACTURER	FUJITSU	FUJITSU	FUJITSU	FUJITSU	FUJITSU
DRIVE	M2266H/HA/HB M2266S/SA/SB	M2380A	M2382K/P	M2391K	F6425H
DISK/TREND GROUP	8	8	8	8	9
MARKET	OEM	OEM	OEM	OEM	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	210 mm OD 100 mm ID	10.5" OD 4.0" ID
Recording medium	Thin Film	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Sputtered
DRIVE: Heads		Ferrite	Ferrite	Thin Film	Ferrite
Interface	SCSI	Modified SMD	Mod. SMD, IPI-2	Modified SMD	Fujitsu
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	F: 1,165*	U: 1,000.2	U: 1,000.2	U: 1,062	F: 1,890
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 46,080*	U: 49,728	U: 49,728	U: 50,400	F: 47,476
Data surfaces per spindle	15	13.5	13.5	11	16
Heads per data surface	1	2/1	2/1	1	2
Tracks per surface	1658	1490	1490	1916	2654
Track density (TPI)	1634	1193	1193	1456	1370
Maximum linear density (BPI)	46635 BPI 34976 FCI	25211 BPI 18908 FCI	25211 BPI 18908 FCI	25055 BPI 18791 FCI	24440 BPI 18330 FCI
Recording code	1,7 RLL	1,7 RLL	1,7 RLL	1,7 RLL	1,7 RLL
Rotational speed (RPM)	3600	3709	3620	3600	3620
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.
Average positioning time (msec)	14.5	16	16	12	16
Average rotational delay (msec)	8.3	8.1	8.3	8.3	8.3
Average access time (msec)	22.8	24.1	24.3	20.3	24.3
Data transfer rate (KBytes/sec)	4800 synch. 2000 asynch.	3074-1844	3000	3000	3000
FIRST CUSTOMER SHIPMENT	2Q90	1Q89	1Q88	1Q90	12/88
COMMENTS	*1024 byte block	Parallel data transfer, 4, 5 or 6 channels Total capacity varies in each version			Drive has 4 spindles

MANUFACTURER	FUJITSU	FUJITSU	FUJITSU	FUJITSU	FUJITSU
DRIVE	F6427H	M2392D	M2392K	M2652P	M2652S/H/HD
DISK/TREND GROUP	9	9	9	9	9
MARKET	Captive	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 100 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID
Recording medium	Thin Film	Oxide Coated	Oxide Coated	Thin Film	Thin Film
DRIVE: Heads	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
Interface	Fujitsu	Modified SMD	Modified SMD	IPI-2	SCSI-2
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	F: 1,890	F: 1,842	U: 2,027	U: 2,000	F: 1,750
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 47,476	F: 45,792	U: 50,400	U: 52,864	F: 43,008
Data surfaces per spindle	15	21	21	20	20
Heads per data surface	1	1	1	1	1
Tracks per surface	2655	1916	1916	2011	2011
Track density (TPI)	2080	1456	1456	1780	1780
Maximum linear density (BPI)	33310 BPI 24980 FCI	22764 BPI 17073 FCI	25055 BPI 18791 FCI	50257 BPI 37692 FCI	50257 BPI 37692 FCI
Recording code	1,7 RLL	1,7 RLL	1,7 RLL	1,7 RLL	1,7 RLL
Rotational speed (RPM)	4340	3600	3600	5400	5400
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.
Average positioning time (msec)	12	12	12	11	11
Average rotational delay (msec)	6.9	8.3	8.3	5.56	5.56
Average access time (msec)	18.9	20.3	20.3	16.56	16.56
Data transfer rate (KBytes/sec)	4500	2750	3000	4758	10000 synch. 3000 asynch.
FIRST CUSTOMER SHIPMENT	12/90	1Q90	1Q90	2Q91	2Q91
COMMENTS	Drive has maximum 16 spindles				

MANUFACTURER	FUJITSU	GREENERY TECHNOLOGY	GREENERY TECHNOLOGY	GREENERY TECHNOLOGY	GREENERY TECHNOLOGY
DRIVE	M2671P	G3100	G360	G360S	G3100S/A
DISK/TREND GROUP	9	4	4	4	5
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	210 mm OD 100 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	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
DRIVE: Heads	Thin Film	Ferrite	Ferrite	Ferrite	Ferrite
Interface	IPI-2	ST412	ST412	PC AT, SCSI	PC AT, SCSI
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	U: 2,648	F: 80	F: 57	F: 60	F: 104
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 66,096	F:	F:	F:	F:
Data surfaces per spindle	15	7	5	5	7
Heads per data surface	1	1	1	1	1
Tracks per surface	2671	855	855	855	855
Track density (TPI)	2080	1200	1088	1088	1200
Maximum linear density (BPI)	33310 BPI 24983 FCI	20625 BPI 13750 FCI	20600 BPI 13733 FCI	22000 BPI 14666 FCI	27500 BPI 18333 FCI
Recording code	1,7 RLL	2,7 RLL	2,7 RLL	2,7 RLL	2,7 RLL
Rotational speed (RPM)	4340	3600	3600	3600	3600
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.
Average positioning time (msec)	12	20	28	20	19
Average rotational delay (msec)	6.91	8.3	8.3	8.3	8.3
Average access time (msec)	18.91	28.3	36.3	28.3	27.3
Data transfer rate (KBytes/sec)	4781	937.5	937.5	1250	1000
FIRST CUSTOMER SHIPMENT	2Q90	1991	1990	1990	1991
COMMENTS		41.3 mm high	41.3 mm high	41.3 mm high	41.3 mm high

MANUFACTURER	HEWLETT-PACKARD	HEWLETT-PACKARD	HEWLETT-PACKARD	HEWLETT-PACKARD	HEWLETT-PACKARD
DRIVE	9153	C2228B/M	C2229B/M	C2233	7959B
DISK/TREND GROUP	2	5	5	5	6
MARKET	Captive	PCM	PCM	OEM	Captive
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	130 mm OD 40 mm ID
Recording medium	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
DRIVE: Heads	Ferrite	MIG	MIG	MIG	Thin Film
Interface	HP	SCSI	SCSI	SCSI-2, PC AT	HPIB
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	F: 20	F: 234	F: 422	F: 234	F: 304
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 7,168	*	*	*	F: 16,128
Data surfaces per spindle	2	5	9	5	12
Heads per data surface	1	1	1	1	1
Tracks per surface	1400	1546	1546	1546	1572
Track density (TPI)	1850	1857	1857	1857	1590
Maximum linear density (BPI)	12700	41100 BPI 27400 FCI	41100 BPI 27400 FCI	41100 BPI 27400 FCI	20500 BPI 13666 FCI
Recording code	MFM	2,7 RLL	2,7 RLL	2,7 RLL	2,7 RLL
Rotational speed (RPM)	3000	3600	3600	3600	3350
PERFORMANCE					
Actuator type	Rotary, Band, Stepping Motor	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Embedded	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Embedded
Average positioning time (msec)	75 (including settling)	12.6	12.6	12.6	17
Average rotational delay (msec)	10	8.3	8.3	8.3	8.95
Average access time (msec)	85	20.9	20.9	20.9	25.95
Data transfer rate (KBytes/sec)	500	10000 synch. 6800 asynch.	10000 synch. 6800 asynch.	10000 synch. 6800 asynch.	1250
FIRST CUSTOMER SHIPMENT	12/85	10/91	10/91	4Q90	2Q88
COMMENTS	51 mm high	41.3 mm high *Varies by zone	41.3 mm high *Varies by zone	41.3 mm high *Varies by zone	HP 9000, 3000, 1000

MANUFACTURER	HEWLETT-PACKARD	HEWLETT-PACKARD	HEWLETT-PACKARD	HEWLETT-PACKARD	HEWLETT-PACKARD
DRIVE	7959S	97544D 97544S	97544E	97544P 97544T	C2200A
DISK/TREND GROUP	6	6	6	6	6
MARKET	Captive	OEM	OEM	OEM	Captive
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: Heads	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
Interface	SCSI	SCSI	ESDI	SCSI-2	ESDI, HPIB
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	F: 323	F: 332	U: 398	F: 332	F: 335
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 17,152	F: 28,672	U: 34,143	F: 28,672	F: 29,184
Data surfaces per spindle	12	8	8	8	8
Heads per data surface	1	1	1	1	1
Tracks per surface	1572	1447	1457	1447	1457
Track density (TPI)	1590	1667	1667	1667	1667
Maximum linear density (BPI)	20500 BPI 13666 FCI	30552 BPI 20368 FCI	30552 BPI 20368 FCI	30552 BPI 20368 FCI	30552 BPI 20368 FCI
Recording code	2,7 RLL	2,7 RLL	2,7 RLL	2,7 RLL	2,7 RLL
Rotational speed (RPM)	3350	4002	4002	4002	4002
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Embedded	Embedded	Embedded	Embedded	Embedded
Average positioning time (msec)	17	16.5	17	16.5	17
Average rotational delay (msec)	8.95	7.5	7.5	7.5	7.5
Average access time (msec)	25.95	24	24.5	24	24.5
Data transfer rate (KBytes/sec)	1250	4000 synch. 1500 asynch.	2500	5000 synch. 1500 asynch.	2500
FIRST CUSTOMER SHIPMENT	2Q88	2Q89	1Q89	3Q90	1/90
COMMENTS	HP 9000				

MANUFACTURER	HEWLETT-PACKARD	HEWLETT-PACKARD	HEWLETT-PACKARD	HEWLETT-PACKARD	HEWLETT-PACKARD
DRIVE	C2212A	C2220B/M	C2234	C2235	C2260A
DISK/TREND GROUP	6	6	6	6	6
MARKET	Captive	PCM	OEM	OEM	PCM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	130 mm OD 40 mm ID	95 mm OD 25 mm ID	95 mm OD 25 mm ID	95 mm OD 25 mm ID	130 mm OD 40 mm ID
Recording medium	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
DRIVE: Heads	Thin Film	MIG	MIG	MIG	Thin Film
Interface	SCSI	SCSI	SCSI-2, PC AT	SCSI-2, IDE	SCSI
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	F: 332	F: 328	F: 328	F: 422	F: 322
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 28,672	*	*	*	F: 28,672
Data surfaces per spindle	8	7	7	9	8
Heads per data surface	1	1	1	1	1
Tracks per surface	1447	1546	1546	1546	1447
Track density (TPI)	1667	1857	1857	1857	1667
Maximum linear density (BPI)	30552 BPI 20368 FCI	41100 BPI 27400 FCI	41100 BPI 27400 FCI	41100 BPI 27400 FCI	30552 BPI 20368 FCI
Recording code	2,7 RLL	2,7 RLL	2,7 RLL	2,7 RLL	2,7 RLL
Rotational speed (RPM)	4002	3600	3600	3600	4002
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Embedded	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Embedded
Average positioning time (msec)	16.5	12.6	12.6	12.6	16.5
Average rotational delay (msec)	7.5	8.3	8.3	8.3	7.5
Average access time (msec)	24	20.9	20.9	20.9	24
Data transfer rate (KBytes/sec)	5000 synch. 1500 asynch.	10000 synch. 6800 asynch.	10000 synch. 6800 asynch.	10000 synch. 6800 asynch.	4000 synch. 1500 asynch.
FIRST CUSTOMER SHIPMENT	2Q90	10/91	4Q90	4Q90	10/90
COMMENTS	HP 9000, S300	41.3 mm high *Varies by zone	41.3 mm high *Varies by zone	41.3 mm high *Varies by zone	

MANUFACTURER	HEWLETT-PACKARD	HEWLETT-PACKARD	HEWLETT-PACKARD	HEWLETT-PACKARD	HEWLETT-PACKARD
DRIVE	C2460F/R	7937FL 7937H 7937XP	97548D 97548S	97548E	97548P 97548T
DISK/TREND GROUP	6	7	7	7	7
MARKET	Captive	Captive	OEM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	95 mm OD 25 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	Thin Film	Thin Film	Thin Film	Thin Film
DRIVE: Heads	MIG	Ferrite	Thin Film	Thin Film	Thin Film
Interface	SCSI	HPIB,Fiber Link	SCSI	ESDI	SCSI-2
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	F: 422	F: 571	F: 664	U: 796	F: 664
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	*	F: 31,488	F: 28,672	U: 34,143	F: 28,672
Data surfaces per spindle	9	13	16	16	16
Heads per data surface	1	1	1	1	1
Tracks per surface	1546	1396	1447	1457	1447
Track density (TPI)	1857	1121	1667	1667	1667
Maximum linear density (BPI)	41100 BPI 27400 FCI	18800 BPI* 14101 FCI	30552 BPI 20368 FCI	30552 BPI 20368 FCI	30552 BPI 20368 FCI
Recording code	2,7 RLL	1,7 RLL	2,7 RLL	2,7 RLL	2,7 RLL
Rotational speed (RPM)	3600	3600	4002	4002	4002
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Dedicated Surf.	Embedded	Embedded	Embedded	Embedded
Average positioning time (msec)	12.6	20.5	16.5	17	16.5
Average rotational delay (msec)	8.3	8.3	7.5	7.5	7.5
Average access time (msec)	20.9	28.8	24	24.5	24
Data transfer rate (KBytes/sec)	10000 synch. 6800 asynch.	2351	4000 synch. 1500 asynch.	2500	5000 synch. 1500 asynch.
FIRST CUSTOMER SHIPMENT	7/91	4Q86	4Q88	4Q88	1Q90
COMMENTS	41.3 mm high *Varies by zone	*Variable Length Frequency Modulation			

MANUFACTURER	HEWLETT-PACKARD	HEWLETT-PACKARD	HEWLETT-PACKARD	HEWLETT-PACKARD	HEWLETT-PACKARD
DRIVE	97556	97556P 97556T	C2201A C2202/03A	C2204A	C2213A
DISK/TREND GROUP	7	7	7	7	7
MARKET	OEM	OEM	Captive	Captive	Captive
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: Heads	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
Interface	ESDI	SCSI-2	ESDI, HPIB, FL	ESDI, FL	SCSI
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	U: 803	F: 677	F: 670	F: 670	F: 664
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 43,056	F: 36,864	F: 29,184	F: 29,184	F: 28,672
Data surfaces per spindle	11	11	16	16	16
Heads per data surface	1	1	1	1	1
Tracks per surface	1697	1670	1457	1457	1447
Track density (TPI)	1865	1865	1667	1667	1667
Maximum linear density (BPI)	42000 BPI 28000 FCI	42000 BPI 28000 FCI	30552 BPI 20368 FCI	30552 BPI 20368 FCI	30552 BPI 20368 FCI
Recording code	2,7 RLL	2,7 RLL	2,7 RLL	2,7 RLL	2,7 RLL
Rotational speed (RPM)	4002	4002	4002	4002	4002
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Dedicated Surf.	Dedicated Surf.	Embedded	Embedded	Embedded
Average positioning time (msec)	13.5	13.5	17	17	16.5
Average rotational delay (msec)	7.5	7.5	7.5	7.5	7.5
Average access time (msec)	21	21	24.5	24.5	24
Data transfer rate (KBytes/sec)	2875	5000 synch. 1500 asynch.	2500	2500	5000 synch. 1500 asynch.
FIRST CUSTOMER SHIPMENT	3Q90	3Q90	1/90	2/90	2Q90
COMMENTS				Drive has 2 spindles	HP 9000, S300

MANUFACTURER	HEWLETT-PACKARD	HEWLETT-PACKARD	HEWLETT-PACKARD	HEWLETT-PACKARD	HEWLETT-PACKARD
DRIVE	C2216A C2481A	C2221B/M	C2261A	C2461F/R	97549P 97549T
DISK/TREND GROUP	7	7	7	7	8
MARKET	Captive	PCM	PCM	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	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
DRIVE: Heads	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
Interface	SCSI-2	SCSI	SCSI	SCSI	SCSI-2
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	F: 677	F: 677	F: 664	F: 677	F: 1,002
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 36,864	F: 36,864	F: 28,672	F: 36,864	F: 32,768
Data surfaces per spindle	11	11	16	11	16
Heads per data surface	1	1	1	1	1
Tracks per surface	1670	1670	1447	1670	1911
Track density (TPI)	1865	1865	1667	1865	1850
Maximum linear density (BPI)	42000 BPI 28000 FCI	42000 BPI 28000 FCI	30552 BPI 20368 FCI	42000 BPI 28000 FCI	40500 BPI 27000 FCI
Recording code	2,7 RLL	2,7 RLL	2,7 RLL	2,7 RLL	2,7 RLL
Rotational speed (RPM)	4002	4002	4002	4002	4002
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Dedicated Surf.	Dedicated Surf.	Embedded	Dedicated Surf.	Embedded
Average positioning time (msec)	13.5	13.5	16.5	13.5	18
Average rotational delay (msec)	7.5	7.5	7.5	7.5	7.5
Average access time (msec)	21	21	24	21	25.5
Data transfer rate (KBytes/sec)	5000 synch. 1500 asynch.	5000 synch. 1500 asynch.	5000 synch. 1500 asynch.	5000 synch. 1500 asynch.	5000 synch. 1500 asynch.
FIRST CUSTOMER SHIPMENT	7/91	10/91	10/90	7/91	1Q90
COMMENTS					

MANUFACTURER	HEWLETT-PACKARD	HEWLETT-PACKARD	HEWLETT-PACKARD	HEWLETT-PACKARD	HEWLETT-PACKARD
DRIVE	97558E	97558P 97558T	97560E	97560P 97560T	C2214B C2217A C2482A
DISK/TREND GROUP	8	8	8	8	8
MARKET	OEM	OEM	OEM	OEM	Captive
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: Heads	MIG	MIG	MIG	MIG	Thin Film
Interface	ESDI	SCSI-2	ESDI	SCSI-2	SCSI-2
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	U: 1,267	F: 1,069	U: 1,605	F: 1,355	F: 1,355
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 43,056	F: 36,864	U: 43,056	F: 36,864	F: 36,864
Data surfaces per spindle	15	15	19	19	19
Heads per data surface	1	1	1	1	1
Tracks per surface	1962	1935	1962	1935	1935
Track density (TPI)	1865	1865	1865	1865	1865
Maximum linear density (BPI)	42000 BPI 28000 FCI	42000 BPI 28000 FCI	42000 BPI 28000 FCI	42000 BPI 28000 FCI	42000 BPI 28000 FCI
Recording code	2,7 RLL	2,7 RLL	2,7 RLL	2,7 RLL	2,7 RLL
Rotational speed (RPM)	4002	4002	4002	4002	4002
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.
Average positioning time (msec)	13.5	13.5	13.5	13.5	13.5
Average rotational delay (msec)	7.5	7.5	7.5	7.5	7.5
Average access time (msec)	21	21	21	21	21
Data transfer rate (KBytes/sec)	2875	5000 synch. 1500 asynch.	2875	5000 synch. 1500 asynch.	5000 synch. 1500 asynch.
FIRST CUSTOMER SHIPMENT	3Q90	3Q90	5/90	5/90	7/91
COMMENTS			Iceberg drive		

MANUFACTURER	HEWLETT-PACKARD	HEWLETT-PACKARD	HEWLETT-PACKARD	HEWLETT-PACKARD	HEWLETT-PACKARD
DRIVE	C2222B/M	C2223B/M	C2262A	C2462F/R	C3007
DISK/TREND GROUP	8	8	8	8	8
MARKET	PCM	PCM	PCM	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	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
DRIVE: Heads	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
Interface	SCSI	SCSI	SCSI	SCSI	SCSI-2
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	F: 1,069	F: 1,355	F: 1,002	F: 1,355	U: 1,612 F: 1,370
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 36,864	F: 36,864	F: 32,768	F: 36,864	*
Data surfaces per spindle	15	19	16	19	13
Heads per data surface	1	1	1	1	1
Tracks per surface	1935	1935	1911	1935	2255
Track density (TPI)	1865	1865	1850	1865	2000
Maximum linear density (BPI)	42000 BPI 28000 FCI	42000 BPI 28000 FCI	40500 BPI 27000 FCI	42000 BPI 28000 FCI	46666 BPI 35000 FCI
Recording code	2,7 RLL	2,7 RLL	2,7 RLL	2,7 RLL	1,7 RLL
Rotational speed (RPM)	4002	4002	4002	4002	5400
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Dedicated Surf.	Dedicated Surf.	Embedded	Dedicated Surf.	Dedicated Surf.
Average positioning time (msec)	13.5	13.5	18	13.5	9
Average rotational delay (msec)	7.5	7.5	7.5	7.5	5.56
Average access time (msec)	21	21	25.5	21	14.56
Data transfer rate (KBytes/sec)	5000 synch. 1500 asynch.	5000 synch. 1500 asynch.	5000 synch. 1500 asynch.	5000 synch. 1500 asynch.	20000 synch.
FIRST CUSTOMER SHIPMENT	10/91	10/91	10/90	7/91	1Q92
COMMENTS					*Varies by zone

MANUFACTURER	HEWLETT-PACKARD	HEWLETT-PACKARD	HEWLETT-PACKARD	HITACHI	HITACHI
DRIVE	C3010-Opt100	C3009	C3010	DK302-2	DK505-2
DISK/TREND GROUP	8	9	9	2	2
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	95 mm OD 25 mm ID	130 mm OD 40 mm ID
Recording medium	Thin Film	Thin Film	Thin Film	Oxide Coated	Oxide Coated
DRIVE: Heads	Thin Film	Thin Film	Thin Film	Ferrite	Ferrite
Interface	SCSI-2	SCSI-2	SCSI-2	ST412	ST412
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	U: 1,207 F: 1,027	U: 2,108 F: 1,792	U: 2,356 F: 2,003	U: 25.5	U: 25.62
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 49,152	*	*	U: 10,416	U: 10,416
Data surfaces per spindle	19	17	19	4	4
Heads per data surface	1	1	1	1	1
Tracks per surface	1100	2255	2255	615	615
Track density (TPI)	2000	2000	2000	822	650
Maximum linear density (BPI)	46666 BPI 35000 FCI	46666 BPI 35000 FCI	46666 BPI 35000 FCI	13700	9490
Recording code	1,7 RLL	1,7 RLL	1,7 RLL	MFM	MFM
Rotational speed (RPM)	5400	5400	5400	3550	3550
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Band, Stepping Motor	Band, Stepping Motor
Servo type	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Open Loop	Open Loop
Average positioning time (msec)	9	11.5	11.5	85 (including settling)	85 (including settling)
Average rotational delay (msec)	5.56	5.56	5.56	8.45	8.45
Average access time (msec)	14.56	17.06	17.06	93.45	93.45
Data transfer rate (KBytes/sec)	20000 synch.	20000 synch.	20000 synch.	625	625
FIRST CUSTOMER SHIPMENT	1Q92	1Q92	1Q92	9/86	3/85
COMMENTS		*Varies by zone	*Varies by zone	41.3 mm high	41.3 mm high Mfg. by Tokico

MANUFACTURER	HITACHI	HITACHI	HITACHI	HITACHI	HITACHI
DRIVE	DK302-3	DK511-3	DK511-5	DK521-5	DK511-8
DISK/TREND GROUP	3	3	3	3	4
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	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	ST412	ST412, SCSI	ST412, SCSI	ST412	ST412, SCSI
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	U: 38.2	U: 36.4	U: 51.0	U: 51.4	U: 85.7
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	5	7	6	10
Heads per data surface	1	1	1	1	1
Tracks per surface	615	699	699	823	823
Track density (TPI)	822	784	784	960	925
Maximum linear density (BPI)	13700	9340	9340	9300	9250
Recording code	MFM	MFM	MFM	MFM	MFM
Rotational speed (RPM)	3550	3600	3600	3600	3600
PERFORMANCE					
Actuator type	Band, Stepping Motor	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Open Loop	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.
Average positioning time (msec)	85 (including settling)	30	30	25	23
Average rotational delay (msec)	8.45	8.3	8.3	8.3	8.3
Average access time (msec)	93.45	38.3	38.3	33.3	31.3
Data transfer rate (KBytes/sec)	625	625	625	625	625
FIRST CUSTOMER SHIPMENT	9/86	1Q84	1Q84	12/86	2Q84
COMMENTS	41.3 mm high			41.3 mm high	

MANUFACTURER	HITACHI	HITACHI	HITACHI	HITACHI	HITACHI
DRIVE	DK312C-20	DK312C-25	DK512-17	DK512C-17	DK512S-17
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	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: Heads	MIG	MIG	Ferrite	Ferrite	Ferrite
Interface	SCSI	SCSI	ESDI	SCSI	SMD
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	F: 209	F: 251	U: 172.3	F: 146.7	U: 172.3
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 19,456	F: 19,456	U: 20,944	F: 17,920	U: 20,944
Data surfaces per spindle	10	12	10	10	10
Heads per data surface	1	1	1	1	1
Tracks per surface	1076	1076	823	819	823
Track density (TPI)	1660	1660	925	925	925
Maximum linear density (BPI)	38800 BPI 25866 FCI	38800 BPI 25866 FCI	18500 BPI 12333 FCI	18500 BPI 12333 FCI	18500 BPI 12333 FCI
Recording code	2,7 RLL	2,7 RLL	2,7 RLL	2,7 RLL	2,7 RLL
Rotational speed (RPM)	3600	3600	3482	3482	3482
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Embedded	Embedded	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.
Average positioning time (msec)	16.8*	16.8*	23	23	23
Average rotational delay (msec)	8.3	8.3	8.6	8.6	8.6
Average access time (msec)	25.1	25.1	31.6	31.6	31.6
Data transfer rate (KBytes/sec)	4000 synch. 1500 asynch.	4000 synch. 1500 asynch.	1209	1500 max.	1215
FIRST CUSTOMER SHIPMENT	3Q89	3Q89	3/85	1/87	3/85
COMMENTS	41.3 mm high *Assumes 4 reads per each write Read: 16 msec. Write: 20 msec.	41.3 mm high *Assumes 4 reads per each write Read: 16 msec. Write: 20 msec.			

MANUFACTURER	HITACHI	HITACHI	HITACHI	HITACHI	HITACHI
DRIVE	DK522-10	DK522C-10	DK524-20	DK524C-20	DK812S-17
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	210 mm OD 100 mm ID
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	ESDI	SCSI	ESDI	SCSI	SMD
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	U: 103.4	F: 87.5	U: 200.5	F: 168.9	U: 170.1
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 20,944	F: 17,920	U:	F:	U: 20,672
Data surfaces per spindle	6	6			10
Heads per data surface	1	1	1	1	1
Tracks per surface	823	819	1105	1105	823
Track density (TPI)	960	960	1100	1100	760
Maximum linear density (BPI)	18500 BPI 12333 FCI	18500 BPI 12333 FCI	29800 BPI 19866 FCI	29800 BPI 19866 FCI	9650 BPI 6433 FCI
Recording code	2,7 RLL	2,7 RLL	2,7 RLL	2,7 RLL	2,7 RLL
Rotational speed (RPM)	3600	3600	3600	3600	3510
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.
Average positioning time (msec)	25	25	25	25	25
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.5
Average access time (msec)	33.3	33.3	33.3	33.3	33.5
Data transfer rate (KBytes/sec)	1250	1500 max.	1814	4000	1209
FIRST CUSTOMER SHIPMENT	12/86	1/87	3Q88	4Q88	6/83
COMMENTS	41.3 mm high	41.3 mm high	41.3 mm high	41.3 mm high	

MANUFACTURER	HITACHI	HITACHI	HITACHI	HITACHI	HITACHI
DRIVE	DK314C-41	DK514-38	DK514C-38	DK514S-38	DK814S-34
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	95 mm OD 25 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	210 mm OD 100 mm ID
Recording medium	Thin Film	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Heads	Thin Film	Ferrite	Ferrite	Ferrite	Ferrite
Interface	SCSI	ESDI	SCSI	Modified SMD	Modified SMD
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	F: 418.9	U: 382.3	F: 321.8	U: 382.3	U: 340
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 25,600	U: 30,240	F: 25,600	U: 30,240	U: 32,768
Data surfaces per spindle	14	14	14	14	10
Heads per data surface	1	1	1	1	1
Tracks per surface	1169	903	898	903	823
Track density (TPI)	1803	1033	1033	1033	800
Maximum linear density (BPI)	44222 BPI 29466 FCI	26000 BPI 17333 FCI	26000 BPI 17333 FCI	26000 BPI 17333 FCI	18500 BPI 12333 FCI
Recording code	2,7 RLL	2,7 RLL	2,7 RLL	2,7 RLL	2,7 RLL
Rotational speed (RPM)	3600	3600	3600	3600	2632
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Embedded	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.
Average positioning time (msec)	16.8	16	16	16	20
Average rotational delay (msec)	8.3	8.3	8.3	8.3	11.4
Average access time (msec)	25.1	24.3	24.3	24.3	31.4
Data transfer rate (KBytes/sec)	4000 synch. 1500 asynch.	1815	4000 synch. 1500 asynch.	1815	1815
FIRST CUSTOMER SHIPMENT	2Q91	3Q87	1Q88	3Q87	12/84
COMMENTS	41.3 mm high				

MANUFACTURER	HITACHI	HITACHI	HITACHI	HITACHI	HITACHI
DRIVE	DK515-78	DK515C-78 DK515C-78D	DK515S-78D DK515S-78S	DK711S-60D DK711S-60S	DK815-5
DISK/TREND GROUP	7	7	7	7	7
MARKET	OEM	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	224 mm OD 100 mm ID
Recording medium	Thin Film	Thin Film	Thin Film	Oxide Coated	Oxide Coated
DRIVE: Heads	MIG	MIG	MIG	Ferrite	Ferrite
Interface	ESDI	SCSI	Modified SMD	Modified SMD	Modified SMD
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	U: 780	F: 660.9	U: 780	U: 600	U: 525.38
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 40,960	F: 34,816	U: 40,960	U: 30,240	U: 30,240
Data surfaces per spindle	14	14	14	22	14
Heads per data surface	1	1	1	1	1
Tracks per surface	1361	1356	1391	903	1241
Track density (TPI)	1296	1296	1296	1033	860
Maximum linear density (BPI)	40210 BPI 26806 FCI	40210 BPI 26806 FCI	40210 BPI 26806 FCI	26000 BPI 17333 FCI	14585 BPI 9723 FCI
Recording code	2,7 RLL	2,7 RLL	2,7 RLL	2,7 RLL	2,7 RLL
Rotational speed (RPM)	3600	3600	3600	4876	3600
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.
Average positioning time (msec)	16	16	16	12	18
Average rotational delay (msec)	8.3	8.3	8.3	6.15	8.3
Average access time (msec)	24.3	24.3	24.3	18.15	26.3
Data transfer rate (KBytes/sec)	2458	4000 synch. 1500 asynch.	2458	2458	1815
FIRST CUSTOMER SHIPMENT	4Q88	4Q88	2Q89	4Q87	11/84
COMMENTS				Oversized packaging	

MANUFACTURER	HITACHI	HITACHI	HITACHI	HITACHI	HITACHI
DRIVE	DKU-85I-D14 DKU-85I-D24	DKU-86I-J14 DKU-86I-J24 H-6586-J14 H-6586-J24	DKU-97I	DKU-97S	H-6555
DISK/TREND GROUP	7	7	7	7	7
MARKET	Captive	Captive,OEM,PCM	OEM	OEM	Captive
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	14"	9.5"	14"	14"	224 mm OD 100 mm ID
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	High Dens Oxide
DRIVE: Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	IBM	IBM, Hitachi	IBM	SMD	Hitachi
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	F: 630	F: 630	F: 635	U: 697.059	F: 500
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 47,476	F: 47,476	F: 19,069	U: 20,672	F: 28,884
Data surfaces per spindle		15	20	20	14
Heads per data surface	2	1	2	2	1
Tracks per surface		885	1666	1682	1237
Track density (TPI)			720	720	860
Maximum linear density (BPI)			6425	6425	14585 BPI 9723 FCI
Recording code			MFM	MFM	2,7 RLL
Rotational speed (RPM)	3600	3600	3600	3600	3600
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Linear, Voice Coil	Dual, Rotary, Voice Coil	Dual, Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.
Average positioning time (msec)	15	11	20/18	20	18
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	23.3	19.3	28.3/26.3	28.3	26.3
Data transfer rate (KBytes/sec)	3000	3000	1198	1240	1815
FIRST CUSTOMER SHIPMENT	4/86	3Q88	1/81	9/83	1Q85
COMMENTS	Drive has 4 spindles	Drive has 8 spindles	Drive has 2 spindles		Drive has 1 to 4 spindles

MANUFACTURER	HITACHI	HITACHI	HITACHI	HITACHI	HITACHI
DRIVE	H-8576-12 H-8576-22	DK516-12	DK516-15	DK516C-16	DK815-10
DISK/TREND GROUP	7	8	8	8	8
MARKET	Captive	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	224 mm OD 100 mm ID
Recording medium	Oxide Coated	Thin Film	Thin Film	Thin Film	Oxide Coated
DRIVE: Heads	Ferrite	Thin Film	Thin Film	Thin Film	Thin Film
Interface	Hitachi	ESDI	ESDI	SCSI	Mod SMD, IPI-2
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	F: 635	U: 1,229	U: 1,538	F: 1,342	U: 1,067
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 19,069	U: 45,880	U: 45,880	F: 41,472	U: 40,960
Data surfaces per spindle	20	15	15	15	15
Heads per data surface	2	1	1	1	1
Tracks per surface	1666	1787	2235	2172	1737
Track density (TPI)	720	1512	2000	1954	1160
Maximum linear density (BPI)	6425	46375 BPI 34780 FCI	44060 BPI 33045 FCI	48525 BPI 36393 FCI	20000 BPI 15000 FCI
Recording code	MFM	1,7 RLL	1,7 RLL	1,7 RLL	1,7 RLL
Rotational speed (RPM)	3600	3600	3600	3600	3600
PERFORMANCE					
Actuator type	Dual, Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Linear, Voice Coil
Servo type	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.
Average positioning time (msec)	20	14	14	13.5	15
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	28.3	22.3	22.3	21.8	23.3
Data transfer rate (KBytes/sec)	1198	2750	2753	5000 synch. 2000 asynch.	2460
FIRST CUSTOMER SHIPMENT	4Q80	3Q90	1Q91	3Q90	1Q87
COMMENTS	Drive has 2 spindles				

MANUFACTURER	HITACHI	HITACHI	HITACHI	HITACHI	HITACHI
DRIVE	DK815-10A	DKU-85I-E14 DKU-85I-E24 H-6585-14 H-6585-24	DKU-86I-G14 DKU-86I-G24 H-6586-G14 H-6586-G24	DKU-87I-114 DKU-87I-124 H-6587-114 H-6587-124	DKU-98I H-8598-12 H-8598-22
DISK/TREND GROUP	8	8	8	8	8
MARKET	OEM	Captive,OEM,PCM	Captive,OEM,PCM	Captive,OEM,PCM	Captive,OEM,PCM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	224 mm OD 100 mm ID	14"	9.5"	9.5"	14"
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Heads	Ferrite	Ferrite	Ferrite	Thin Film	Ferrite
Interface	Modified SMD	IBM, Hitachi	IBM, Hitachi	IBM, Hitachi	IBM, Hitachi
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	U: 1,067	F: 1,260	F: 1,260	F: 946	F: 1,260
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 40,960	F: 47,476	F: 47,476	F: 56,664	F: 47,476
Data surfaces per spindle	15		15	15	20
Heads per data surface	1	2	1	2	2
Tracks per surface	1737		1770 (Physical)	1113	1328 (Physical)
Track density (TPI)	1220				600
Maximum linear density (BPI)	19560 BPI 14670 FCI				15240 BPI 10160 FCI
Recording code	1,7 RLL			1,7 RLL	2,7 RLL
Rotational speed (RPM)	3600	3600	3600	4260	3600
PERFORMANCE					
Actuator type	Linear, Voice Coil	Rotary, Voice Coil	Linear, Voice Coil	Linear, Voice Coil	Dual, Rotary, Voice Coil
Servo type	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.
Average positioning time (msec)	13	17	13	8.5	16
Average rotational delay (msec)	8.3	8.3	8.3	7.1	8.3
Average access time (msec)	21.3	25.3	21.3	15.6	24.3
Data transfer rate (KBytes/sec)	2460	3000	3000	4200	3000
FIRST CUSTOMER SHIPMENT	4Q87	12/85	3Q88	9/90	4Q82
COMMENTS		Drive has 4 spindles	Drive has 8 spindles	-114: max. 8 HDAs -124: max. 12 HDAs Also compatible mode to H-6586J	Drive has 2 spindles 2 actuators per spindle

MANUFACTURER	HITACHI	HITACHI	HITACHI	HITACHI	HITACHI
DRIVE	H-6556-1	DK816-20	DK816-20P	DKU-86I-K14 DKU-86I-K24 H-6586-K14 H-6586-K24	DKU-87I-214 DKU-87I-224
DISK/TREND GROUP	8	9	9	9	9
MARKET	Captive	OEM	OEM	Captive,OEM,PCM	OEM, PCM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	9.5"	224 mm OD 100 mm ID	224 mm OD 100 mm ID	9.5"	9.5"
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Heads	Ferrite	Thin Film	Thin Film	Thin Film	Thin Film
Interface	Hitachi	IPI-2	IPI-2	IBM, Hitachi	IBM, Hitachi
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	F: 1,260	U: 2,000	U: 1,869	F: 1,890	F: 1,892
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 47,476	U: 74,600	U: 74,600	F: 47,476	F: 56,664
Data surfaces per spindle	15	15	15	15	15
Heads per data surface	1	1	1	2	2
Tracks per surface	1770 (Physical)	1790	1790	2655	2226
Track density (TPI)		1256	1256		
Maximum linear density (BPI)		35470 BPI 26602 FCI	35470 BPI 26602 FCI		
Recording code		1,7 RLL	1,7 RLL		1,7 RLL
Rotational speed (RPM)	3600	3600	3600	3600	4260
PERFORMANCE					
Actuator type	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil
Servo type	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.
Average positioning time (msec)	15	13.5	13.5	12.5	10.5
Average rotational delay (msec)	8.3	8.3	8.3	8.3	7.1
Average access time (msec)	23.3	21.8	21.8	20.8	17.6
Data transfer rate (KBytes/sec)	3000	4500	9000*	3000	4200
FIRST CUSTOMER SHIPMENT	3/88	3Q89	3Q90	3Q88	9/90
COMMENTS	Drive has 4 spindles		*Parallel data transfer, 2 channels	Drive has 8 spindles	-214: max. 8 HDAs -224: max. 12 HDAs

MANUFACTURER	HITACHI	HITACHI DATA SYSTEMS	HITACHI DATA SYSTEMS	HITACHI DATA SYSTEMS	HITACHI DATA SYSTEMS
DRIVE	H-6587-314 H-6587-324	7380-J	7390-1	7390-JX	7380-K
DISK/TREND GROUP	9	7	8	8	9
MARKET	Captive	PCM	PCM	PCM	PCM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	9.5"	9.5"	9.5"	9.5"	9.5"
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Heads	Thin Film	Thin Film	Thin Film	Ferrite	Thin Film
Interface	Hitachi	IBM	IBM	IBM	IBM
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	F: 2,920	F: 630	F: 946	F: 1,260	F: 1,890
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 56,664	F: 47,476	F: 56,664	F: 47,476	F: 47,476
Data surfaces per spindle	15	15	15	15	15
Heads per data surface	2	1	2	1	2
Tracks per surface	3436	885	1113	1770	2655
Track density (TPI)			1900		
Maximum linear density (BPI)			29000 BPI 21750 FCI		
Recording code	1,7 RLL		1,7 RLL		
Rotational speed (RPM)	4260	3600	4260	3600	3600
PERFORMANCE					
Actuator type	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil
Servo type	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.
Average positioning time (msec)	12	11	8.5	13	12.5
Average rotational delay (msec)	7.1	8.3	7.1	8.3	8.3
Average access time (msec)	19.1	19.3	15.6	21.3	20.8
Data transfer rate (KBytes/sec)	4200	3000	4200	3000	3000
FIRST CUSTOMER SHIPMENT	9/90	6/88	10/90	6/88	8/88
COMMENTS	-314: max. 8 HDAs -324: max. 12 HDAs Also compatible mode to H-6586K	PCM 3380-J Drive has 4 or 8 spindles	PCM 3390-1 Drive has 4, 8, or 12 spindles	PCM 3380-E Drive has 4 or 8 spindles	PCM 3380-K Drive has 4 or 8 spindles

MANUFACTURER	HITACHI DATA SYSTEMS	HITACHI DATA SYSTEMS	HITACHI DATA SYSTEMS	HYOSUNG COMPUTER	HYOSUNG COMPUTER
DRIVE	7390-2	7390-3	7390-F	HC8085	HC8128
DISK/TREND GROUP	9	9	9	4	5
MARKET	PCM	PCM	PCM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	9.5"	9.5"	9.5"	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: Heads	Thin Film	Thin Film	Thin Film	Ferrite	Ferrite
Interface	IBM	IBM	IBM	ST412	ST412
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	F: 1,892	F: 2,838	F: 1,890/1,892	U: 85.3	U: 127.9
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 56,664	F: 56,664	F: 47,476/ 56,664	U: 10,416	U: 15,624
Data surfaces per spindle	15	15	15	8	8
Heads per data surface	2	2	2	1	1
Tracks per surface	2226	3339	2655/2226	1024	1024
Track density (TPI)	1900		1900	1053	1053
Maximum linear density (BPI)	29000 BPI 21750 FCI		29000 BPI 21750 FCI	9290	13935 BPI 9250 FCI
Recording code	1,7 RLL	1,7 RLL	1,7 RLL	MFM	2,7 RLL
Rotational speed (RPM)	4260	4260	4260	3600	3600
PERFORMANCE					
Actuator type	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil	Rotary, DC Motor	Rotary, DC Motor
Servo type	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.
Average positioning time (msec)	10	12.5	11/10	25	25
Average rotational delay (msec)	7.1	7.1	7.1	8.3	8.3
Average access time (msec)	17.1	19.6	18.1/17.1	33.3	33.3
Data transfer rate (KBytes/sec)	4200	4200	4200	625	937.5
FIRST CUSTOMER SHIPMENT	10/90	2Q92	1/91	1989	1989
COMMENTS	PCM 3390-2 Drive has 4, 8, or 12 spindles	PCM 3390-3 Drive has 4, 8, or 12 spindles	PCM 3380-K/ 3390-2 Drive has 4, 8, or 12 spindles Field reformatable		

MANUFACTURER	HYOSUNG COMPUTER	IBM	IBM	IBM	IBM
DRIVE	HC8170E	8530-021	WD-325	WDL-320	4956-G10(40 MB) 4956-H10(40 MB)
DISK/TREND GROUP	5	2	2	2	3
MARKET	OEM	Captive	OEM	OEM	Captive
MEDIA: Generic type	Fixed	Fixed	Captive	Fixed	Fixed
Nominal disk diameter	130 mm OD 40 mm ID	95 mm OD 25 mm ID	95 mm OD 25 mm ID	95 mm OD 25 mm ID	130 mm OD 40 mm ID
Recording medium	Thin Film	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	ESDI	PS/2-30	ST412	PS/2-30	ST412
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	U: 171.5	F: 20	U: 25.5	U: 26.9 F: 20	F: 40
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 20,934	F: 12,920	U: 10,416	F: 12,920	F: 8,704
Data surfaces per spindle	8	2	4	2	7
Heads per data surface	1	1	1	1	1
Tracks per surface	1024	774	612	774	733
Track density (TPI)	1053	1170	850	1170	815
Maximum linear density (BPI)	19222 BPI 12815 FCI	21700 BPI 14466 FCI	13400	21700 BPI 14466 FCI	9398
Recording code	2,7 RLL	2,7 RLL	MFM	2,7 RLL	MFM
Rotational speed (RPM)	3600	3600	3600	3600	3600
PERFORMANCE					
Actuator type	Rotary, DC Motor	Rotary, Voice Coil	Rotary, Stepping Motor	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Dedicated Surf.	Embedded	Open Loop	Embedded	Dedicated Surf.
Average positioning time (msec)	25	27	80 (including settling)	27	40
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	33.3	35.3	88.3	35.3	48.3
Data transfer rate (KBytes/sec)	1250	1050	625	1050	625
FIRST CUSTOMER SHIPMENT	1989	10/88	7/86	2/89	9/86
COMMENTS		25.4 mm high PS/2	41.3 mm high	25.4 mm high	Series/1

MANUFACTURER	IBM	IBM	IBM	IBM	IBM
DRIVE	5364-001	8530-E31	8535-043 8540-043	8555-041	8573-031
DISK/TREND GROUP	3	3	3	3	3
MARKET	Captive	Captive	Captive	Captive	Captive
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	130 mm OD 40 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	Thin Film	Thin Film	Thin Film	Thin Film
DRIVE: Heads	Ferrite	MIG	MIG	MIG	MIG
Interface	IBM, ST412	PS/2-30,Microch	PC AT	Microchannel	SCSI
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	F: 41.92	F: 30	F: 40	F: 40	F: 30
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 8,192	F: 16,384	F: 19,968	F: 19,968	F: 16,384
Data surfaces per spindle	7	2	2	2	2
Heads per data surface	1	1	1	1	1
Tracks per surface	733	922	1038	1038	920
Track density (TPI)	815	1302	1517	1517	1302
Maximum linear density (BPI)	9398	26700 BPI 17800 FCI	31700 BPI 21133 FCI	31700 BPI 21133 FCI	26700 BPI 17800 FCI
Recording code	MFM	2,7 RLL	2,7 RLL	2,7 RLL	2,7 RLL
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
Servo type	Dedicated Surf.	Embedded	Embedded	Embedded	Embedded
Average positioning time (msec)	40	27	16	16	19
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	48.3	35.3	24.3	24.3	27.3
Data transfer rate (KBytes/sec)	625	1275	1500	1500	1250
FIRST CUSTOMER SHIPMENT	6/85	9/89	6/91	6/91	3/90
COMMENTS	System unit for System/36 PC	25.4 mm high	25.4 mm high PS/2	25.4 mm high PS/2	25.4 mm high

MANUFACTURER	IBM	IBM	IBM	IBM	IBM
DRIVE	WD-L40	WDA-240	WDA-L40	WDP-L40	WDS-240
DISK/TREND GROUP	3	3	3	3	3
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	95 mm OD 25 mm ID	65 mm OD 20 mm ID	95 mm OD 25 mm ID	95 mm OD 25 mm ID	65 mm OD 20 mm ID
Recording medium	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
DRIVE: Heads	MIG	MIG	MIG	MIG	MIG
Interface	Microchannel	PC AT	PC AT	PC XT	SCSI
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	U: 51.8 F: 40	F: 43.1	F: 40	F: 40	F: 42.9
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 19,968	F: 19,456	F: 19,968	F: 19,968	F: 19,456
Data surfaces per spindle	2	2	2	2	2
Heads per data surface	1	1	1	1	1
Tracks per surface	1038	1123	1038	1038	1123
Track density (TPI)	1517	2199	1517	1517	2199
Maximum linear density (BPI)	31700 BPI 21133 FCI	42885 BPI 32164 FCI	31700 BPI 21133 FCI	31700 BPI 21133 FCI	42885 BPI 32164 FCI
Recording code	2,7 RLL	1,7 RLL	2,7 RLL	2,7 RLL	1,7 RLL
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
Servo type	Embedded	Embedded	Embedded	Embedded	Embedded
Average positioning time (msec)	16	19	16	16	19
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	24.3	27.3	24.3	24.3	27.3
Data transfer rate (KBytes/sec)	1500	5700 max.	1500	1500	5000 synch.
FIRST CUSTOMER SHIPMENT	4/90	4Q91	6/90	6/90	3Q91
COMMENTS	25.4 mm high	12.7 mm high	25.4 mm high	25.4 mm high	12.7 mm high

MANUFACTURER	IBM	IBM	IBM	IBM	IBM
DRIVE	WDS-L40	4956-G10(72 MB) 4956-H10(72 MB) 4956-J00(72 MB)	4965-E00	5363-P10	5364-003 5364-004 5364-023 5364-024
DISK/TREND GROUP	3	4	4	4	4
MARKET	OEM	Captive	Captive	Captive	Captive
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	Thin Film	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Heads	MIG	Ferrite	Ferrite	Ferrite	Ferrite
Interface	SCSI-2	ESDI	ESDI	ESDI	ESDI
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	U: 51.8 F: 40.8	F: 72	F: 72	F: 67.56	F: 65.9
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 19,968	F: 17,664	F: 17,664	F: 16,640	F: 16,640
Data surfaces per spindle	2	7	7	7	7
Heads per data surface	1	1	1	1	1
Tracks per surface	1038	582	582	580	580
Track density (TPI)	1517	648	648	648	648
Maximum linear density (BPI)	31700 BPI 21133 FCI	18942 BPI 12628 FCI	18942 BPI 12628 FCI	18942 BPI 12628 FCI	18942 BPI 12628 FCI
Recording code	2,7 RLL	2,7 RLL	2,7 RLL	2,7 RLL	2,7 RLL
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
Servo type	Embedded	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.
Average positioning time (msec)	16	30	30	30	30
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	24.3	38.3	38.3	38.3	38.3
Data transfer rate (KBytes/sec)	1500	1250	1250	1250	1250
FIRST CUSTOMER SHIPMENT	6/90	2/88	2/88	10/87	2/87
COMMENTS	25.4 mm high	Series/1	Storage expansion unit for Series/1	System unit for System/36 PC	System unit for System/36 PC

MANUFACTURER	IBM	IBM	IBM	IBM	IBM
DRIVE	5551-T0A 8573-061	5571-T0A	8540-045	8555-081 8570-A81,081	8557-045 8580-081 8590-0J5
DISK/TREND GROUP	4	4	4	4	4
MARKET	Captive	Captive	Captive	Captive	Captive
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	95 mm OD 25 mm ID	130 mm OD 40 mm ID	95 mm OD 25 mm ID	95 mm OD 25 mm ID	95 mm OD 25 mm ID
Recording medium	Thin Film	Oxide Coated	Thin Film	Thin Film	Thin Film
DRIVE: Heads	Ferrite	Ferrite	MIG	MIG	MIG
Interface	SCSI, MC	ESDI	PC AT	Microchannel	SCSI
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	F: 60.8	F: 70	F: 80	F: 80	F: 80
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 13,312	F: 18,432	F: 18,815	F: 18,815	F: 18,815
Data surfaces per spindle	6	7	4	4	4
Heads per data surface	1	1	1	1	1
Tracks per surface	762	583	1063	1063	1063
Track density (TPI)	1169	648	1517	1517	1517
Maximum linear density (BPI)	21700 BPI 14466 FCI	18942 BPI 12628 FCI	31700 BPI 21133 FCI	31700 BPI 21133 FCI	31700 BPI 21133 FCI
Recording code	2,7 RLL	2,7 RLL	2,7 RLL	2,7 RLL	2,7 RLL
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
Servo type	Embedded	Dedicated Surf.	Embedded	Embedded	Embedded
Average positioning time (msec)	27	30	16	16	16
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	35.3	38.3	24.3	24.3	24.3
Data transfer rate (KBytes/sec)	1050	1250	1500	1500	1500
FIRST CUSTOMER SHIPMENT	5/88	2Q87	6/91	6/91	10/90
COMMENTS	41.3 mm high PS/2	PS/2	41.3 mm high PS/2	41.3 mm high	41.3 mm high PS/2

MANUFACTURER	IBM	IBM	IBM	IBM	IBM
DRIVE	WD-380	WD-387G	WDA-260	WDA-280	WDA-380
DISK/TREND GROUP	4	4	4	4	4
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	65 mm OD 20 mm ID	65 mm OD 20 mm ID	95 mm OD 25 mm ID
Recording medium	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
DRIVE: Heads	MIG	MIG	MIG	MIG	MIG
Interface	SCSI, Microch.	Microchannel	PC AT	PC AT	PC AT
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	F: 80	F: 60	U: 81.0 F: 62.9	F: 86.2	F: 80
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 18,815	F: 16,384	F: 15,360	F: 19,456	F: 18,815
Data surfaces per spindle	4	4	4	4	4
Heads per data surface	1	1	1	1	1
Tracks per surface	1063	920	1044	1123	1063
Track density (TPI)	1517	1302	2032	2199	1517
Maximum linear density (BPI)	31700 BPI 21133 FCI	26700 BPI 17800 FCI	34100 BPI 22733 FCI	42885 BPI 32164 FCI	31700 BPI 17333 FCI
Recording code	2,7 RLL	2,7 RLL	2,7 RLL	1,7 RLL	2,7 RLL
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
Servo type	Embedded	Embedded	Embedded	Embedded	Embedded
Average positioning time (msec)	16	23	19	17	16
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	24.3	31.3	27.3	24.3	24.3
Data transfer rate (KBytes/sec)	1500	1250	1100	5700 max.	1500
FIRST CUSTOMER SHIPMENT	3/90	3/90	4Q90	4Q91	6/90
COMMENTS	41.3 mm high	41.3 mm high	22.6 mm high	17 mm high	41.3 mm high

MANUFACTURER	IBM	IBM	IBM	IBM	IBM
DRIVE	WDS-280	WDS-380	0671-284	5363-P20 5363-P22	5363-S10
DISK/TREND GROUP	4	4	5	5	5
MARKET	OEM	OEM	OEM	Captive	Captive
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	65 mm OD 20 mm ID	95 mm OD 25 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	Thin Film
DRIVE: Heads	MIG	MIG	Ferrite	Ferrite	Ferrite
Interface	SCSI	SCSI	ESDI, SCSI	ESDI	ESDI
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	F: 85.9	F: 80	U: 284	F: 106.2	F: 106.46
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 19,456	F: 18,815	U: 21,080	F: 16,640	F: 16,640
Data surfaces per spindle	4	4	11	7	7
Heads per data surface	1	1	1	1	1
Tracks per surface	1123	1063	1225	914	914
Track density (TPI)	2199	1517	1168	1000	1000
Maximum linear density (BPI)	42885 BPI 32164 FCI	31700 BPI 17333 FCI	21384 BPI 14256 FCI	19159 BPI 12772 FCI	19159 BPI 12772 FCI
Recording code	1,7 RLL	2,7 RLL	2,7 RLL	2,7 RLL	2,7 RLL
Rotational speed (RPM)	3600	3600	3283	3600	3600
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Embedded	Embedded	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.
Average positioning time (msec)	17	16	21.5	28	28
Average rotational delay (msec)	8.3	8.3	9.14	8.3	8.3
Average access time (msec)	24.3	24.3	30.64	36.3	36.3
Data transfer rate (KBytes/sec)	5000 synch.	1500	1250	1250	1250
FIRST CUSTOMER SHIPMENT	3Q91	12/89	1Q88	10/87	9/90
COMMENTS	17 mm high	41.3 mm high		System unit for System/36 PC	AS/Entry

MANUFACTURER	IBM	IBM	IBM	IBM	IBM
DRIVE	5551-T0B 8570-121 8573-121	5571-T0B	6156-001 6156-003	7012-320(#2120)	8557-049 8573-161 8580-A16,161 8590-0J9 8595-0J9
DISK/TREND GROUP	5	5	5	5	5
MARKET	Captive	Captive	Captive	Captive	Captive
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	95 mm OD 25 mm ID	95 mm OD 25 mm ID
Recording medium	Thin Film	Oxide Coated	Oxide Coated	Thin Film	Thin Film
DRIVE: Heads	MIG	Ferrite	Ferrite	MIG	MIG
Interface	Microchannel	ESDI	ESDI	Microchannel	SCSI
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	F: 120.5	F: 115	F: 114	F: 120	F: 160
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 16,384	F: 18,432	F: 17,920	F: 16,384	F: 18,815
Data surfaces per spindle	8	7	7	8	8
Heads per data surface	1	1	1	1	1
Tracks per surface	920	915	915	920	1021
Track density (TPI)	1302	1000	1000	1302	1517
Maximum linear density (BPI)	26700 BPI 17800 FCI	19159 BPI 12772 FCI	19159 BPI 12772 FCI	26700 BPI 17800 FCI	31700 BPI 21133 FCI
Recording code	2,7 RLL	2,7 RLL	2,7 RLL	2,7 RLL	2,7 RLL
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
Servo type	Embedded	Dedicated Surf.	Dedicated Surf.	Embedded	Embedded
Average positioning time (msec)	23	28	28	23	16
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	31.3	36.3	36.3	31.3	24.3
Data transfer rate (KBytes/sec)	1250	1250	1250	1270	1500
FIRST CUSTOMER SHIPMENT	5/88	4Q87	6/88	2Q90	10/90
COMMENTS	41.3 mm high PS/2	PS/2	Removable disk drive for RT PC 003 holds up to 3 disk modules 310 MB drive is optional	System/6000	41.3 mm high PS/2

MANUFACTURER	IBM	IBM	IBM	IBM	IBM
DRIVE	8570-A16,A61, 161	WDS-3158	WD-3158G	WD-3160	WDA-3160
DISK/TREND GROUP	5	5	5	5	5
MARKET	Captive	Captive	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	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
DRIVE: Heads	MIG	MIG	Ferrite	MIG	MIG
Interface	Microchannel	SCSI	Microchannel	Microchannel	PC AT
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	F: 160	U: 157.3 F: 120.5	U: 157.3 F: 120.5	U: 206.4 F: 160	U: 206.4 F: 160
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 18,815	F: 16,384	F: 16,384	F: 18,815	F: 18,815
Data surfaces per spindle	8	8	8	8	8
Heads per data surface	1	1	1	1	1
Tracks per surface	1021	925	925	1021	1021
Track density (TPI)	1517	1302	1302	1517	1517
Maximum linear density (BPI)	31700 BPI 21133 FCI	26700 BPI 17800 FCI	26700 BPI 17800 FCI	31700 BPI 21133 FCI	31700 BPI 21133 FCI
Recording code	2,7 RLL	2,7 RLL	2,7 RLL	2,7 RLL	2,7 RLL
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
Servo type	Embedded	Embedded	Embedded	Embedded	Embedded
Average positioning time (msec)	16	23	23	16	16
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	24.3	31.3	31.3	24.3	24.3
Data transfer rate (KBytes/sec)	1500	1250	1250	1500	1500
FIRST CUSTOMER SHIPMENT	6/91	8/89	5/88	3/90	6/90
COMMENTS	41.3 mm high PS/2	41.3 mm high	41.3 mm high	41.3 mm high	41.3 mm high

MANUFACTURER	IBM	IBM	IBM	IBM	IBM
DRIVE	WDS-3160	0661-371	0661-467	0671-387	5363-S20 5363-S22
DISK/TREND GROUP	5	6	6	6	6
MARKET	OEM	Captive, OEM	Captive, OEM	OEM	Captive
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	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
DRIVE: Heads	MIG	MIG	MIG	Ferrite	Ferrite
Interface	SCSI	SCSI-2	SCSI-2	ESDI, SCSI	ESDI
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	F: 160	U: 371 F: 320.1	U: 467 F: 400	U: 387	F: 314.4
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 18,815	F: 24,576	F: 24,576	U: 21,080	F: 17,408
Data surfaces per spindle	8	14	14	15	15
Heads per data surface	1	1	1	1	1
Tracks per surface	1063	949	1199	1225	1225
Track density (TPI)	1517	1201.5	1469	1168	1168
Maximum linear density (BPI)	31700 BPI 21133 FCI	37341 BPI 28006 FCI	38427 BPI 28820 FCI	21384 BPI 14256 FCI	21384 BPI 14256 FCI
Recording code	2,7 RLL	1,7 RLL	1,7 RLL	2,7 RLL	2,7 RLL
Rotational speed (RPM)	3600	4317.8	4316	3283	3283
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Embedded	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.
Average positioning time (msec)	16	12.5	11.5	21.5	22
Average rotational delay (msec)	8.3	6.95	6.95	9.14	9.14
Average access time (msec)	24.3	19.45	18.45	30.64	31.14
Data transfer rate (KBytes/sec)	1500	4000 max.	5000 max.	1250	1250
FIRST CUSTOMER SHIPMENT	12/89	8/89	8/90	1Q88	9/90
COMMENTS	41.3 mm high	41.3 mm high	41.3 mm high		AS/Entry

MANUFACTURER	IBM	IBM	IBM	IBM	IBM
DRIVE	6150-4300 Opt. 6150-5300 Opt. 6151-4300 Opt. 6151-5300 Opt.	7012-320(#2540) 7013-520(#2542) 7013-530(#2542) 7013-540(#2542) 7204-320	7013-520(#2500) 7013-530(#2500) 7016-730(#2500) 7203-001(#2300)	8565-321 8580-A31,321 8590-0KD 8595-0JD,0KD	8573-401
DISK/TREND GROUP	6	6	6	6	6
MARKET	Captive	Captive	Captive	Captive	Captive, OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	130 mm OD 40 mm ID	95 mm OD 25 mm ID	130 mm OD 40 mm ID	95 mm OD 25 mm ID	95 mm OD 25 mm ID
Recording medium	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
DRIVE: Heads	Ferrite	MIG	Thin Film	MIG	MIG
Interface	ESDI	SCSI	SCSI	SCSI-2	SCSI-2
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	F: 310	F: 320	F: 355	F: 320	F: 400
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 17,408	F: 24,576	F: 27,648	F: 24,576	F: 24,576
Data surfaces per spindle	15	14	8	14	14
Heads per data surface	1	1	1	1	1
Tracks per surface	1224	949	1632	949	1199
Track density (TPI)	1168	1201.5	1376	1201.5	1469
Maximum linear density (BPI)	21384 BPI 14256 FCI	37341 BPI 28006 FCI	31596 BPI 21064 FCI	37341 BPI 28006 FCI	38427 BPI 28820 FCI
Recording code	2,7 RLL	1,7 RLL	2,7 RLL	1,7 RLL	1,7 RLL
Rotational speed (RPM)	3283	4318	3600	4318	4316
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.
Average positioning time (msec)	21.5	12.5	16	12.5	11.5
Average rotational delay (msec)	9.14	7	8.3	6.95	6.95
Average access time (msec)	30.64	19.5	24.3	19.45	18.45
Data transfer rate (KBytes/sec)	1250	4000 max.	1875	4000 max.	5000 max.
FIRST CUSTOMER SHIPMENT	7/88	2Q90	2Q90	10/90	11/90
COMMENTS	RT PC	RS/6000	RS/6000 Mfg. by Maxtor	41.3 mm high PS/2	41.3 mm high PS/2

MANUFACTURER	IBM	IBM	IBM	IBM	IBM
DRIVE	9371-10 9371-12 9371-14	9371-PS/2	9402-C04 9402-C06	9402-D02,D04, D06 9404-D10,D20, D25	9404-C10 9404-C20 9404-C25
DISK/TREND GROUP	6	6	6	6	6
MARKET	Captive	Captive	Captive	Captive, OEM	Captive
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	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
DRIVE: Heads	MIG	MIG	MIG	MIG	MIG
Interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	F: 295	F: 320	F: 320	F: 400	F: 320
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 24,576	F: 24,576	F: 24,576	F: 24,576	F: 24,576
Data surfaces per spindle	14	14	14	14	14
Heads per data surface	1	1	1	1	1
Tracks per surface	949	949	949	1199	949
Track density (TPI)	1201.5	1201.5	1201.5	1469	1201.5
Maximum linear density (BPI)	37341 BPI 28006 FCI	37341 BPI 28006 FCI	37341 BPI 28006 FCI	38427 BPI 28820 FCI	37341 BPI 28006 FCI
Recording code	1,7 RLL	1,7 RLL	1,7 RLL	1,7 RLL	1,7 RLL
Rotational speed (RPM)	4317.8	4317.8	4317.8	4316	4317.8
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.
Average positioning time (msec)	12.5	12.5	12.5	11.5	12.5
Average rotational delay (msec)	6.95	6.95	6.95	6.95	6.95
Average access time (msec)	19.45	19.45	19.45	18.45	19.45
Data transfer rate (KBytes/sec)	4000 max.	4000 max.	4000	5000 max.	4000 max.
FIRST CUSTOMER SHIPMENT	3/90	3/90	9/90	5/91	2/90
COMMENTS	41.3 mm high 9370	41.3 mm high 9370	AS/400	41.3 mm high AS/400	41.3 mm high AS/400

MANUFACTURER	IBM	IBM	IBM	IBM	IBM
DRIVE	0681-500	7013-520(#2510) 7013-530(#2510) 7015-930(#2510) 7016-730(#2310) 7203-001(#2310)	9332-600 9332-602	9336-10	0615
DISK/TREND GROUP	7	7	7	7	8
MARKET	OEM	Captive	Captive	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	210 mm OD 100 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID
Recording medium	Thin Film	Thin Film	Oxide Coated	Thin Film	Thin Film
DRIVE: Heads	MIG	Thin Film	Thin Film	MIG	MR Thin Film
Interface	SCSI-2	SCSI	IPI-3	SCSI-2	IPI-2
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	U: 579 F: 471	F: 670	F: 600	F: 471	U: 1,639
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 29,696	F: 27,648	F: 37,376	F: 29,696	U: 50,668
Data surfaces per spindle	11	15	8	11	15
Heads per data surface	1	1	1	1	1
Tracks per surface	1458	1632	2017	1458	2157
Track density (TPI)	1677	1376	1500	1677	2403
Maximum linear density (BPI)	30320 BPI 26951 FCI	31596 BPI 21064 FCI	23570 BPI 17677 FCI	30320 BPI 26951 FCI	44663 BPI 33497 FCI
Recording code	PRML	2,7 RLL	1,7 RLL	PRML	1,7 RLL
Rotational speed (RPM)	4986	3600	3119	4986	5380
PERFORMANCE					
Actuator type	Linear, Voice Coil	Rotary, Voice Coil	Dual, Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil
Servo type	Dedicated Surf.	Dedicated Surf.	Embedded	Dedicated Surf.	Dedicated Surf.
Average positioning time (msec)	11.2	18	19.5	11.2	12
Average rotational delay (msec)	6.02	8.3	9.62	6.02	5.58
Average access time (msec)	17.22	26.3	29.12	17.22	17.58
Data transfer rate (KBytes/sec)	4000 max.	1875	2500	4000	4550
FIRST CUSTOMER SHIPMENT	3/90	2Q90	9/88	9/90	5/91
COMMENTS		RS/6000 Mfg. by Maxtor	568 MB capacity when used with 9370 series	AS/400 9406 Disk unit, contains 2-4 disk drives	2 HDAs per drawer

MANUFACTURER	IBM	IBM	IBM	IBM	IBM
DRIVE	0663-H11	0663-H12	0663-L11	0663-L12	0681-1000
DISK/TREND GROUP	8	8	8	8	8
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	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	130 mm OD 40 mm ID
Recording medium	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
DRIVE: Heads	MR Thin Film	MR Thin Film	MR Thin Film	MR Thin Film	MIG
Interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	U: 1,111 F: 868	U: 1,283 F: 1,004	U: 1,111 F: 868	U: 1,283 F: 1,004	U: 1,054 F: 857
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 33,792	F: 33,792	F: 33,792	F: 33,792	F: 29,696
Data surfaces per spindle	13	15	13	15	20
Heads per data surface	1	1	1	1	1
Tracks per surface	2051	2051	2051	2051	1458
Track density (TPI)	2238	2238	2238	2238	1677
Maximum linear density (BPI)	58874 BPI 52332 FCI	58874 BPI 52332 FCI	58874 BPI 52332 FCI	58874 BPI 52332 FCI	30320 BPI 26951 FCI
Recording code	PRML	PRML	PRML	PRML	PRML
Rotational speed (RPM)	4316	4316	4316	4316	4986
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Linear, Voice Coil
Servo type	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.
Average positioning time (msec)	9.8	9.8	11	11	11.2
Average rotational delay (msec)	6.95	6.95	6.95	6.95	6.02
Average access time (msec)	16.75	16.75	17.95	17.95	17.22
Data transfer rate (KBytes/sec)	5000 synch. 3000 asynch.	5000 synch. 3000 asynch.	5000 synch. 3000 asynch.	5000 synch. 3000 asynch.	4000 max.
FIRST CUSTOMER SHIPMENT	4Q91	4Q91	4Q91	4Q91	3/90
COMMENTS	41.3 mm high	41.3 mm high	41.3 mm high 0663 low power version	41.3 mm high 0663 low power version	

MANUFACTURER	IBM	IBM	IBM	IBM	IBM
DRIVE	0685-B01	3380-AJ4 3380-BJ4 3380-CJ2	3390-A14 3390-A18 3390-B14 3390-B18 3390-B1C	7013-520(#2530) 7013-530(#2530) 7013-540(#2530) 7015-930(#2530) 7016-730(#2530)	9333-3100
DISK/TREND GROUP	8	8	8	8	8
MARKET	OEM	Captive	Captive	Captive	Captive
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	14"	14"	10.8"	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: Heads	Thin Film	Thin Film	Thin Film	MIG	MIG
Interface	IBM	IBM	IBM	SCSI-2	IBM Serial
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	U: 1,043.1 F: 855.9	F: 1,260.4	F: 1,892	F: 857	F: 857
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 44,280 F: 36,352	F: 47,476	F: 56,664	F: 29,696	F: 29,696
Data surfaces per spindle	6	15	15	20	20
Heads per data surface	2	2	2	1	1
Tracks per surface	3926	1770	2226	1458	1458
Track density (TPI)	1600	2089	2242	1677	1677
Maximum linear density (BPI)	16200 BPI 10800 FCI	15190 BPI 10126 FCI	27940 BPI 20955 FCI	30320 BPI 26951 FCI	30320 BPI 26951 FCI
Recording code	2,7 RLL	2,7 RLL	1,7 RLL	PRML	PRML
Rotational speed (RPM)	3623	3620	4260	4986	4986
PERFORMANCE					
Actuator type	Dual, Rotary, Voice Coil	Dual, Linear, Voice Coil	Dual, Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil
Servo type	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.
Average positioning time (msec)	18	12	9.5	11.2	11.2
Average rotational delay (msec)	8.28	8.3	7.1	6.02	6.02
Average access time (msec)	26.28	24.3	16.6	17.22	17.22
Data transfer rate (KBytes/sec)	3000	3000	4200	4000 max.	4000
FIRST CUSTOMER SHIPMENT	6/86	10/87 (A,B)	12/89	2Q90	7/91
COMMENTS	685-A01 has IPI-3 interface	AJ4 & BJ4 have 2 spindles	A14=2 HDAs A18=4 HDAs B14=2 HDAs B18=4 HDAs B1C=6 HDAs	RS/6000	RS/6000 Feature on models 010 and 500

MANUFACTURER	IBM	IBM	IBM	IBM	IBM
DRIVE	9335-B01	9336-20	9345-B12	9345-B22	3380-AK4 3380-BK4
DISK/TREND GROUP	8	8	8	8	9
MARKET	Captive	Captive	Captive	Captive	Captive
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	14"
Recording medium	Oxide Coated	Thin Film	Thin Film	Thin Film	Oxide Coated
DRIVE: Heads	Thin Film	MIG	MR Thin Film	MR Thin Film	Thin Film
Interface	IBM	SCSI-2	IBM	IBM	IBM
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	F: 855.9	F: 857	F: 1,001	F: 1,502	F: 3,781.4
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 36,352	F: 29,696	F: 46,456	F: 46,456	F: 47,476
Data surfaces per spindle	6	20	15	15	15
Heads per data surface	2	1	1	1	2
Tracks per surface	3924	1458	1438	2156	5310
Track density (TPI)	1600	1677	2403	2403	2089
Maximum linear density (BPI)	16200 BPI 10800 FCI	30320 BPI 26951 FCI	44663 BPI 33497 FCI	44663 BPI 33497 FCI	15190 BPI 10126 FCI
Recording code	2,7 RLL	PRML	1,7 RLL	1,7 RLL	2,7 RLL
Rotational speed (RPM)	3623	4986	5380	5380	3620
PERFORMANCE					
Actuator type	Dual, Rotary, Voice Coil	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil	Dual, Linear, Voice Coil
Servo type	Embedded	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.
Average positioning time (msec)	18	11.2	10	12	16
Average rotational delay (msec)	8.28	6.02	5.58	5.58	8.3
Average access time (msec)	26.28	17.22	15.58	17.58	24.3
Data transfer rate (KBytes/sec)	3000	4000	4400	4400	3000
FIRST CUSTOMER SHIPMENT	8/86	9/90	1Q92	1Q92	10/87
COMMENTS	System/38 AS/400 9335-A01 has IPI-3 interface	AS/400 9406 Disk unit, contains 2-4 disk drives	2 HDAs per drawer	2 HDAs per drawer	Drive has 2 spindles

MANUFACTURER	IBM	IBM	INTEGRAL PERIPHERALS	INTEGRAL PERIPHERALS	ITAUTEC
DRIVE	3390-A24 3390-A28 3390-B24 3390-B28 3390-B2C	3390-A34 3390-A38 3390-B34 3390-B38 3390-B3C	1820 Mustang	1842 Stingray	DRG20
DISK/TREND GROUP	9	9	2	3	2
MARKET	Captive	Captive	OEM	OEM	Captive
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	10.8"	10.8"	48 mm OD 12 mm ID	48 mm OD 12 mm ID	130 mm OD 40 mm ID
Recording medium	Oxide Coated	Thin Film	Thin Film	Thin Film	Oxide Coated
DRIVE: Heads	Thin Film	Thin Film	MIG	MIG	Thin Film
Interface	IBM	IBM	PC AT/XT	PC AT/XT	ST412
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	F: 3,784	F: 5,676	F: 21.4	F: 42.5	U: 25.6
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 56,664	F: 56,664	*	*	U: 10,416
Data surfaces per spindle	15	15	2	4	4
Heads per data surface	2	2	1	1	1
Tracks per surface	4452	6678	608	830	616
Track density (TPI)	2242	2984	1942	1942	585
Maximum linear density (BPI)	27940 BPI 20955 FCI	30008 BPI 22506 FCI	46100 BPI 34600 FCI	46100 BPI 34600 FCI	9800
Recording code	1,7 RLL	1,7 RLL	1,7 RLL	1,7 RLL	MFM
Rotational speed (RPM)	4260	4260	3571	3571	3600
PERFORMANCE					
Actuator type	Dual, Linear, Voice Coil	Dual, Linear, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Band, Stepping Motor
Servo type	Dedicated Surf.	Dedicated Surf.	Embedded	Embedded	Open Loop
Average positioning time (msec)	12.5	15	20	20	65 (including settling)
Average rotational delay (msec)	7.1	7.1	8.4	8.4	8.3
Average access time (msec)	19.6	22.18	28.4	28.4	73.3
Data transfer rate (KBytes/sec)	4200	4200	4000	4000	625
FIRST CUSTOMER SHIPMENT	12/89	9/91	3Q91	2Q92	1/88
COMMENTS	A24=2 HDAs A28=4 HDAs B24=2 HDAs B28=4 HDAs B2C=6 HDAs	A34= 2 HDAs A38= 4 HDAs B34= 2 HDAs B38= 4 HDAs B36= 6 HDAs	15 mm high HDA 10 mm high *Varies by zone Ramp loaded heads	15 mm high HDA 12 mm high *Varies by zone Ramp loaded heads	

MANUFACTURER	ITAUTEC	JVC	JVC	JVC	JVC
DRIVE	ADR96	JD-E2825P	JD-E3848V	JD-E2850P	JD-E3896V
DISK/TREND GROUP	4	2	3	3	4
MARKET	Captive	OEM	OEM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	130 mm OD 40 mm ID	65 mm OD 20 mm ID	95 mm OD 25 mm ID	65 mm OD 20 mm ID	95 mm OD 25 mm ID
Recording medium	Metal Plated	Thin Film	Thin Film	Thin Film	Thin Film
DRIVE: Heads	Thin Film	Ferrite	Ferrite	Ferrite	Ferrite
Interface	ST412	PCAT,Prop.,SCSI	PC AT, SCSI	PC AT/XT, SCSI	PC AT/XT, SCSI
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	U: 95.99	F: 21.45	F: 42.42	F: 42.52	F: 84.84
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 10,416	F: 18,432	F: 24,576	F: 17,920	F: 24,576
Data surfaces per spindle	9	2	2	3	4
Heads per data surface	1	1	1	1	1
Tracks per surface	1024	581	862	791	862
Track density (TPI)	1000	1300	1300	1700	1300
Maximum linear density (BPI)	10000	39665 BPI 26443 FCI	38145 BPI 25430 FCI	42362 BPI 28241 FCI	38145 BPI 25430 FCI
Recording code	MFM	2,7 RLL	2,7 RLL	2,7 RLL	2,7 RLL
Rotational speed (RPM)	3600	3109	2332	3109	2332
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Dedicated Surf.	Embedded	Embedded	Embedded	Embedded
Average positioning time (msec)	30	23	25	25	25
Average rotational delay (msec)	8.3	9.6	12.8	9.6	12.8
Average access time (msec)	38.3	32.6	37.8	34.6	37.8
Data transfer rate (KBytes/sec)	625	1250	1250	1250	1250
FIRST CUSTOMER SHIPMENT	1/90	4Q89	3Q89	11/90	1990
COMMENTS		19.05 mm high	20.8 mm high	19.05 mm high	25.4 mm high

MANUFACTURER	KALOK	KALOK	KALOK	KALOK	KYOCERA
DRIVE	KL320 Octagon 20	KL330 Octagon 30	KL343 Octagon I	KL3100 Octagon II	KC 20A
DISK/TREND GROUP	2	3	3	5	2
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	Thin Film	Thin Film	Thin Film	Thin Film
DRIVE: Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	ST412	ST412	PC AT	PC AT, IDE	ST412
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	U: 25.62	U: 38.44*	F: 42.57	F: 105	U: 25.5
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 10,416	U: 15,624*	F: 15,872	F: 17,920	U: 10,416
Data surfaces per spindle	4	4	4	6	4
Heads per data surface	1	1	1	1	1
Tracks per surface	615	615	676	978	616
Track density (TPI)	814	814	814		835
Maximum linear density (BPI)	13533	20300 BPI 13533 FCI	23610 BPI 15740 FCI	29161 BPI 19441 FCI	12268
Recording code	MFM	2,7 RLL*	2,7 RLL	2,7 RLL	MFM
Rotational speed (RPM)	3600	3600	3375	3662	3600
PERFORMANCE					
Actuator type	Rotary, Stepping Motor	Rotary, Stepping Motor	Rotary, Stepping Motor	Rotary, Stepping Motor	Rotary, Band, Stepping Motor
Servo type	Open Loop	Open Loop	Open Loop	Open Loop	Open Loop
Average positioning time (msec)	40 (including settling)	40 (including settling)	28 (including settling)	19 (including settling)	65 (including settling)
Average rotational delay (msec)	8.3	8.3	8.8	8.1	8.3
Average access time (msec)	48.3	48.3	36.8	27.1	73.3
Data transfer rate (KBytes/sec)	625	937.5*	4500 max.	1800	625
FIRST CUSTOMER SHIPMENT	2Q88	2Q88	1/89	2Q91	1987
COMMENTS	41.3 mm high	41.3 mm high *With RLL controller	41.3 mm high	41.3 mm high	41.3 mm high

MANUFACTURER	KYOCERA	KYOCERA	KYOCERA	KYOCERA	KYOCERA
DRIVE	KC 20B	KC 30A	KC 30B	KC 40GA	KC 80GA
DISK/TREND GROUP	2	3	3	3	4
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	Thin Film	Oxide Coated	Thin Film	Thin Film
DRIVE: Heads	Ferrite	Ferrite	Ferrite	MIG	MIG
Interface	ST412	ST412	ST412	PC AT	PC AT
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	U: 25.5	U: 38.4*	U: 38.4*	F: 40.54	F: 84.0
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 10,416	U: 15,624*	U: 15,624*	*	*
Data surfaces per spindle	4	4	4	2	4
Heads per data surface	1	1	1	1	2
Tracks per surface	615	616	615	1069	1069
Track density (TPI)	800	835	800	1309	1309
Maximum linear density (BPI)	13464	18402 BPI 12268 FCI	20196 BPI 13464 FCI	29589 BPI 19726 FCI	29589 BPI 19726 FCI
Recording code	MFM	2,7 RLL*	2,7 RLL*	2,7 RLL	2,7 RLL
Rotational speed (RPM)	3600	3600	3600	2746	2746
PERFORMANCE					
Actuator type	Rotary, Band, Stepping Motor	Rotary, Stepping Motor	Rotary, Stepping Motor	Rotary, Stepping Motor	Rotary, Stepping Motor
Servo type	Open Loop	Open Loop	Open Loop	Embedded	Embedded
Average positioning time (msec)	62 (including settling)	65 (including settling)	62 (including settling)	28 (including settling)	23 (including settling)
Average rotational delay (msec)	8.3	8.3	8.3	10.92	10.92
Average access time (msec)	70.3	73.3	70.3	38.92	33.92
Data transfer rate (KBytes/sec)	625	937.5*	937.5*	4000 max.	4000 max.
FIRST CUSTOMER SHIPMENT	1987	1987	1987	1Q90	4Q90
COMMENTS	41.3 mm high	41.3 mm high *With RLL controller	41.3 mm high *With RLL controller	41.3 mm high *Varies by zone	41.3 mm high *Varies by zone

MANUFACTURER	KYOCERA	KYOCERA	KYOCERA	KYUSHU MATSUSHITA ELECTRIC	MAGTRON
DRIVE	KC 80GS	KC 120DA	KC 120DS	RD-210AA	MT3040A
DISK/TREND GROUP	4	5	5	5	3
MARKET	OEM	OEM	OEM	OEM	OEM, PCM
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	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
DRIVE: Heads	MIG	MIG	MIG	MIG	Ferrite
Interface	SCSI	PC AT	SCSI	SCSI-2	PC AT
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	F: 81.08	F: 120.27	F: 120.27	F: 210	F: 40
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	*	F: 30,070	F: 30,070	F: 64,000	F: 23,552
Data surfaces per spindle	4	4	4	4	2
Heads per data surface	2	2	2	1	1
Tracks per surface	1069	1305	1305	1636	850
Track density (TPI)	1309	1528	1528	1775	1408
Maximum linear density (BPI)	29589 BPI 19726 FCI	39939 BPI 26626 FCI	39939 BPI 26626 FCI	45300 BPI 33975 FCI	33276 BPI 22184 FCI
Recording code	2,7 RLL	2,7 RLL	2,7 RLL	1,7 RLL	2,7 RLL
Rotational speed (RPM)	2746	3600	3600	3300	3600
PERFORMANCE					
Actuator type	Rotary, Stepping Motor	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Embedded	Embedded	Embedded	Embedded	Embedded
Average positioning time (msec)	23 (including settling)	19	19	16	20
Average rotational delay (msec)	10.92	8.3	8.3	9.09	8.3
Average access time (msec)	33.92	27.3	27.3	25.09	28.3
Data transfer rate (KBytes/sec)	4000 max.	4000 max.	4000 max.	5000 synch. 3000 asynch.	1780
FIRST CUSTOMER SHIPMENT	4Q90	1991	1991	8/92	7/91
COMMENTS	41.3 mm high *Varies by zone	25.4 mm high	25.4 mm high	25.4 mm high Negative pressure sliders	25.4 mm high

MANUFACTURER	MAGTRON	MAGTRON	MAGTRON	MAGTRON	MAGTRON
DRIVE	MT3080A	MT4115	MT4140	MT4170	MT5400E
DISK/TREND GROUP	4	5	5	5	6
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	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	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
DRIVE: Heads		Thin Film	Thin Film	Thin Film	Thin Film
Interface	PC AT	ESDI, SCSI	ESDI, SCSI	ESDI, SCSI	ESDI
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	F: 80	U: 138	U: 172	U: 207	F: 360.90 U: 400
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 23,552	U: 17,920	U: 17,920	U: 17,920	U: 31,250
Data surfaces per spindle	4	4	5	6	8
Heads per data surface	1	1	1	1	1
Tracks per surface	850	1600	1600	1600	1632
Track density (TPI)	1408	1460	1460	1460	1400
Maximum linear density (BPI)	33276 BPI 22184 FCI	20320 BPI 13546 FCI	20320 BPI 13546 FCI	20320 BPI 13546 FCI	32332 BPI 24249 FCI
Recording code	2,7 RLL	2,7 RLL	2,7 RLL	2,7 RLL	1,7 RLL
Rotational speed (RPM)	3600	3600	3600	3600	3600
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil	Rotary, Voice Coil
Servo type	Embedded	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.
Average positioning time (msec)	20	25	25	25	14
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	28.3	33.3	33.3	33.3	22.3
Data transfer rate (KBytes/sec)	1780	1250	1250	1250	1875
FIRST CUSTOMER SHIPMENT	7/91	4/89	4/89	4/89	5/91
COMMENTS	25.4 mm high	41.3 mm high	41.3 mm high	41.3 mm high	

MANUFACTURER	MAGTRON	MAGTRON	MAGTRON	MAGTRON	MAXTOR
DRIVE	MT5400S	MT5760E	MT5760S	MT51200S	7040A
DISK/TREND GROUP	6	7	7	8	3
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: Heads	Thin Film	Thin Film	Thin Film	Thin Film	MIG
Interface	SCSI	ESDI	SCSI	SCSI	PC AT
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	F: 358.90 U: 400	F: 678.8 U: 765	F: 673 U: 765	U: 1,204 F: 1,063	F: 40.7
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 31,250	U: 31,250	U: 31,250	*	F: 18,432
Data surfaces per spindle	8	15	15	15	2
Heads per data surface	1	1	1	1	1
Tracks per surface	1623	1632	1623	1924	1170
Track density (TPI)	1400	1400	1400	1600	1490
Maximum linear density (BPI)	32332 BPI 24249 FCI	32332 BPI 24249 FCI	32332 BPI 24249 FCI	46036 BPI 34535 FCI	30625 BPI 22969 FCI
Recording code	1,7 RLL	1,7 RLL	1,7 RLL	1,7 RLL	1,7 RLL
Rotational speed (RPM)	3600	3600	3600	3600	3703
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Embedded
Average positioning time (msec)	14	14	14	14	17
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.1
Average access time (msec)	22.3	22.3	22.3	22.3	25.1
Data transfer rate (KBytes/sec)	4000 synch.	1875	4000 synch.	6000 synch. 4000 asynch.	1350
FIRST CUSTOMER SHIPMENT	5/91	5/91	5/91	4Q91	1Q90
COMMENTS				*Varies by zone	25.4 mm high

MANUFACTURER	MAXTOR	MAXTOR	MAXTOR	MAXTOR	MAXTOR
DRIVE	7040S	2585A	2585S	7060A Cheyenne	7060S Cheyenne
DISK/TREND GROUP	3	4	4	4	4
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	95 mm OD 25 mm ID	65 mm OD 20 mm ID	65 mm OD 20 mm ID	95 mm OD 25 mm ID	95 mm OD 25 mm ID
Recording medium	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
DRIVE: Heads	MIG	MIG	MIG	MIG	MIG
Interface	SCSI	PC AT	SCSI	PC AT	SCSI
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	F: 40.0	F: 85.4	F: 85.4	F: 65.2	F: 65.2
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 18,432	*	*	F: 21,504	F: 21,504
Data surfaces per spindle	2	4	4	2	2
Heads per data surface	1	1	1	1	1
Tracks per surface	1155	1092	1092	1516	1516
Track density (TPI)	1490	1993	1993	1800	1800
Maximum linear density (BPI)	30625 BPI 22969 FCI	39000 BPI 29000 FCI	39000 BPI 29000 FCI	34087 BPI 25565 FCI	34087 BPI 25565 FCI
Recording code	1,7 RLL	1,7 RLL	1,7 RLL	1,7 RLL	1,7 RLL
Rotational speed (RPM)	3703	3551	3551	3524	3524
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Embedded	Embedded	Embedded	Embedded	Embedded
Average positioning time (msec)	17	15	15	15	15
Average rotational delay (msec)	8.1	8.4	8.4	8.5	8.5
Average access time (msec)	25.1	23.4	23.4	23.5	23.5
Data transfer rate (KBytes/sec)	5000 synch. 3000 asynch.	8000	4500 synch. 3000 asynch.	6000	5000 synch. 3000 asynch.
FIRST CUSTOMER SHIPMENT	1Q90	4Q91	4Q91	12/90	12/90
COMMENTS	25.4 mm high	17.5 mm high *Varies by zone	17.5 mm high *Varies by zone	25.4 mm high	25.4 mm high

MANUFACTURER	MAXTOR	MAXTOR	MAXTOR	MAXTOR	MAXTOR
DRIVE	7080A	7080S	XT-1085	7120A Cheyenne	7120S Cheyenne
DISK/TREND GROUP	4	4	4	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	130 mm OD 40 mm ID	95 mm OD 25 mm ID	95 mm OD 25 mm ID
Recording medium	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
DRIVE: Heads	MIG	MIG	Ferrite	MIG	MIG
Interface	PC AT	SCSI	ST412	PC AT	SCSI
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	F: 81.4	F: 80.7	U: 85.32	F: 130.4	F: 130.4
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 18,432	F: 18,432	U: 10,416	F: 21,504	F: 21,504
Data surfaces per spindle	4	4	8	4	4
Heads per data surface	1	1	1	1	1
Tracks per surface	1170	1155	1024	1516	1516
Track density (TPI)	1490	1490	1070	1800	1800
Maximum linear density (BPI)	30625 BPI 22969 FCI	30625 BPI 22969 FCI	9934	34087 BPI 25565 FCI	34087 BPI 25565 FCI
Recording code	1,7 RLL	1,7 RLL	MFM	1,7 RLL	1,7 RLL
Rotational speed (RPM)	3703	3703	3600	3524	3524
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Embedded	Embedded	Dedicated Surf.	Embedded	Embedded
Average positioning time (msec)	17	17	27	15	15
Average rotational delay (msec)	8.1	8.1	8.3	8.5	8.5
Average access time (msec)	25.1	25.1	35.3	23.5	23.5
Data transfer rate (KBytes/sec)	1350	5000 synch. 3000 asynch.	625	6000	5000 synch. 3000 asynch.
FIRST CUSTOMER SHIPMENT	1Q90	3Q90	2Q83	12/90	12/90
COMMENTS	25.4 mm high	25.4 mm high		25.4 mm high	25.4 mm high

MANUFACTURER	MAXTOR	MAXTOR	MAXTOR	MAXTOR	MAXTOR
DRIVE	LXT-213S/A	XT-1120R	XT-1140	XT-1240R	XT-2190
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	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: Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	SCSI, PC AT	ST412	ST412	ST412	ST412
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	F: 213	U: 127.99*	U: 143.42	U: 239.98*	U: 191.23
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	*	U: 15,624*	U: 10,416	U: 15,624*	U: 10,416
Data surfaces per spindle	7	8	15	15	15
Heads per data surface	1	1	1	1	1
Tracks per surface	1320	1024	918	1024	1224
Track density (TPI)	1591	1070	1070	1070	1070
Maximum linear density (BPI)		14901 BPI 9934 FCI	9280	14901 BPI 9934 FCI	11155
Recording code	1,7 RLL	2,7 RLL*	MFM	2,7 RLL*	MFM
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
Servo type	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.
Average positioning time (msec)	15	27	25.8	27	28.9
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	23.3	35.3	34.1	35.3	37.2
Data transfer rate (KBytes/sec)	5000 synch. 3000 asynch.	937.5*	625	937.5*	625
FIRST CUSTOMER SHIPMENT	3Q90	2Q87	2Q83	2Q87	3Q84
COMMENTS	41.3 mm high *Varies by zone	*With RLL controller		*With RLL controller	

MANUFACTURER	MAXTOR	MAXTOR	MAXTOR	MAXTOR	MAXTOR
DRIVE	XT-4170E	XT-4170S	XT-4230E	LXT-340S/A	LXT-437S/A
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	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	Thin Film	Thin Film	Thin Film	Thin Film
DRIVE: Heads	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
Interface	ESDI	SCSI	ESDI	SCSI, PC AT	SCSI-2, PC AT
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	U: 179.45	F: 157.93	U: 230.6	F: 340	F: 437
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 20,940	F: 18,432	U: 20,940	*	*
Data surfaces per spindle	7	7	9	7	9
Heads per data surface	1	1	1	1	1
Tracks per surface	1224	1224	1224	1560	1560
Track density (TPI)	1070	1070	1070	1613	1600
Maximum linear density (BPI)	21064 BPI 14043 FCI	21064 BPI 14043 FCI	21064 BPI 14042 FCI	44000 BPI 33000 FCI	44000 BPI 33000 FCI
Recording code	2,7 RLL	2,7 RLL	2,7 RLL	1,7 RLL	1,7 RLL
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
Servo type	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.
Average positioning time (msec)	14	14	16	15	12 read/13 wr.
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	22.3	22.3	24.3	23.3	20.3/21.3
Data transfer rate (KBytes/sec)	1250	4800 synch.	1250	5000 synch. 3000 asynch.	6000 synch. 5000 asynch.
FIRST CUSTOMER SHIPMENT	2Q87	2/86	3Q90	3Q90	1Q91
COMMENTS				41.3 mm high *Varies by zone 8 recording bands	41.3 mm high *Varies by zone

MANUFACTURER	MAXTOR	MAXTOR	MAXTOR	MAXTOR	MAXTOR
DRIVE	XT-4380E	XT-4380S	XT-8380EH	XT-8380SH	LXT-535S/A
DISK/TREND GROUP	6	6	6	6	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	95 mm OD 25 mm ID
Recording medium	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
DRIVE: Heads	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
Interface	ESDI	SCSI	ESDI	SCSI	SCSI-2, PC AT
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	U: 384.53	F: 338.41	U: 410.0	F: 360.31	F: 535
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 20,940	F: 18,432	U: 31,410	F: 27,648	*
Data surfaces per spindle	15	15	8	8	11
Heads per data surface	1	1	1	1	1
Tracks per surface	1224	1224	1632	1632	1560
Track density (TPI)	1070	1070	1376	1376	1600
Maximum linear density (BPI)	21064 BPI 14043 FCI	21064 BPI 14043 FCI	31596 BPI 21064 FCI	31596 BPI 21064 FCI	44000 BPI 33000 FCI
Recording code	2,7 RLL	2,7 RLL	2,7 RLL	2,7 RLL	1,7 RLL
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
Servo type	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.
Average positioning time (msec)	16	16	14.5	14.5	12 read/13 wr.
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	24.3	24.3	22.8	22.8	20.3/21.3
Data transfer rate (KBytes/sec)	1250	4800 synch.	1875	4800 synch.	6000 synch. 5000 asynch.
FIRST CUSTOMER SHIPMENT	2Q87	4Q87	1Q87	1Q88	1Q91
COMMENTS					41.3 mm high *Varies by zone

MANUFACTURER	MAXTOR	MAXTOR	MAXTOR	MAXTOR	MAXTOR
DRIVE	XT-8610E	XT-8702S	XT-8760EH	XT-8760SH	XT-8800E
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: Heads	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
Interface	ESDI	SCSI	ESDI	SCSI	ESDI
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	U: 615.3	U: 702.0	U: 768.9	F: 675.58	U: 800.5
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 31,410	U: 31,410	U: 31,410	F: 27,648	U: 41,888
Data surfaces per spindle	12	15	15	15	15
Heads per data surface	1	1	1	1	1
Tracks per surface	1632	1490	1632	1632	1274
Track density (TPI)	1376	1376	1376	1376	1376
Maximum linear density (BPI)	32320 BPI 21546 FCI	31596 BPI 21064 FCI	31596 BPI 21064 FCI	31596 BPI 21064 FCI	35020 BPI 21546 FCI
Recording code	2,7 RLL	2,7 RLL	2,7 RLL	2,7 RLL	2,7 RLL
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
Servo type	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.
Average positioning time (msec)	16	16.5	16.5	16.5	15
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	24.3	24.3	24.8	24.8	23.3
Data transfer rate (KBytes/sec)	1875	4800 synch.	1875	4800 synch.	2500
FIRST CUSTOMER SHIPMENT	3Q90	3Q90	1Q87	1Q88	3Q90
COMMENTS					

MANUFACTURER	MAXTOR	MAXTOR	MEMOREX TELEX	MEMOREX TELEX	MEMOREX TELEX
DRIVE	P0-12S	P1-17S	3890-00J4 3890-02J4	3890-00K6 3890-02K6	3892-00K7 3892-02K7
DISK/TREND GROUP	8	8	7	9	9
MARKET	OEM	OEM	PCM	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	210 mm OD 100 mm ID	210 mm OD 100 mm ID	210 mm OD 100 mm ID
Recording medium	Thin Film	Thin Film	Oxide Coated	Oxide Coated	Thin Film
DRIVE: Heads	Thin Film	Thin Film	Ferrite	Ferrite	Thin Film
Interface	SCSI-2	SCSI-2	IBM	IBM	IBM
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	F: 1,029	F: 1,503	F: 630.24	F: 1,890	F: 1,890
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	*	*	F: 47,476	F: 47,476	F: 58,664
Data surfaces per spindle	15	19	13.5	21	15
Heads per data surface	1	1	2	1	1
Tracks per surface	1632	1778	990	1916	2226
Track density (TPI)	1376	1498	1193	1456	2080
Maximum linear density (BPI)	36548 BPI 27411 FCI	42981 BPI 32235 FCI	25211 BPI 18908 FCI	25055 BPI 18791 FCI	30706 BPI 23029 FCI
Recording code	1,7 RLL	1,7 RLL	1,7 RLL	1,7 RLL	1,7 RLL
Rotational speed (RPM)	3600	3600	3620	3600	4200
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.
Average positioning time (msec)	13	13	12	12	12
Average rotational delay (msec)	8.3	8.3	8.3	8.3	7.1
Average access time (msec)	21.3	21.3	20.3	20.3	19.1
Data transfer rate (KBytes/sec)	5000 synch. 3000 asynch.	5000 synch. 3000 asynch.	3000	3000	4260
FIRST CUSTOMER SHIPMENT	2Q91	2Q91	1989	1Q91	4Q91
COMMENTS	*Varies by zone	*Varies by zone	PCM 3380J Drive has 8 or 16 spindles Manufactured by Fujitsu	PCM 3380-K Drive has 8 or 16 spindles Manufactured by Fujitsu	PCM 3390-2 Drive has 8 or 16 spindles Manufactured by Fujitsu

MANUFACTURER	MFM TECHNOLOGY	MFM TECHNOLOGY	MFM TECHNOLOGY	MFM TECHNOLOGY	MFM TECHNOLOGY
DRIVE	11/11 Micro-Magnum	11/R Micro-Magnum	20/20 Micro-Magnum	20/R Micro-Magnum	5/5 Micro-Magnum
DISK/TREND GROUP	1	1	1	1	1
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	5.25" Cartridge	5.25" Cartridge	5.25" Cartridge	5.25" Cartridge	5.25" Cartridge
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: Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	ST506	ST506	ST506	ST506	ST506
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	U: 13.6	--	U: 24.25	--	U: 6.4
REMOVABLE	U: 13.6	U: 13.6	U: 24.25	U: 24.25	U: 6.4
Capacity per track (Bytes)	U: 10,640	U: 10,640	U: 10,640	U: 10,640	U: 10,032
Data surfaces per spindle	4	2	4	2	4
Heads per data surface	1	1	1	1	1
Tracks per surface	640	640	1120	1120	320
Track density (TPI)	908	908	1250	1250	454
Maximum linear density (BPI)	10890	10890	11080	11080	8725
Recording code	MFM	MFM	MFM	MFM	MFM
Rotational speed (RPM)	3254	3254	3248	3248	3443
PERFORMANCE					
Actuator type	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil
Servo type	Embedded	Embedded	Embedded	Embedded	Embedded
Average positioning time (msec)	40	40	40	40	40
Average rotational delay (msec)	9.2	9.2	9.2	9.2	8.7
Average access time (msec)	49.2	49.2	49.2	49.2	48.7
Data transfer rate (KBytes/sec)	625	625	625	625	625
FIRST CUSTOMER SHIPMENT	1986	1986	1990	1987	1986
COMMENTS					

MANUFACTURER	MFM TECHNOLOGY	MICROLAB	MICROLAB	MICROLAB	MICROLAB
DRIVE	5/R Micro-Magnum	DFW 5025	DFW 3040	DFW 5038	DFW 5053
DISK/TREND GROUP	1	2	3	3	3
MARKET	OEM	OEM	OEM, PCM	OEM	OEM
MEDIA: Generic type	5.25" Cartridge	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	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: Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	ST506	ST412	PC AT	ST412	ST412
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	--	U: 25.6	F: 42	U: 38.4*	U: 53.3
REMOVABLE	U: 6.75	--	--	--	--
Capacity per track (Bytes)	F: 10,890	U: 10,416	F: 20,480	U: 15,624*	U: 10,416
Data surfaces per spindle	2	4	2	4	5
Heads per data surface	1	1	1	1	1
Tracks per surface	311	615	1045	615	1024
Track density (TPI)	454	588	1400	588	1031
Maximum linear density (BPI)	8617	9827	30800 BPI 20533 FCI	14740 BPI 9827 FCI	9726
Recording code	MFM	MFM	2,7 RLL	2,7 RLL*	MFM
Rotational speed (RPM)	3443	3600	3550	3600	3600
PERFORMANCE					
Actuator type	Linear, Voice Coil	Band, Stepping Motor	Rotary, Voice Coil	Rotary, Band, Stepping Motor	Linear, Voice Coil
Servo type	Embedded	Open Loop	Embedded	Open Loop	Dedicated Surf.
Average positioning time (msec)	40	65 (including settling)	20	65 (including settling)	28
Average rotational delay (msec)	8.7	8.3	8.5	8.3	8.3
Average access time (msec)	48.7	73.3	28.5	73.3	36.3
Data transfer rate (KBytes/sec)	625	625	1500	937.5*	625
FIRST CUSTOMER SHIPMENT	1986	9/88	9/91	3Q91	10/89
COMMENTS		41.3 mm high	25.4 mm high	41.3 mm high *With RLL controller	

MANUFACTURER	MICROLAB	MICROPOLIS	MICROPOLIS	MICROPOLIS	MICROPOLIS
DRIVE	DFW 5096	1335	1355	1375	1654-7
DISK/TREND GROUP	4	4	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	Thin Film	Thin Film	Thin Film
DRIVE: Heads	Ferrite	Ferrite	Ferrite	Ferrite	Thin Film/Ferr.
Interface	ST412	ST412	ESDI	SCSI	ESDI
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	U: 96.0	U: 85.3	U: 170.6	F: 145.9	U: 182.1
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 10,416	U: 10,416	U: 20,832	F: 18,432	U: 20,832
Data surfaces per spindle	9	8	8	8	7
Heads per data surface	1	1	1	1	1
Tracks per surface	1024	1024	1024	1016	1249
Track density (TPI)	1031	1000	1055	1055	1100
Maximum linear density (BPI)	9726	9824	19804 BPI 13202 FCI	19804 BPI 13202 FCI	21185 BPI 14123 FCI
Recording code	MFM	MFM	2,7 RLL	2,7 RLL	2,7 RLL
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
Servo type	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.
Average positioning time (msec)	28	28	23	23	16
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	36.3	36.3	31.3	31.3	24.3
Data transfer rate (KBytes/sec)	625	625	1250	1600	1250
FIRST CUSTOMER SHIPMENT	10/89	3Q84	3Q85	1Q86	1Q90
COMMENTS					41.3 mm high

MANUFACTURER	MICROPOLIS	MICROPOLIS	MICROPOLIS	MICROPOLIS	MICROPOLIS
DRIVE	1674-7	1558-15	1578-15	1664-7	1684-7
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	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: Heads	Thin Film/Ferr.	Thin Film/Ferr.	Thin Film/Ferr.	Thin Film	Thin Film
Interface	SCSI	ESDI	SCSI	ESDI	SCSI
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	F: 158	U: 382.3	F: 331.7	U: 389.3	F: 340
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 18,432	U: 20,832	F: 18,432	U: 31,248	F: 27,648
Data surfaces per spindle	7	15	15	7	7
Heads per data surface	1	1	1	1	1
Tracks per surface	1249	1224	1220	1780	1776
Track density (TPI)	1100	1075	1075	1554	1554
Maximum linear density (BPI)	21185 BPI 14123 FCI	21231 BPI 14154 FCI	21231 BPI 14154 FCI	31776 BPI 21184 FCI	31776 BPI 21184 FCI
Recording code	2,7 RLL	2,7 RLL	2,7 RLL	2,7 RLL	2,7 RLL
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
Servo type	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.
Average positioning time (msec)	16	18	16	15	14
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	24.3	26.3	24.3	23.3	22.3
Data transfer rate (KBytes/sec)	4000 synch. 1800 asynch.	1250	4000 synch. 1800 asynch.	1875	4000 synch. 1800 asynch.
FIRST CUSTOMER SHIPMENT	1Q88	4Q86	2Q87	1Q89	1Q89
COMMENTS	41.3 mm high			41.3 mm high	41.3 mm high

MANUFACTURER	MICROPOLIS	MICROPOLIS	MICROPOLIS	MICROPOLIS	MICROPOLIS
DRIVE	1568-15	1588-15	1588-15D	1588T	1624
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: Heads	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
Interface	ESDI	SCSI	SCSI	SCSI	SCSI-2
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	U: 765	F: 668	F: 668	F: 668	F: 668
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 31,250	F: 27,648	F: 27,648	F: 27,648	*
Data surfaces per spindle	15	15	15	15	7
Heads per data surface	1	1	1	1	1
Tracks per surface	1632	1628	1628	1628	2099
Track density (TPI)	1440	1440	1440	1440	1850
Maximum linear density (BPI)	31846 BPI 21230 FCI	31833 BPI 21222 FCI	31833 BPI 23874 FCI	31833 BPI 23874 FCI	40646 BPI 30485 FCI
Recording code	2,7 RLL	2,7 RLL	1,7 RLL	1,7 RLL	1,7 RLL
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
Servo type	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.
Average positioning time (msec)	16	16	16	16	15
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	24.3	24.3	24.3	24.3	23.3
Data transfer rate (KBytes/sec)	1875	4000 synch. 1800 asynch.	5000 synch. 1800 asynch.	5000 synch. 1800 asynch.	10000 synch. 4000 asynch.
FIRST CUSTOMER SHIPMENT	2Q88	2Q88	11/88	10/90	3Q91
COMMENTS					41.3 mm high *Varies by zone

MANUFACTURER	MICROPOLIS	MICROPOLIS	MICROPOLIS	MICROPOLIS	MICROPOLIS
DRIVE	1518-15	1528-15 1528-15D	1538-15	1598-15	1598-15D
DISK/TREND GROUP	8	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: Heads	Thin Film	Thin Film/Ferr.	Thin Film	Thin Film	Thin Film
Interface	ESDI	SCSI	ESDI	SCSI-2	SCSI-2
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	U: 1,530	U: 1,530 F: 1,346	U: 1,010	F: 1,049	F: 1,049
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 48,600	F: 43,008	U: 41,380	F: 36,864	F: 36,352
Data surfaces per spindle	15	15	15	15	15
Heads per data surface	1	1	1	1	1
Tracks per surface	2100	2100	1669	1919	1919
Track density (TPI)	1853	1853	1702	1702	1702
Maximum linear density (BPI)	48608 BPI 36456 FCI	49532 BPI 37149 FCI	37664 BPI 28248 FCI	42462 BPI 31846 FCI	42462 BPI 31846 FCI
Recording code	1,7 RLL	1,7 RLL	1,7 RLL	1,7 RLL	1,7 RLL
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
Servo type	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.
Average positioning time (msec)	14.5	14.5	14.5	14.5	14.5
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	22.8	22.8	22.8	22.8	22.8
Data transfer rate (KBytes/sec)	5000	5000 synch. 1800 asynch.	4000	5000 synch. 1800 asynch.	5000 synch. 1800 asynch.
FIRST CUSTOMER SHIPMENT	8/90	7/90	7/90	3Q89	3Q89
COMMENTS					

MANUFACTURER	MICROPOLIS	MICROPOLIS	MICROPOLIS	MICROPOLIS	MICROSCIENCE INTERNATIONAL
DRIVE	1908 1908D	2112	1548 1548D	1924	8040
DISK/TREND GROUP	8	8	9	9	3
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	130 mm OD 40 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	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
DRIVE: Heads	Thin Film	Thin Film	Thin Film	Thin Film	
Interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	PC AT
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	F: 1,408	F: 1,050	F: 1,748	U: 2,440 F: 2,100	F: 42
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	*	*	*	*	F: 20,480
Data surfaces per spindle	15	15	15	20	2
Heads per data surface	1	1	1	1	1
Tracks per surface	2089	1770	2089	2246	1024
Track density (TPI)	1854	1980	1853	2000	1389
Maximum linear density (BPI)	50000 BPI 37500 FCI	48750 BPI 36563 FCI	49278 BPI 36959 FCI	42130 BPI 31600 FCI	32498 BPI 21665 FCI
Recording code	1,7 RLL	1,7 RLL	1,7 RLL	1,7 RLL	2,7 RLL
Rotational speed (RPM)	5400	5400	3600	5400	3600
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Embedded
Average positioning time (msec)	11.5	10	11	11.5	25
Average rotational delay (msec)	5.6	5.6	8.3	5.56	8.3
Average access time (msec)	17.1	15.6	17.3	17.06	33.3
Data transfer rate (KBytes/sec)	10000 synch. 4000 asynch.	10000 synch. 4000 asynch.	10000 synch. 4000 asynch.	10000 synch. 4000 asynch.	1500
FIRST CUSTOMER SHIPMENT	2Q91	3Q91	1Q91	3Q91	5/90
COMMENTS	*Varies by zone	41.3 mm high *Varies by zone	*Varies by zone	*Varies by zone	25.4 mm high

MANUFACTURER	MICROSCIENCE INTERNATIONAL	MICROSCIENCE INTERNATIONAL	MICROSCIENCE INTERNATIONAL	MICROSCIENCE INTERNATIONAL	MICROSCIENCE INTERNATIONAL
DRIVE	8080	5100-20	7100-20	8200	FH-7200
DISK/TREND GROUP	4	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	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
DRIVE: Heads	MIG				
Interface	PC AT	ESDI	PC AT, IDE	PC AT, IDE	PC AT, IDE
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	F: 85	U: 139.9	F: 120.4	F: 210	F: 201.38
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 24,064	U: 20,832	F: 17,920	*	F: 22,528
Data surfaces per spindle	2	7	7	4	7
Heads per data surface	1	1	1	1	1
Tracks per surface	1768	960	960	1904	1277
Track density (TPI)	2250	1250	1250	2250	1561
Maximum linear density (BPI)	45000 BPI 33750 FCI	26895 BPI 17930 FCI	26895 BPI 17930 FCI	40000 BPI 30000 FCI	37341 BPI 24894 FCI
Recording code	1,7 RLL	2,7 RLL	2,7 RLL	1,7 RLL	2,7 RLL
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
Servo type	Embedded	Dedicated Surf.	Dedicated Surf.	Embedded	Dedicated Surf.
Average positioning time (msec)	18	18	18	16	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	24.3	26.3
Data transfer rate (KBytes/sec)	8000	1250	1250	8000	1562.5
FIRST CUSTOMER SHIPMENT	4Q91			1Q92	1991
COMMENTS	25.4 mm high	41.3 mm high	41.3 mm high	25.4 mm high *Varies by zone	41.3 mm high

MANUFACTURER	MICROSCIENCE INTERNATIONAL	MICROSCIENCE INTERNATIONAL	MICROSCIENCE INTERNATIONAL	MICROSCIENCE INTERNATIONAL	MICROSCIENCE INTERNATIONAL
DRIVE	7400	FH-2414	FH-3414	FH-2777	FH-3777
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	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	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
DRIVE: Heads	MIG	Thin Film	Thin Film	Thin Film	Thin Film
Interface	PC AT	ESDI	SCSI	ESDI	SCSI
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	F: 420	U: 414	F: 366.7	U: 777	F: 687
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	*	U: 31,248	F: 27,648	U: 31,740	F: 27,648
Data surfaces per spindle	8	8	8	15	15
Heads per data surface	1	1	1	1	1
Tracks per surface	1904	1658	1658	1658	1658
Track density (TPI)	2250	1499	1499	1499	1499
Maximum linear density (BPI)	40000 BPI 30000 FCI	29575 BPI 19717 FCI	29575 BPI 19717 FCI	29575 BPI 19717 FCI	29575 BPI 19717 FCI
Recording code	1,7 RLL	2,7 RLL	2,7 RLL	2,7 RLL	2,7 RLL
Rotational speed (RPM)	3600	3600	3600	3558	3558
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Embedded	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.
Average positioning time (msec)	15	14	14	14	14
Average rotational delay (msec)	8.3	8.3	8.3	8.43	8.43
Average access time (msec)	23.3	22.3	22.3	22.43	22.43
Data transfer rate (KBytes/sec)	8000	1875	1875	1875	2500
FIRST CUSTOMER SHIPMENT	2Q92	2Q91	2Q91	1Q91	1Q91
COMMENTS	41.3 mm high *Varies by zone				

MANUFACTURER	MICROSCIENCE INTERNATIONAL	MICROSCIENCE INTERNATIONAL	MICROSCIENCE INTERNATIONAL	MILTOPE	MILTOPE
DRIVE	FH-21200	FH-31200	FH-31600	RDS-1500	RDS-5000
DISK/TREND GROUP	8	8	8	2	3
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Special	Special
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: Heads	Thin Film	Thin Film	Thin Film	Ferrite	Ferrite
Interface	ESDI	SCSI	SCSI	SCSI, NTDS	SCSI, NTDS
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	U: 1,200	F: 1,062	F: 1,610	F: 18.5	F: 47.0
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 41,664	F: 36,864	F: 44,032	F: 9,216	F: 9,216
Data surfaces per spindle	15	15	15	3	5
Heads per data surface	1	1	1	1	1
Tracks per surface	1921	1921	2147	670	1024
Track density (TPI)	1678	1678	1813	680	1000
Maximum linear density (BPI)	40622 BPI 30466 FCI	40622 BPI 30466 FCI	50262 BPI 37697 FCI	9890	9824
Recording code	1,7 RLL	1,7 RLL	1,7 RLL	MFM	MFM
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
Servo type	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.
Average positioning time (msec)	14	14	13	40	40
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	22.3	22.3	21.3	48.3	48.3
Data transfer rate (KBytes/sec)	1875	2500	10000 synch. 6000 asynch.	625	625
FIRST CUSTOMER SHIPMENT	3Q91	3Q91	4Q92	5/84	4Q86
COMMENTS				Sold as militarized subsystem Removable disk assembly	Sold as militarized subsystem Removable disk assembly

MANUFACTURER	MILTOPE	MITSUBISHI ELECTRIC CORPORATION	MITSUBISHI ELECTRIC CORPORATION	MITSUMI ELECTRIC	MITSUMI ELECTRIC
DRIVE	RDS-3800	E1880B E1880C E1880D	E1880E E1880F E1880G E1880H	HD309AA	HD309AC
DISK/TREND GROUP	6	7	8	4	4
MARKET	OEM	Captive	Captive	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	130 mm OD 40 mm ID	224 mm OD 100 mm ID	224 mm OD 100 mm ID	95 mm OD 25 mm ID	95 mm OD 25 mm ID
Recording medium	Thin Film	Oxide Coated	Oxide Coated	Thin Film	Thin Film
DRIVE: Heads	Ferrite	Thin Film	Thin Film	MIG	MIG
Interface	SCSI, NTDS	Mitsubishi	Mitsubishi	PC AT	SCSI
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	U: 382	F: 630	F: 946	F: 90	F: 90
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 19,456	F: 47,476	F: 47,476	F:	F:
Data surfaces per spindle	15	15	15	6	6
Heads per data surface	1	2	2	1	1
Tracks per surface	1224	885	1334	928	928
Track density (TPI)	1075	1060	1307	1175	1175
Maximum linear density (BPI)	19794 BPI 13196 FCI	21500 BPI 14333 FCI	22452 BPI 14968 FCI	30000 BPI 20000 FCI	30000 BPI 20000 FCI
Recording code	2,7 RLL	2,7 RLL	2,7 RLL	2,7 RLL	2,7 RLL
Rotational speed (RPM)	3600	3620	3620	3600	3600
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Linear, Voice Coil	Linear, Voice Coil
Servo type	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.
Average positioning time (msec)	18	13	13	20	20
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	26.3	21.3	21.3	28.3	28.3
Data transfer rate (KBytes/sec)	1250	3000	3000	1250	1250
FIRST CUSTOMER SHIPMENT	12/89	3Q88	4Q90	1Q90	1Q90
COMMENTS	Sold as militarized and ruggedized subsystem Removable disk assembly	E1880B: 1 spindle E1880C: 4 spindles E1880D: 8 spindles	E1880E: 1 spindle E1880F: 5 spindles E1880G: 9 spindles E1880H: 13-16	41.3 mm high	41.3 mm high

MANUFACTURER	MITSUMI ELECTRIC	MITSUMI ELECTRIC	MULTIDIGIT	MULTIDIGIT	MULTIDIGIT
DRIVE	HD313AA	HD313AC	DW 2061	MC 2021	MC 2022
DISK/TREND GROUP	5	5	2	2	2
MARKET	OEM	OEM	OEM, PCM	PCM	PCM
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	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
DRIVE: Heads	MIG	MIG	Ferrite	Ferrite	Ferrite
Interface	PC AT	SCSI	ST412	PC XT	PC XT
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	F: 130	F: 130	U: 25.5	U: 25.83	U: 23.54
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F:	F:	U: 10,416	U: 10,416	U: 19,231
Data surfaces per spindle	8	8	4	4	2
Heads per data surface	1	1	1	1	1
Tracks per surface	963	963	612	612	612
Track density (TPI)	1175	1175	804	804	804
Maximum linear density (BPI)	30000 BPI 20000 FCI	30000 BPI 20000 FCI	13412	13412	24761 BPI 16507 FCI
Recording code	2,7 RLL	2,7 RLL	MFM	MFM	2,7 RLL
Rotational speed (RPM)	3600	3600	3600	3600	2925
PERFORMANCE					
Actuator type	Linear, Voice Coil	Linear, Voice Coil	Rack & Pinion, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor
Servo type	Dedicated Surf.	Dedicated Surf.	Open Loop	Open Loop	Open Loop
Average positioning time (msec)	20	20	70 (including settling)	70 (including settling)	45 (including settling)
Average rotational delay (msec)	8.3	8.3	8.3	8.3	10.25
Average access time (msec)	28.3	28.3	78.3	78.3	55.25
Data transfer rate (KBytes/sec)	1250	1250	625	625	937.5
FIRST CUSTOMER SHIPMENT	2Q90	2Q90	1988	1989	1989
COMMENTS	41.3 mm high	41.3 mm high		41.3 mm high Drive on Card	41.3 mm high Drive on Card

MANUFACTURER	MULTIDIGIT	MULTIDIGIT	MULTIDIGIT	MULTIDIGIT	MULTIDIGIT
DRIVE	DW 2061R	DW 3063	DW 4063	MC 3021	MC 3022
DISK/TREND GROUP	3	3	3	3	3
MARKET	OEM	OEM	OEM, PCM	PCM	PCM
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	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
DRIVE: Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	ST412	ST412	ST412	PC XT	PC XT
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	U: 38.25*	U: 38.25*	U: 47.08	U: 38.75	U: 38.25
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 15,625*	U: 15,625*	U: 19,231	U: 15,625	U: 15,625
Data surfaces per spindle	4	4	4	4	4
Heads per data surface	1	1	1	1	1
Tracks per surface	612	612	612	612	612
Track density (TPI)	804	804	804	804	804
Maximum linear density (BPI)	20118 BPI 13412 FCI	20118 BPI 13412 FCI	24761 BPI 16507 FCI	20118 BPI 13412 FCI	20118 BPI 13412 FCI
Recording code	2,7 RLL*	2,7 RLL*	2,7 RLL	2,7 RLL	2,7 RLL
Rotational speed (RPM)	3600	3600	2925	3600	3600
PERFORMANCE					
Actuator type	Rack & Pinion, Stepping Motor	Rack & Pinion, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor
Servo type	Open Loop	Open Loop	Open Loop	Open Loop	Open Loop
Average positioning time (msec)	70 (including settling)	45 (including settling)	45 (including settling)	70 (including settling)	45 (including settling)
Average rotational delay (msec)	8.3	8.3	10.25	8.3	8.3
Average access time (msec)	78.3	53.3	55.25	78.3	53.3
Data transfer rate (KBytes/sec)	937.5*	937.5*	937.5	937.5	937.5
FIRST CUSTOMER SHIPMENT	1988	1990	1989	1989	1989
COMMENTS	*With RLL controller	*With RLL controller	41.3 mm high	41.3 mm high Drive on Card	41.3 mm high Drive on Card

MANUFACTURER	MULTIDIGIT	MULTIDIGIT	MULTIDIGIT	MULTIDIGIT	MULTIDIGIT
DRIVE	MC 4022	DW 8910	DW 0133	DW 0178	DW 0178S
DISK/TREND GROUP	3	4	5	5	5
MARKET	PCM	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	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
DRIVE: Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	PC XT	ST412	ST412	ST412	SCSI
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	U: 47.08	U: 88.88	U: 133.33*	U: 177.77*	U: 177.77*
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 19,231	U: 10,416	U: 15,625*	U: 20,833*	U: 20,833*
Data surfaces per spindle	4	7	7	7	7
Heads per data surface	1	1	1	1	1
Tracks per surface	612	1219	1219	1219	1219
Track density (TPI)	804	1100	1100	1100	1100
Maximum linear density (BPI)	24761 BPI 16507 FCI	10228	15342 BPI 10228 FCI	20456 BPI 13637 FCI	20456 BPI 13637 FCI
Recording code	2,7 RLL	MFM	2,7 RLL*	2,7 RLL*	2,7 RLL*
Rotational speed (RPM)	2925	3600	3600	2700	2700
PERFORMANCE					
Actuator type	Band, Stepping Motor	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Open Loop	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.
Average positioning time (msec)	45 (including settling)	28	28	28	28
Average rotational delay (msec)	10.25	8.3	8.3	11.1	11.1
Average access time (msec)	55.25	36.3	36.3	39.1	39.1
Data transfer rate (KBytes/sec)	937.5	625	937.5*	937.5*	937.5*
FIRST CUSTOMER SHIPMENT	1989	1991	1991	1991	1991
COMMENTS	41.3 mm high Drive on Card		*With RLL controller	*With RLL controller	*With RLL controller

MANUFACTURER	NEC	NEC	NEC	NEC	NEC
DRIVE	D3142	D3735	D3741	D3835	D3841
DISK/TREND GROUP	3	3	3	3	3
MARKET	Captive, OEM	Captive, OEM	Captive, 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	95 mm OD 25 mm ID	95 mm OD 25 mm ID
Recording medium	Oxide Coated	Thin Film	Oxide Coated	Thin Film	Oxide Coated
DRIVE: Heads	Ferrite	MIG	Ferrite	MIG	Ferrite
Interface	ST412	PC AT	PC AT	SCSI	SCSI
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	U: 53.4	F: 45	F: 45.09	F: 45	F: 45.05
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 10,416	F: 20,992	F: 12,800	F: 20,992	F: 12,800
Data surfaces per spindle	8	2	8	2	8
Heads per data surface	1	1	1	1	1
Tracks per surface	642	1074	440	1075	440
Track density (TPI)	850	1800	850	1800	850
Maximum linear density (BPI)	14000	30000 BPI 22500 FCI	17000 BPI 11333 FCI	30000 BPI 22500 FCI	17000 BPI 11333 FCI
Recording code	MFM	1,7 RLL	2,7 RLL	1,7 RLL	2,7 RLL
Rotational speed (RPM)	3600	3456	3600	3456	3600
PERFORMANCE					
Actuator type	Rotary, Torque Motor	Rotary, Voice Coil	Rotary, Torque Motor	Rotary, Voice Coil	Rotary, Torque Motor
Servo type	Embedded	Embedded	Embedded	Embedded	Embedded
Average positioning time (msec)	28	25	23	25	28
Average rotational delay (msec)	8.3	8.7	8.3	8.7	8.3
Average access time (msec)	36.3	33.7	31.3	33.7	36.3
Data transfer rate (KBytes/sec)	625	1500	937.5	1500	937.5
FIRST CUSTOMER SHIPMENT	1Q88	6/90	7/89	2/90	12/87
COMMENTS	41.3 mm high	25.4 mm high	41.3 mm high	25.4 mm high	41.3 mm high

MANUFACTURER	NEC	NEC	NEC	NEC	NEC
DRIVE	D3661	D3755 D3756	D3761	D3765	D3855 D3856
DISK/TREND GROUP	5	5	5	5	5
MARKET	Captive, OEM	Captive, OEM	Captive, 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	95 mm OD 25 mm ID	95 mm OD 25 mm ID
Recording medium	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
DRIVE: Heads	Ferrite	MIG	Ferrite	Thin Film	MIG
Interface	ESDI	PC AT	PC AT	PC AT	SCSI
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	U: 134.5	F: 105	F: 114.78	F: 176	F: 105
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 20,992	F: 20,992	F: 17,920	F: 29,690	F: 20,992
Data surfaces per spindle	7	4	7	4	4
Heads per data surface	1	1	1	1	1
Tracks per surface	915	1251	915	1486	1251
Track density (TPI)	1311	1800	1311	2036	1800
Maximum linear density (BPI)	25484 BPI 16989 FCI	32000 BPI 24000 FCI	25484 BPI 16989 FCI	49403 BPI 37052 FCI	32000 BPI 24000 FCI
Recording code	2,7 RLL	1,7 RLL	2,7 RLL	1,7 RLL	1,7 RLL
Rotational speed (RPM)	3573	3456	3573	3600	3456
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Dedicated Surf.	Embedded	Dedicated Surf.	Embedded	Embedded
Average positioning time (msec)	20	25	20	16.5	25
Average rotational delay (msec)	8.4	8.7	8.4	8.3	8.7
Average access time (msec)	28.4	33.7	28.4	24.8	33.7
Data transfer rate (KBytes/sec)	1250	1500	1250	2365	1500
FIRST CUSTOMER SHIPMENT	11/88	6/90	9/89	2Q91	12/89
COMMENTS	41.3 mm high	25.4 mm high D3756 has 19 msec. average positioning time	41.3 mm high	25.4 mm high	25.4 mm high D3856 has 19 msec. average positioning time

MANUFACTURER	NEC	NEC	NEC	NEC	NEC
DRIVE	D3861	D3865	D5652	D5655	D5852
DISK/TREND GROUP	5	5	5	5	5
MARKET	Captive, OEM	Captive, OEM	Captive, 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	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: Heads	Ferrite	Thin Film	Ferrite	Ferrite	Ferrite
Interface	SCSI	SCSI	ESDI	ESDI	SCSI
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	F: 114.78	F: 176	U: 172.76	U: 179.86	F: 147.48
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 17,920	F: 29,690	U: 20,992	U: 20,992	F: 17,920
Data surfaces per spindle	7	4	10	7	10
Heads per data surface	1	1	1	1	1
Tracks per surface	915	1486	823	1224	823
Track density (TPI)	1311	2036	926	1240	925
Maximum linear density (BPI)	25484 BPI 16989 FCI	49403 BPI 37052 FCI	18758 BPI 12505 FCI	19610 BPI 13073 FCI	18759 BPI 12506 FCI
Recording code	2,7 RLL	1,7 RLL	2,7 RLL	2,7 RLL	2,7 RLL
Rotational speed (RPM)	3573	3600	3573	3573	3573
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Dedicated Surf.	Embedded	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.
Average positioning time (msec)	20	16.5	23	18	23
Average rotational delay (msec)	8.4	8.3	8.4	8.4	8.4
Average access time (msec)	28.4	24.8	31.4	26.4	31.4
Data transfer rate (KBytes/sec)	1250	2365	1250	1250	1250
FIRST CUSTOMER SHIPMENT	3/89	2Q91	2/86	12/87	5/87
COMMENTS	41.3 mm high	25.4 mm high		41.3 mm high	

MANUFACTURER	NEC	NEC	NEC	NEC	NEC
DRIVE	D3772	D3781	D3872	D3881	D5662
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	95 mm OD 25 mm ID	95 mm OD 25 mm ID	95 mm OD 25 mm ID	95 mm OD 25 mm ID	130 mm OD 40 mm ID
Recording medium	Thin Film	Thin Film	Thin Film	Thin Film	Oxide Coated
DRIVE: Heads	Thin Film	Thin Film	Thin Film	Thin Film	Ferrite
Interface	PC AT	PC AT	SCSI-2	SCSI-2	ESDI
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	F: 331.46	F: 426.16	F: 331.46	F: 426.16	U: 385.41
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 32,200	F: 32,200	F: 32,200	F: 32,200	U: 20,992
Data surfaces per spindle	7	9	7	9	15
Heads per data surface	1	1	1	1	1
Tracks per surface	1464	1464	1464	1464	1224
Track density (TPI)	2000	2000	2000	2000	1240
Maximum linear density (BPI)	49000 BPI 36750 FCI	49000 BPI 36750 FCI	49000 BPI 36750 FCI	49000 BPI 36750 FCI	19660 BPI 13106 FCI
Recording code	1,7 RLL	1,7 RLL	1,7 RLL	1,7 RLL	2,7 RLL
Rotational speed (RPM)	3600	3600	3600	3600	3573
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.
Average positioning time (msec)	14	14	14	14	18
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.4
Average access time (msec)	22.3	22.3	22.3	22.3	26.4
Data transfer rate (KBytes/sec)	5000 synch. 2365 asynch.	5000 synch. 2365 asynch.	5000 synch. 2365 asynch.	5000 synch. 2365 asynch.	1250
FIRST CUSTOMER SHIPMENT	2Q91	2Q91	2Q91	2Q91	11/87
COMMENTS	41.3 mm high	41.3 mm high	41.3 mm high	41.3 mm high	

MANUFACTURER	NEC	NEC	NEC	NEC	NEC
DRIVE	D5862	D2362	D2366	D2462	D5682
DISK/TREND GROUP	6	7	7	7	7
MARKET	OEM	OEM	Captive, OEM	OEM	Captive, OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	130 mm OD 40 mm ID	230 mm OD 100 mm ID	230 mm OD 100 mm ID	230 mm OD 100 mm ID	130 mm OD 40 mm ID
Recording medium	Oxide Coated	Thin Film	Thin Film	Thin Film	Thin Film
DRIVE: Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	SCSI	Modified SMD	IPI-2	SCSI	ESDI
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	F: 328.2	U: 800.7	U: 800.7	U: 800	U: 765.42
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 17,920	U: 40,960	U: 40,960	U: 40,960	U: 31,248
Data surfaces per spindle	15	11.5	11.5	11.5	16
Heads per data surface	1	2/1	2/1	2/1	1
Tracks per surface	1221	1700	1700	1700	1633
Track density (TPI)	1240	1070	1070	1070	1480
Maximum linear density (BPI)	19660 BPI 13106 FCI	21400 BPI 14266 FCI	21400 BPI 14266 FCI	21400 BPI 14266 FCI	30760 BPI 23070 FCI
Recording code	2,7 RLL	2,7 RLL	2,7 RLL	2,7 RLL	1,7 RLL
Rotational speed (RPM)	3573	3600	3600	3600	3600
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.
Average positioning time (msec)	18	15	15	15	16
Average rotational delay (msec)	8.4	8.3	8.3	8.3	8.3
Average access time (msec)	26.4	23.3	23.3	23.3	24.3
Data transfer rate (KBytes/sec)	1250	2460	2460	2460	1875
FIRST CUSTOMER SHIPMENT	11/87	2/86	3/87	6/87	4/89
COMMENTS					

MANUFACTURER	NEC	NEC	NEC	NEC	NEC
DRIVE	D5882	N7756	N7757	N7767	D2363
DISK/TREND GROUP	7	7	7	7	8
MARKET	Captive, OEM	Captive	Captive	Captive	Captive, OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	130 mm OD 40 mm ID	230 mm OD 100 mm ID	230 mm OD 100 mm ID	230 mm OD 100 mm ID	230 mm OD 100 mm ID
Recording medium	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
DRIVE: Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	SCSI	NEC	NEC	NEC	Modified SMD
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	F: 675.99	F: 486.2	F: 750.5	F: 635.3	U: 1,132.4
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 27,136	F: 34,036	F: 38,708	F: 32,768	U: 40,960
Data surfaces per spindle	16	9.5	11.5	11.5	13.5
Heads per data surface	1	2/1	2	2	2/1
Tracks per surface	1630	1506	1686	1686	2048
Track density (TPI)	1480	1000	1070	1070	1290
Maximum linear density (BPI)	30760 BPI 23070 FCI	18600 BPI 12400 FCI	21400 BPI 14266 FCI	21400 BPI 14266 FCI	21400 BPI 14266 FCI
Recording code	1,7 RLL	2,7 RLL	2,7 RLL	2,7 RLL	2,7 RLL
Rotational speed (RPM)	3600	3070	3600	3600	3600
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.
Average positioning time (msec)	16	15	15	15	15
Average rotational delay (msec)	8.3	9.8	8.3	8.3	8.3
Average access time (msec)	24.3	24.8	23.3	23.3	23.3
Data transfer rate (KBytes/sec)	4800 synch. 1875 asynch.	1860	2460	19600	2460
FIRST CUSTOMER SHIPMENT	6/89	3Q84	9/87	1988	5/87
COMMENTS		Drive has 2 spindles	Drive has 2 spindles	N7767 uses 8 spindles in parallel array with 5 GB total capacity	

MANUFACTURER	NEC	NEC	NEC	NEC	NEC
DRIVE	D2367	D2373	D2377	D2463	D5892 D5894
DISK/TREND GROUP	8	8	8	8	8
MARKET	Captive, OEM	Captive, OEM	Captive, OEM	Captive, OEM	OEM
MEDIA: Generic type	Fixed	Fixed	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	130 mm OD 40 mm ID
Recording medium	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
DRIVE: Heads	Ferrite	Ferrite	Ferrite	Ferrite	Thin Film
Interface	IPI-2	SMD-E	IPI-2	SCSI	SCSI-2
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	U: 1,132.4	U: 1,415	U: 1,415	F: 1,044	F: 1,403
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 40,960	U: 51,200	U: 51,200	F: 37,888	F: 44,032
Data surfaces per spindle	13.5	13.5	13.5	13.5	19
Heads per data surface	2/1	2/1	2/1	2/1	1
Tracks per surface	2048	2048	2048	2048	1675
Track density (TPI)	1290	1290	1290	1290	1603
Maximum linear density (BPI)	21400 BPI 14266 FCI	26800 BPI 20100 FCI	26800 BPI 20100 FCI	21400 BPI 14266 FCI	45850 BPI 34387 FCI
Recording code	2,7 RLL	1,7 RLL	1,7 RLL	2,7 RLL	1,7 RLL
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
Servo type	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.
Average positioning time (msec)	15	15	15	15	14
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	23.3	23.3	23.3	23.3	22.3
Data transfer rate (KBytes/sec)	2460	3070	3070	2460	5000 synch. 3000 asynch.
FIRST CUSTOMER SHIPMENT	9/87	10/87	12/87	8/87	10/90
COMMENTS					D5894 has aver. positioning time of 12 msec

MANUFACTURER	NEC	NEC	NEC	NEC	NEC
DRIVE	N7759	N7766	N7768	D2387	D2387P
DISK/TREND GROUP	8	8	8	9	9
MARKET	Captive	Captive	Captive	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	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	230 mm OD 100 mm ID
Recording medium	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
DRIVE: Heads	Ferrite	Ferrite	Ferrite	Thin Film	Thin Film
Interface	NEC	NEC	NEC	IPI-2	IPI-2
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	F: 972	F: 1,301.1	F: 1,301.1	U: 3,000.8	U: 3,000.8
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 38,708	F: 47,476	F: 47,476	U: 72,959	U: 72,959
Data surfaces per spindle	11.5	13.5	13.5	15	15
Heads per data surface	2/1	2/1	2/1	2/1	2/1
Tracks per surface	1686	2030	2030	2742	2742
Track density (TPI)	1070	1290	1290	1670	1670
Maximum linear density (BPI)	21400 BPI 14266 FCI	26800 BPI 20100 FCI	26800 BPI 20100 FCI	37800 BPI 28350 FCI	37800 BPI 28350 FCI
Recording code	2,7 RLL	1,7 RLL	1,7 RLL	1,7 RLL	1,7 RLL
Rotational speed (RPM)	3600	3600	3600	3700	3700
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.
Average positioning time (msec)	13	15	15	12	12
Average rotational delay (msec)	8.3	8.3	8.3	8.1	8.1
Average access time (msec)	21.3	23.3	23.3	20.1	20.1
Data transfer rate (KBytes/sec)	2460	3000	3000	4500	9000
FIRST CUSTOMER SHIPMENT	9/88	9/90	9/89	4/90	1990
COMMENTS		Drive has 4 spindles	Drive has 8 spindles		2 head parallel transfer version of D2387

MANUFACTURER	NEC	ORCA TECHNOLOGY	ORCA TECHNOLOGY	ORCA TECHNOLOGY	PLUS DEVELOPMENT
DRIVE	N7795	OT304S/A Dolphin	OT506S Barracuda	OT510S Barracuda	Hardcard 20
DISK/TREND GROUP	9	6	7	8	2
MARKET	Captive	OEM	OEM	OEM	PCM, OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Drive On Card
Nominal disk diameter	230 mm OD 100 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	Thin Film	Thin Film	Thin Film	Thin Film	
DRIVE: Heads	Thin Film	Thin Film	Thin Film	Thin Film	Ferrite
Interface	NEC	SCSI, PC AT	SCSI	SCSI	IBM PC
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	F: 2,855	U: 494 F: 430	U: 765 F: 677	U: 1,204 F: 1,063	F: 21.2
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 69,416	*	F: 27,648	*	F: 8,704
Data surfaces per spindle	15	9	15	15	4
Heads per data surface	2/1	1	1	1	1
Tracks per surface	2742	1585	1632	1924	615
Track density (TPI)	1670	1800	1400	1600	812
Maximum linear density (BPI)	37800 BPI 28350 FCI	37391 BPI 28050 FCI	32332 BPI 24249 FCI	46036 BPI 34535 FCI	13917 BPI 9278 FCI
Recording code	1,7 RLL	1,7 RLL	1,7 RLL	1,7 RLL	2,7 RLL
Rotational speed (RPM)	3700	3600	3600	3600	3600
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Torque Motor
Servo type	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Embedded
Average positioning time (msec)	12	12	14	14	49 (including settling)
Average rotational delay (msec)	8.1	8.3	8.3	8.3	8.3
Average access time (msec)	20.1	20.3	22.3	22.3	57.3
Data transfer rate (KBytes/sec)	4500	6000 synch. 4000 asynch.	6000 synch. 4000 asynch.	6000 synch. 4000 asynch.	625
FIRST CUSTOMER SHIPMENT	6/91	4Q91	2Q91	4Q91	6/86
COMMENTS		41.3 mm high *Varies by zone		*Varies by zone	25.4 mm high

MANUFACTURER	PLUS DEVELOPMENT	PLUS DEVELOPMENT	PLUS DEVELOPMENT	PLUS DEVELOPMENT	PLUS DEVELOPMENT
DRIVE	Plus Passport	Hardcard 40	Hardcard II 40	Plus Passport	52AT/LP Impulse
DISK/TREND GROUP	2	3	3	3	4
MARKET	PCM, OEM	PCM, OEM	PCM	PCM, OEM	OEM, PCM
MEDIA: Generic type	Removable Drive	Drive On Card	Drive On Card	Removable Drive	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		Thin Film	Thin Film		Thin Film
DRIVE: Heads	Ferrite	Ferrite	MIG	Ferrite	MIG
Interface	IBM PC	IBM PC	PC AT	IBM PC	PC AT
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	--	F: 42.26	F: 40.2	--	F: 52.2
REMOVABLE	F: 21.4	--	--	F: 42.6	--
Capacity per track (Bytes)	F: 14,336 and 17,408	F: 14,336 and 17,408	F: 8,704	F: 14,336 and 17,408	*
Data surfaces per spindle	2	4	2	4	2
Heads per data surface	1	1	1	1	1
Tracks per surface	612	612	962	612	1219
Track density (TPI)	812	812	1227	812	1330
Maximum linear density (BPI)	21524 and 22392	21524 and 22392	27225 BPI 18150 FCI	21524 and 22392	29307 BPI 19538 FCI
Recording code	2,7 RLL	2,7 RLL	2,7 RLL	2,7 RLL	2,7 RLL
Rotational speed (RPM)	3000	3000	3662	3000	3662
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Embedded	Embedded	Embedded	Embedded	Embedded
Average positioning time (msec)	40	40	25	40	17
Average rotational delay (msec)	10	10	8.2	10	8.2
Average access time (msec)	50	50	33.2	50	25.2
Data transfer rate (KBytes/sec)	843.7/1031	843.7/1031	Up to 4000	843.7/1031	4000
FIRST CUSTOMER SHIPMENT	6/88	5/87	1/90	6/88	12/90
COMMENTS	Drive with adapter mounts in half high 5.25" slot	25.4 mm high	25.4 mm high	Drive with adapter mounts in half high 5.25" slot	25.4 mm high *Varies by zone

MANUFACTURER	PLUS DEVELOPMENT	PLUS DEVELOPMENT	PLUS DEVELOPMENT	PLUS DEVELOPMENT	PLUS DEVELOPMENT
DRIVE	52S/C Impulse	52S/LP Impulse	80AT/LP Impulse	80S/LP Impulse	Hardcard II 80
DISK/TREND GROUP	4	4	4	4	4
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	PCM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Drive On Card
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	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
DRIVE: Heads	MIG	MIG	MIG	MIG	MIG
Interface	SCSI	SCSI	PC AT	SCSI	PC AT
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	F: 52.2	F: 52.2	F: 85.7	F: 85.7	F: 80.5
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	*	*	*	*	F: 8,704
Data surfaces per spindle	2	2	4	4	4
Heads per data surface	1	1	1	1	1
Tracks per surface	1219	1219	1219	1219	962
Track density (TPI)	1330	1330	1330	1330	1227
Maximum linear density (BPI)	29307 BPI 19538 FCI	29307 BPI 19538 FCI	29307 BPI 19538 FCI	29307 BPI 19538 FCI	27225 BPI 18150 FCI
Recording code	2,7 RLL	2,7 RLL	2,7 RLL	2,7 RLL	2,7 RLL
Rotational speed (RPM)	3662	3662	3662	3662	3662
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Embedded	Embedded	Embedded	Embedded	Embedded
Average positioning time (msec)	25	17	17	17	25
Average rotational delay (msec)	8.2	8.2	8.2	8.2	8.2
Average access time (msec)	33.2	25.2	25.2	25.2	33.2
Data transfer rate (KBytes/sec)	4000 synch. 2000 asynch.	4000 synch. 2000 asynch.	4000	4000 synch. 2000 asynch.	Up to 4000
FIRST CUSTOMER SHIPMENT	6/91	12/90	12/91	12/90	1/90
COMMENTS	25.4 mm high *Varies by zone Low power, for Mac Classic	25.4 mm high *Varies by zone	25.4 mm high *Varies by zone	25.4 mm high *Varies by zone	25.4 mm high

MANUFACTURER	PLUS DEVELOPMENT	PLUS DEVELOPMENT	PLUS DEVELOPMENT	PLUS DEVELOPMENT	PLUS DEVELOPMENT
DRIVE	XL50 Hardcard II XL	105AT/LP Impulse	105S/C Impulse	105S/LP Impulse	120AT Impulse
DISK/TREND GROUP	4	5	5	5	5
MARKET	PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
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	95 mm OD 25 mm ID	95 mm OD 25 mm ID
Recording medium	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
DRIVE: Heads	MIG	MIG	MIG	MIG	MIG
Interface	PC AT	PC AT	SCSI	SCSI	PC AT
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	F: 52	F: 105.1	F: 105.1	F: 105.1	F: 120
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	*	*	*	*	*
Data surfaces per spindle	2	4	4	4	3
Heads per data surface	1	1	1	1	1
Tracks per surface	1233	1219	1219	1219	1123
Track density (TPI)	1330	1330	1330	1330	1414
Maximum linear density (BPI)	29307 BPI 19538 FCI	29307 BPI 19538 FCI	29307 BPI 19538 FCI	29307 BPI 19538 FCI	27746 BPI 20810 FCI
Recording code	2,7 RLL	2,7 RLL	2,7 RLL	2,7 RLL	1,7 RLL
Rotational speed (RPM)	3662	3662	3662	3662	3605
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Embedded	Embedded	Embedded	Embedded	Embedded
Average positioning time (msec)	17**	17	25	17	15
Average rotational delay (msec)	8.2	8.2	8.2	8.2	8.3
Average access time (msec)	25.2	25.2	33.2	25.2	23.3
Data transfer rate (KBytes/sec)	4000	4000	4000 synch. 2000 asynch.	4000 synch. 2000 asynch.	4000
FIRST CUSTOMER SHIPMENT	10/90	12/90	3/91	12/90	8/90
COMMENTS	23.5 mm high *Varies by zone **About 9 msec using cache	25.4 mm high *Varies by zone	25.4 mm high *Varies by zone	25.4 mm high *Varies by zone	41.3 mm high *Varies by zone

MANUFACTURER	PLUS DEVELOPMENT	PLUS DEVELOPMENT	PLUS DEVELOPMENT	PLUS DEVELOPMENT	PLUS DEVELOPMENT
DRIVE	120S Impulse	170AT Impulse	170S Impulse	210AT Impulse	210S Impulse
DISK/TREND GROUP	5	5	5	5	5
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
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	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
DRIVE: Heads	MIG	MIG	MIG	MIG	MIG
Interface	SCSI	PC AT	SCSI	PC AT	SCSI
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	F: 120	F: 168.5	F: 168.5	F: 209.1	F: 209.1
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	*	*	*	*	*
Data surfaces per spindle	3	7	7	7	7
Heads per data surface	1	1	1	1	1
Tracks per surface	1123	1123	1123	1156	1156
Track density (TPI)	1414	1414	1414	1454	1454
Maximum linear density (BPI)	27746 BPI 20810 FCI	27746 BPI 20810 FCI	27746 BPI 20810 FCI	30000 BPI 22500 FCI	30000 BPI 22500 FCI
Recording code	1,7 RLL	1,7 RLL	1,7 RLL	1,7 RLL	1,7 RLL
Rotational speed (RPM)	3605	3605	3605	3605	3605
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Embedded	Embedded	Embedded	Embedded	Embedded
Average positioning time (msec)	15	15	15	15	15
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	23.3	23.3	23.3	23.3	23.3
Data transfer rate (KBytes/sec)	4000 synch. 2300 asynch.	4000	4000 synch. 2300 asynch.	4000	4000 synch. 2300 asynch.
FIRST CUSTOMER SHIPMENT	8/90	8/90	8/90	12/90	9/90
COMMENTS	41.3 mm high *Varies by zone	41.3 mm high *Varies by zone	41.3 mm high *Varies by zone	41.3 mm high *Varies by zone	41.3 mm high *Varies by zone

MANUFACTURER	PLUS DEVELOPMENT	PLUS DEVELOPMENT	PLUS DEVELOPMENT	PROLOGICA (MICRO-PERIFERICOS)	PROLOGICA (MICRO-PERIFERICOS)
DRIVE	XL105 Hardcard II XL	425AT Impulse	425S Impulse	W320B	V340ST
DISK/TREND GROUP	5	6	6	2	3
MARKET	PCM	OEM, PCM	OEM, PCM	Captive, OEM	Captive, 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	95 mm OD 25 mm ID	95 mm OD 25 mm ID
Recording medium	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
DRIVE: Heads	MIG	MIG	MIG	Ferrite	Ferrite
Interface	PC AT	PC AT	SCSI	ST412	ST412
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	F: 105	F: 425.8	F: 425.8	U: 25.5 F: 21.3	U: 52.5 F: 44.4
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	*	*	*	U: 10,416	F: 13,312
Data surfaces per spindle	4	9	9	4	4
Heads per data surface	1	1	1	1	1
Tracks per surface	1233	1511	1512	612	834
Track density (TPI)	1330	1695	1695	805	1000
Maximum linear density (BPI)	29307 BPI 19538 FCI	37146 BPI 27860 FCI	37146 BPI 27860 FCI	13014	14700 BPI 9800 FCI
Recording code	2,7 RLL	1,7 RLL	1,7 RLL	MFM	2,7 RLL
Rotational speed (RPM)	3662	3606	3606	3555	3575
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rack & Pinion, Stepping Motor	Rotary, Voice Coil
Servo type	Embedded	Embedded	Embedded	Open Loop	Optical Encoder
Average positioning time (msec)	17**	14	14	48 (including settling)	22
Average rotational delay (msec)	8.2	8.3	8.3	8.45	8.4
Average access time (msec)	25.2	22.3	22.3	56.45	30.4
Data transfer rate (KBytes/sec)	4000	4000	5000 synch. 4000 asynch.	625	937.5
FIRST CUSTOMER SHIPMENT	10/90	4Q91	4Q91	4/89	3Q90
COMMENTS	23.5 mm high *Varies by zone **About 9 msec using cache	41.3 mm high *Varies by zone	41.3 mm high *Varies by zone	41.3 mm high Usable with RLL controller	41.3 mm high

MANUFACTURER	PROLOGICA (MICRO-PERIFERICOS)	PROLOGICA (MICRO-PERIFERICOS)	QUALITRON	QUALITRON	QUALITRON
DRIVE	V366ST	V380ST	QW-521	QW-530	QW-540
DISK/TREND GROUP	4	5	2	3	3
MARKET	Captive, OEM	Captive, 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	130 mm OD 40 mm ID
Recording medium	Thin Film	Thin Film	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	ST412	ST412	ST412	ST412	ST412
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	U: 78.8 F: 66.6	U: 105.5 F: 92.5	U: 25.6	U: 38.4	U: 51.3
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 13,312	F: 18,432	U: 10,416	U: 15,624	U: 10,416
Data surfaces per spindle	6	6	2	2	4
Heads per data surface	1	1	1	1	1
Tracks per surface	834	834	615	615	820
Track density (TPI)	1000	1000	588	588	777
Maximum linear density (BPI)	14700 BPI 9800 FCI	19600 BPI 13066 FCI	9827	14791 BPI 9827 FCI	9935
Recording code	2,7 RLL	2,7 RLL	MFM	2,7 RLL	MFM
Rotational speed (RPM)	3575	3575	3600	3600	3600
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor
Servo type	Optical Encoder	Optical Encoder	Open Loop	Open Loop	Open Loop
Average positioning time (msec)	22	22	40 (including settling)	40 (including settling)	40 (including settling)
Average rotational delay (msec)	8.4	8.4	8.3	8.3	8.3
Average access time (msec)	30.4	30.4	48.3	48.3	48.3
Data transfer rate (KBytes/sec)	937.5	1250	625	937.5	625
FIRST CUSTOMER SHIPMENT	3Q90	3Q90	1986	1986	1988
COMMENTS	41.3 mm high	41.3 mm high	41.3 mm high	41.3 mm high	41.3 mm high

MANUFACTURER	QUALITRON	QUANTUM	QUANTUM	QUANTUM	QUANTUM
DRIVE	QW-560	40AT Go.Drive	40S Go.Drive	52AT ProDrive LPS	52S ProDrive LPS
DISK/TREND GROUP	4	3	3	4	4
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	130 mm OD 40 mm ID	65 mm OD 20 mm ID	65 mm OD 20 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: Heads	Ferrite	Thin Film	Thin Film	MIG	MIG
Interface	ST412	PC AT	SCSI	PC AT	SCSI
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	U: 76.9	F: 43	F: 43	F: 52	F: 52
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 15,624	*	*	*	*
Data surfaces per spindle	4	2	2	2	2
Heads per data surface	1	1	1	1	1
Tracks per surface	820	870	870	1219	1219
Track density (TPI)	777	1700	1700	1330	1330
Maximum linear density (BPI)	14903 BPI 9935 FCI	48371 BPI 36278 FCI	48371 BPI 36278 FCI	29307 BPI 19538 FCI	29307 BPI 19538 FCI
Recording code	2,7 RLL	1,7 RLL	1,7 RLL	2,7 RLL	2,7 RLL
Rotational speed (RPM)	3600	3600	3600	3662	3662
PERFORMANCE					
Actuator type	Band, Stepping Motor	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Open Loop	Embedded	Embedded	Optical Encoder	Optical Encoder
Average positioning time (msec)	40 (including settling)	19	19	17	17
Average rotational delay (msec)	8.3	8.3	8.3	8.2	8.2
Average access time (msec)	48.3	27.3	27.3	25.2	25.2
Data transfer rate (KBytes/sec)	937.5	4000 max.	4000 synch. 2000 asynch.	4000 max.	4000 synch. 2000 asynch.
FIRST CUSTOMER SHIPMENT	1988	6/91	6/91	2/90	2/90
COMMENTS	41.3 mm high	15.6 mm high *Varies by zone	15.6 mm high *Varies by zone	25.4 mm high *Varies by zone	25.4 mm high *Varies by zone

MANUFACTURER	QUANTUM	QUANTUM	QUANTUM	QUANTUM	QUANTUM
DRIVE	80AT Go.Drive	80S Go.Drive	105AT ProDrive LPS	105S ProDrive LPS	120AT ProDrive
DISK/TREND GROUP	4	4	5	5	5
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	65 mm OD 20 mm ID	65 mm OD 20 mm ID	95 mm OD 25 mm ID	95 mm OD 25 mm ID	95 mm OD 25 mm ID
Recording medium	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
DRIVE: Heads	Thin Film	Thin Film	MIG	MIG	MIG
Interface	PC AT	SCSI	PC AT	SCSI	PC AT
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	F: 86	F: 86	F: 105	F: 105	F: 120
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	*	*	*	*	*
Data surfaces per spindle	4	4	4	4	5
Heads per data surface	1	1	1	1	1
Tracks per surface	870	870	1219	1219	1123
Track density (TPI)	1700	1700	1330	1330	1414
Maximum linear density (BPI)	48371 BPI 36278 FCI	48371 BPI 36278 FCI	29307 BPI 19538 FCI	29307 BPI 19538 FCI	27740 BPI 20805 FCI
Recording code	1,7 RLL	1,7 RLL	2,7 RLL	2,7 RLL	1,7 RLL
Rotational speed (RPM)	3600	3600	3662	3662	3605
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Embedded	Embedded	Optical Encoder	Optical Encoder	Dedicated Surf.
Average positioning time (msec)	19	19	17	17	14.3
Average rotational delay (msec)	8.3	8.3	8.2	8.2	8.3
Average access time (msec)	27.3	27.3	25.2	25.2	22.6
Data transfer rate (KBytes/sec)	4000 max.	4000 synch. 2000 asynch.	4000 max.	4000 synch. 2000 asynch.	4000 max.
FIRST CUSTOMER SHIPMENT	8/91	8/91	--	2/90	4Q89
COMMENTS	19 mm high *Varies by zone	19 mm high *Varies by zone	25.4 mm high *Varies by zone	25.4 mm high *Varies by zone	41.3 mm high *Varies by zone

MANUFACTURER	QUANTUM	QUANTUM	QUANTUM	QUANTUM	QUANTUM
DRIVE	120S ProDrive	170AT ProDrive	170S ProDrive	210AT ProDrive	210S ProDrive
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	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
DRIVE: Heads	MIG	Thin Film	MIG	MIG	MIG
Interface	SCSI, SCSI-2	PC AT	SCSI, SCSI-2	PC AT	SCSI, SCSI-2
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	F: 120	F: 168.5	F: 168.5	F: 209.2	F: 209.4
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	*	*	*	*	*
Data surfaces per spindle	5	7	7	7	7
Heads per data surface	1	1	1	1	1
Tracks per surface	1123	1123	1123	1156	1156
Track density (TPI)	1414	1414	1414	1454	1454
Maximum linear density (BPI)	27740 BPI 20805 FCI	27740 BPI 20805 FCI	27740 BPI 20810 FCI	30000 BPI 22500 FCI	30000 BPI 22500 FCI
Recording code	1,7 RLL	1,7 RLL	1,7 RLL	1,7 RLL	1,7 RLL
Rotational speed (RPM)	3605	3605	3605	3605	3605
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.
Average positioning time (msec)	14.3	14.3	14.3	14.3	14.3
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	22.6	22.6	22.6	22.6	22.6
Data transfer rate (KBytes/sec)	4000 synch. 2000 asynch.	4000 max.	4000 synch. 2000 asynch.	4000 max.	4000 synch. 2000 asynch.
FIRST CUSTOMER SHIPMENT	3Q89	4Q89	1Q89	3Q89	4Q89
COMMENTS	41.3 mm high *Varies by zone	41.3 mm high *Varies by zone	41.3 mm high *Varies by zone	41.3 mm high *Varies by zone	41.3 mm high *Varies by zone

MANUFACTURER	QUANTUM	QUANTUM	RICOH	RICOH	RICOH
DRIVE	425AT ProDrive	425S ProDrive	RH5130	RH5260 RH5261	RH5500
DISK/TREND GROUP	6	6	1	1	1
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	5.25" Cartridge	5.25" Cartridge	5.25" Cartridge
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	130 mm OD 40 mm ID
Recording medium	Thin Film	Thin Film	Oxide Coated	Thin Film	Thin Film
DRIVE: Heads	MIG	MIG	Ferrite	Ferrite	Ferrite
Interface	PC AT	SCSI	ST412	ST506, SCSI	SCSI
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	F: 425.8	F: 425.8	--	--	--
REMOVABLE	--	--	U: 12.75	U: 25.5	F: 50.0
Capacity per track (Bytes)	*	*	U: 10,416	U: 10,416	F: 19,455
Data surfaces per spindle	9	9	2	2	2
Heads per data surface	1	1	1	1	1
Tracks per surface	1520	1520	612	1224	1285
Track density (TPI)	1695	1695	612	1222	1200
Maximum linear density (BPI)	37146 BPI 27860 FCI	37146 BPI 27860 FCI	10894	10894	25750 BPI 17166 FCI
Recording code	1,7 RLL	1,7 RLL	MFM	MFM	2,7 RLL
Rotational speed (RPM)	3605	3605	3473	3473	3183
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rack & Pinion, Stepping Motor	Rack & Pinion, Stepping Motor	Rotary, Voice Coil
Servo type	Dedicated Surf.	Dedicated Surf.	Embedded	Embedded	Embedded
Average positioning time (msec)	14**	14**	98 (including settling)	98 (including settling)	25
Average rotational delay (msec)	8.3	8.3	8.6	8.6	9.4
Average access time (msec)	22.3	22.3	106.6	106.6	34.4
Data transfer rate (KBytes/sec)	4000 max.	5000 synch. 4000 asynch.	625	625	2000
FIRST CUSTOMER SHIPMENT	2Q91	2Q91	3Q85	1987	2Q89
COMMENTS	41.3 mm high *Varies by zone **13 msec. average read positioning	41.3 mm high *Varies by zone **13 msec. average read positioning	41.3 mm high DMA license	41.3 mm high RH5261 has SCSI interface	41.3 mm high

MANUFACTURER	RODIME	RODIME	RODIME	RODIME	SAGEM
DRIVE	RO3139AP	RO3139S	RO3259AP	RO3259S	MSA 252-100
DISK/TREND GROUP	5	5	5	5	5
MARKET	OEM	OEM	PCM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Special
Nominal disk diameter	95 mm OD 25 mm ID	95 mm OD 25 mm ID	95 mm OD 25 mm ID	95 mm OD 25 mm ID	130 mm OD 40 mm ID
Recording medium	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
DRIVE: Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	PC AT	SCSI-2	PC AT	SCSI-2	SCSI
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	F: 112.5	F: 112.5	F: 213.0	F: 210.02	--
REMOVABLE	--	--	--	--	F: 100
Capacity per track (Bytes)	*	*	*	*	F: 23,040
Data surfaces per spindle	5	5	9	9	8
Heads per data surface	1	1	1	1	1
Tracks per surface	1168	1148	1235	1216	720
Track density (TPI)	1700	1700	1700	1700	950
Maximum linear density (BPI)	25804 BPI 17202 FCI	25826 BPI 17217 FCI	25804 BPI 17202 FCI	25826 BPI 17217 FCI	19680 BPI 14760 FCI
Recording code	2,7 RLL	2,7 RLL	2,7 RLL	2,7 RLL	1,7 RLL
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
Servo type	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.
Average positioning time (msec)	16	16	16	16	17
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	24.3	24.3	24.3	24.3	25.3
Data transfer rate (KBytes/sec)	8000	5000 synch. 3000 asynch.	8000	5000 synch. 3000 asynch.	1500
FIRST CUSTOMER SHIPMENT	1990	1990	1990	1990	10/90
COMMENTS	41.3 mm high *Varies by zone	41.3 mm high *Varies by zone	41.3 mm high *Varies by zone	41.3 mm high *Varies by zone	Militarized Subsystem Removable Head/Disk Module

MANUFACTURER	SAGEM	SAMSUNG ELECTRONICS	SAMSUNG ELECTRONICS	SAMSUNG ELECTRONICS	SAMSUNG ELECTRONICS
DRIVE	MSA 252-200	SHD-2040N	SHD-2041B	SHD-2041N	SHD-3101A
DISK/TREND GROUP	5	3	3	3	5
MARKET	OEM	Captive, OEM	Captive, OEM	Captive, OEM	Captive, OEM
MEDIA: Generic type	Special	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	130 mm OD 40 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	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
DRIVE: Heads	Ferrite	Ferrite	Ferrite	Ferrite	MIG
Interface	SCSI	ST412	PC AT	PC AT	PC AT
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	--	U: 51.2*	F: 47.0	F: 47.0	U: 133.52 F: 105
REMOVABLE	F: 200	--	--	--	--
Capacity per track (Bytes)	F: 23,040	U: 15,624*	F: 14,336	F: 14,336	F: 20,480
Data surfaces per spindle	16	4	4	4	4
Heads per data surface	1	1	1	1	1
Tracks per surface	720	820	820	820	1282
Track density (TPI)	950	1065	1065	1065	1658
Maximum linear density (BPI)	19680 BPI 14760 FCI	20196 BPI 13464 FCI	22386 BPI 14924 FCI	22386 BPI 14924 FCI	35161 BPI 26371 FCI
Recording code	1,7 RLL	2,7 RLL*	2,7 RLL	2,7 RLL	1,7 RLL
Rotational speed (RPM)	3600	3568	3525	3525	3600
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rack & Pinion, Stepping Motor	Rack & Pinion, Stepping Motor	Rack & Pinion, Stepping Motor	Rotary, Voice Coil
Servo type	Dedicated Surf.	Embedded	Embedded	Embedded	Embedded
Average positioning time (msec)	17	35 (including settling)	29 (including settling)	28 (including settling)	19
Average rotational delay (msec)	8.3	8.4	8.51	8.51	8.3
Average access time (msec)	25.3	43.4	37.51	36.51	27.31
Data transfer rate (KBytes/sec)	1500	937.5*	937.5	937.5	6000
FIRST CUSTOMER SHIPMENT	10/90	4Q88	1Q90	1Q90	4Q91
COMMENTS	Militarized Subsystem Removable Head/Disk Module	41.3 mm high *With RLL controller	41.3 mm high	41.3 mm high	25.4 mm high

MANUFACTURER	SAMSUNG ELECTRONICS	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY
DRIVE	SHD-3201S	ST683J RSD	ST124	ST125	ST225
DISK/TREND GROUP	5	1	2	2	2
MARKET	Captive, OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	Fixed	Removable Storage Drive	Fixed	Fixed	Fixed
Nominal disk diameter	95 mm OD 25 mm ID	230 mm OD 100 mm ID	95 mm OD 25 mm ID	95 mm OD 25 mm ID	130 mm OD 40 mm ID
Recording medium	Thin Film	Oxide Coated	Thin Film	Thin Film	Oxide Coated
DRIVE: Heads	MIG	Ferrite	Ferrite	Ferrite	Ferrite
Interface	SCSI-2	SMD	ST412	ST412	ST412
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	U: 245.142 F: 211	--	U: 25.6	U: 25.6	U: 25.6
REMOVABLE	--	U: 82.9	--	--	--
Capacity per track (Bytes)	F: 22,016	U: 20,160	U: 10,416	U: 10,416	U: 10,416
Data surfaces per spindle	7	5	4	4	4
Heads per data surface	1	1	1	1	1
Tracks per surface	1376	823	615	615	615
Track density (TPI)	1600	550	824	824	588
Maximum linear density (BPI)	35653 BPI 26740 FCI	10000 BPI 6666 FCI	14953	14953	9827
Recording code	1,7 RLL	2,7 RLL	MFM	MFM	MFM
Rotational speed (RPM)	3600	3600	3600	3600	3600
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Linear, Voice Coil	Rotary, Band, Stepping Motor	Rotary, Band, Stepping Motor	Rotary, Band, Stepping Motor
Servo type	Embedded	Dedicated Surf.	Open Loop	Open Loop	Open Loop
Average positioning time (msec)	15	27	40 (including settling)	28 (including settling)	65 (including settling)
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	23.3	35.3	48.3	36.3	73.3
Data transfer rate (KBytes/sec)	5000 synch. 3000 asynch.	1209	625	625	625
FIRST CUSTOMER SHIPMENT	4Q91	1Q83	3Q89	3Q87	10/84
COMMENTS	41.3 mm high		41.3 mm high	41.3 mm high	41.3 mm high

MANUFACTURER	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY
DRIVE	ST325N	ST325X	ST9051A	ST138	ST138R
DISK/TREND GROUP	2	2	3	3	3
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	65 mm OD 20 mm ID	95 mm OD 25 mm ID	95 mm OD 25 mm ID
Recording medium	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
DRIVE: Heads	Ferrite	Ferrite	Thin Film	Ferrite	Ferrite
Interface	SCSI	PC XT	PC AT	ST412	ST412
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	F: 21.4	F: 21.4	F: 42.8	U: 38.4	U: 38.4*
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F:	F:	F: 16,384	U: 10,416	U: 15,624*
Data surfaces per spindle	2	2	4	6	4
Heads per data surface	1	1	1	1	1
Tracks per surface	1230	1230	654	615	615
Track density (TPI)	1015	1015	1750	824	824
Maximum linear density (BPI)	22762 BPI 15175 FCI	22762 BPI 15175 FCI	34007 BPI 22671 FCI	14953	22430 BPI 14953 FCI
Recording code	2,7 RLL	2,7 RLL	2,7 RLL	MFM	2,7 RLL*
Rotational speed (RPM)	3600	3600	3631	3600	3600
PERFORMANCE					
Actuator type	Rotary, Rack, Stepping Motor	Rotary, Rack, Stepping Motor	Rotary, Voice Coil	Rotary, Band, Stepping Motor	Rotary, Band, Stepping Motor
Servo type	Open Loop	Open Loop	Embedded	Open Loop	Open Loop
Average positioning time (msec)	28 (including settling)	45 (including settling)	19	28 (including settling)	28 (including settling)
Average rotational delay (msec)	8.3	8.3	8.26	8.3	8.3
Average access time (msec)	36.3	53.3	27.26	36.3	36.3
Data transfer rate (KBytes/sec)	1150	1150	4000 max.	625	937.5*
FIRST CUSTOMER SHIPMENT	3Q90	2Q89	2Q91	3Q87	3Q87
COMMENTS	31.5 mm high	30 mm high	19 mm high	41.3 mm high	41.3 mm high *With RLL controller

MANUFACTURER	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY
DRIVE	ST151	ST157A	ST157N	ST157R	ST238R
DISK/TREND GROUP	3	3	3	3	3
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	130 mm OD 40 mm ID
Recording medium	Thin Film	Thin Film	Thin Film	Thin Film	Oxide Coated
DRIVE: Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	ST412	PC AT	SCSI	ST412	ST412
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	U: 50.8	F: 44.7	F: 48.6	U: 57.7*	U: 38.4*
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 10,416	F: 13,312	F: 13,312	U: 15,624*	U: 15,624*
Data surfaces per spindle	5	6	6	6	4
Heads per data surface	1	1	1	1	1
Tracks per surface	977	560	615	615	615
Track density (TPI)	1300	824	824	824	588
Maximum linear density (BPI)	14108	20280 BPI 13520 FCI	22430 BPI 14953 FCI	22430 BPI 14953 FCI	14740 BPI 9827 FCI
Recording code	MFM	2,7 RLL	2,7 RLL	2,7 RLL*	2,7 RLL*
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	Rotary, Band, Stepping Motor
Servo type	Dedicated Surf.	Open Loop	Open Loop	Open Loop	Open Loop
Average positioning time (msec)	24	28 (including settling)	28 (including settling)	28 (including settling)	65 (including settling)
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	32.3	36.3	36.3	36.3	73.3
Data transfer rate (KBytes/sec)	625	937.5	937.5	937.5*	937.5*
FIRST CUSTOMER SHIPMENT	2Q88	1Q89	3Q87	3Q87	1Q86
COMMENTS	41.3 mm high	41.3 mm high	41.3 mm high	41.3 mm high *With RLL controller	41.3 mm high *With RLL controller

MANUFACTURER	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY
DRIVE	ST251	ST351A/X	ST1096N	ST277N	ST277R
DISK/TREND GROUP	3	3	4	4	4
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	130 mm OD 40 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: Heads	Ferrite		Ferrite	Ferrite	Ferrite
Interface	ST412	PC AT/XT	SCSI	SCSI	ST412
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	U: 51.2	F: 42.8	F: 83.9	F: 64.9	U: 76.9*
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 10,416	*	F: 13,312	F: 17,408	U: 15,624*
Data surfaces per spindle	6	2	7	6	6
Heads per data surface	1	1	1	1	1
Tracks per surface	820	820	906	628	820
Track density (TPI)	777	1290	1300	777	777
Maximum linear density (BPI)	9935	28922 BPI 19281 FCI	19893 BPI 13262 FCI	19869 BPI 13246 FCI	14902 BPI 9935 FCI
Recording code	MFM	2,7 RLL	2,7 RLL	2,7 RLL	2,7 RLL*
Rotational speed (RPM)	3600	3048	3600	3600	3600
PERFORMANCE					
Actuator type	Rotary, Band, Stepping Motor	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Band, Stepping Motor	Rotary, Band, Stepping Motor
Servo type	Open Loop	Embedded	Dedicated Surf.	Open Loop	Open Loop
Average positioning time (msec)	28 (including settling)	28	20	28 (including settling)	28 (including settling)
Average rotational delay (msec)	8.3	9.8	8.3	8.3	8.3
Average access time (msec)	36.3	37.8	28.3	36.3	36.3
Data transfer rate (KBytes/sec)	625	1250-1750	937.5	1250	937.5*
FIRST CUSTOMER SHIPMENT	3Q87	4Q90	1Q89	1/87	3Q86
COMMENTS	41.3 mm high	25.4 mm high *Varies by zone	41.3 mm high	41.3 mm high	41.3 mm high *With RLL controller

MANUFACTURER	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY
DRIVE	ST296N	ST3096A	ST4096	ST9077A	ST9096A
DISK/TREND GROUP	4	4	4	4	4
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	130 mm OD 40 mm ID	95 mm OD 25 mm ID	130 mm OD 40 mm ID	65 mm OD 20 mm ID	65 mm OD 20 mm ID
Recording medium	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
DRIVE: Heads	Ferrite	Ferrite	Ferrite	Thin Film	Thin Film
Interface	SCSI	PC AT	ST412	PC AT	PC AT
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	F: 84.9	F: 89.2	U: 96	F: 64.0	F: 85.2
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 17,408	*	U: 10,416	F: 19,968	*
Data surfaces per spindle	6	3	9	4	4
Heads per data surface	1	1	1	1	1
Tracks per surface	820	1024	1024	802	1065
Track density (TPI)	777	1760	1031	1750	2165
Maximum linear density (BPI)	19869 BPI 13246 FCI	27000 BPI 18000 FCI	9792	46766 BPI 31177 FCI	41051 BPI 27000 FCI
Recording code	2,7 RLL	2,7 RLL	MFM	2,7 RLL	2,7 RLL
Rotational speed (RPM)	3600	3528	3600	3546	3450
PERFORMANCE					
Actuator type	Rotary, Band, Stepping Motor	Rotary, Voice Coil	Linear, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Open Loop	Dedicated Surf.	Dedicated Surf.	Embedded	Embedded
Average positioning time (msec)	28 (including settling)	17	28	16	16
Average rotational delay (msec)	8.3	8.5	8.3	8.46	8.7
Average access time (msec)	36.3	25.5	36.3	24.46	24.7
Data transfer rate (KBytes/sec)	1250	4000 max.	625	4000 max.	4000
FIRST CUSTOMER SHIPMENT	4Q87	1Q90	1Q86	3Q91	1991
COMMENTS	41.3 mm high	25.4 mm high *Varies by zone		19 mm high	19 mm high *Varies by zone

MANUFACTURER	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY
DRIVE	ST1100 Swift	ST1111E Swift	ST1126N Swift	ST1133N Swift	ST1144A
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	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
DRIVE: Heads	Ferrite	MIG	Ferrite	MIG	Ferrite
Interface	ST412	ESDI	SCSI	SCSI	PC AT
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	U: 100.5	U: 111.9	F: 107.0	F: 117	F: 124.7
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 10,416	U: 20,880	F: 14,848	F: 18,432	*
Data surfaces per spindle	9	5	7	5	7
Heads per data surface	1	1	1	1	1
Tracks per surface	1072	1072	1068	1272	1024
Track density (TPI)	1350	1350	1350	1543	1300
Maximum linear density (BPI)	14019	28103 BPI 18735 FCI	22638 BPI 15092 FCI	28103 BPI 18735 FCI	20400 BPI 13600 FCI
Recording code	MFM	2,7 RLL	2,7 RLL	2,7 RLL	2,7 RLL
Rotational speed (RPM)	3600	3600	3600	3600	3528
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.
Average positioning time (msec)	15	15	15	15	19
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.5
Average access time (msec)	23.3	23.3	23.3	23.3	27.5
Data transfer rate (KBytes/sec)	625	1250	1000	1250	1025-1500
FIRST CUSTOMER SHIPMENT	2Q88	1Q89	1Q89	4Q89	2Q90
COMMENTS	41.3 mm high	41.3 mm high	41.3 mm high	41.3 mm high	41.3 mm high *Varies by zone

MANUFACTURER	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY
DRIVE	ST1150R Swift	ST1186A Swift	ST1186N Swift	ST1201A Swift	ST1201E Swift
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	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
DRIVE: Heads	Ferrite	MIG	MIG	MIG	MIG
Interface	ST412	PC AT	SCSI	PC AT	ESDI
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	U: 150.7	F: 164	F: 164	F: 177.5	U: 201.4
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 15,624	F: 18,432	F: 18,432	F: 18,432	U: 20,880
Data surfaces per spindle	9	7	7	9	9
Heads per data surface	1	1	1	1	1
Tracks per surface	1072	1272	1272	1072	1072
Track density (TPI)	1350	1543	1543	1543	1543
Maximum linear density (BPI)	21030 BPI 14020 FCI	28103 BPI 18735 FCI	28103 BPI 18375 FCI	28103 BPI 18735 FCI	28103 BPI 18735 FCI
Recording code	2,7 RLL	2,7 RLL	2,7 RLL	2,7 RLL	2,7 RLL
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
Servo type	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.
Average positioning time (msec)	15	15	15	15	15
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	23.3	23.3	23.3	23.3	23.3
Data transfer rate (KBytes/sec)	938	1250	1250	1250	1250
FIRST CUSTOMER SHIPMENT	2Q88	4Q89	4Q89	1Q89	1Q89
COMMENTS	41.3 mm high	41.3 mm high	41.3 mm high	41.3 mm high	41.3 mm high

MANUFACTURER	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY
DRIVE	ST1201N Swift	ST1239A Swift	ST1239N Swift	ST2106E Wren 3 HH	ST2106N Wren 3 HH
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	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: Heads	MIG	MIG	MIG	Ferrite	Ferrite
Interface	SCSI	PC AT	SCSI	ESDI	SCSI
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	F: 171.9	F: 210.7	F: 204.2	U: 106	U: 106 F: 94
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 18,432	F: 18,432	F: 18,432	U: 20,880	F: 18,432
Data surfaces per spindle	9	9	9	5	5
Heads per data surface	1	1	1	1	1
Tracks per surface	1072	1272	1272	1024	1024
Track density (TPI)	1543	1543	1543	960	960
Maximum linear density (BPI)	28103 BPI 18735 FCI	28103 BPI 18735 FCI	28103 BPI 18735 FCI	19058 BPI 12705 FCI	19058 BPI 12705 FCI
Recording code	2,7 RLL	2,7 RLL	2,7 RLL	2,7 RLL	2,7 RLL
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
Servo type	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.
Average positioning time (msec)	15	15	15	18	18
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	23.3	23.3	23.3	26.3	26.3
Data transfer rate (KBytes/sec)	1250	1250	1250	1250	1250 synch.
FIRST CUSTOMER SHIPMENT	1Q89	3Q89	3Q89	2/87	2/87
COMMENTS	41.3 mm high	41.3 mm high	41.3 mm high	41.3 mm high	41.3 mm high

MANUFACTURER	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY
DRIVE	ST2125N Wren 5 HH	ST2182E Wren 6 HH	ST2209N Wren 5 HH	ST2274A Wren 6 HH	ST3120A
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	95 mm OD 25 mm ID
Recording medium	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
DRIVE: Heads	Ferrite	Thin Film	Ferrite	Thin Film	Thin Film
Interface	SCSI	ESDI	SCSI	PC AT	PC AT
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	U: 125 F: 107	U: 182	U: 209 F: 183	F: 193	F: 106.9
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	*	U: 31,320	*	F: 27,648	*
Data surfaces per spindle	3	5	5	5	3
Heads per data surface	1	1	1	1	1
Tracks per surface	1544	1453	1544	1453	1024
Track density (TPI)	1280	1459	1280	1459	1760
Maximum linear density (BPI)	19213 BPI 12808 FCI	31699 BPI 21132 FCI	19213 BPI 12808 FCI	31699 BPI 21132 FCI	
Recording code	2,7 RLL	2,7 RLL	2,7 RLL	2,7 RLL	2,7 RLL
Rotational speed (RPM)	3600	3600	3600	3600	3528
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.
Average positioning time (msec)	18	15	18	16	18
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.5
Average access time (msec)	26.3	23.3	26.3	24.3	26.5
Data transfer rate (KBytes/sec)	4700 synch.	1875	4700 synch.	1875	4000 max.
FIRST CUSTOMER SHIPMENT	3Q88	1/89	3Q88	4/89	1/91
COMMENTS	41.3 mm high *Varies by zone	41.3 mm high	41.3 mm high *Varies by zone	41.3 mm high	25.4 mm high *Varies by zone

MANUFACTURER	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY
DRIVE	ST3144A	ST3144N	ST3283A	ST3283N	ST4144R
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	130 mm OD 40 mm ID
Recording medium	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
DRIVE: Heads			Thin Film	Thin Film	Ferrite
Interface	PC AT	SCSI	PC AT	SCSI-2	ST412
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	F: 130	F: 126	F: 245.38	F: 248.62	U: 144*
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	*	*	*	*	U: 15,624*
Data surfaces per spindle	3	3	5	5	9
Heads per data surface	1	1	1	1	1
Tracks per surface	1001	1001	1672	1672	1024
Track density (TPI)			1960	1960	1031
Maximum linear density (BPI)			35000 BPI 26250 FCI	35000 BPI 26250 FCI	14688 BPI 9792 FCI
Recording code	2,7 RLL	2,7 RLL	1,7 RLL	1,7 RLL	2,7 RLL*
Rotational speed (RPM)	3528	3528	4500	4500	3600
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Linear, Voice Coil
Servo type	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.
Average positioning time (msec)	16	16	12	12	28
Average rotational delay (msec)	8.5	8.5	6.7	6.7	8.3
Average access time (msec)	24.5	24.5	18.7	18.7	36.3
Data transfer rate (KBytes/sec)	4000 max.		3000	10000 synch. 3000 asynch.	937.5*
FIRST CUSTOMER SHIPMENT	3Q91	3Q91	1Q92	1Q92	3Q87
COMMENTS	41.3 mm high *Varies by zone	41.3 mm high *Varies by zone	25.4 mm high *Varies by zone	25.4 mm high *Varies by zone	*With RLL controller

MANUFACTURER	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY
DRIVE	ST4182E Wren 3	ST4182N Wren 3	ST6344J FSD	ST1400N	ST1401N
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	130 mm OD 40 mm ID	230 mm OD 100 mm ID	95 mm OD 25 mm ID	95 mm OD 25 mm ID
Recording medium	Thin Film	Thin Film	Oxide Coated	Thin Film	Thin Film
DRIVE: Heads	Ferrite	Ferrite	Thin Film		
Interface	ESDI	SCSI	SMD	SCSI-2	SCSI-2
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	U: 182	U: 182 F: 155	U: 344	U: 383 F: 331	U: 390 F: 338
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 20,880	F: 19,456	U: 20,160	*	*
Data surfaces per spindle	9	9	12	7	9
Heads per data surface	1	1	2	1	1
Tracks per surface	969	969	1422	1476	1100
Track density (TPI)	960	960	960	1760	1760
Maximum linear density (BPI)	19058 BPI 12705 FCI	19058 BPI 12705 FCI	10000	36000 BPI 27000 FCI	36000 BPI 27000 FCI
Recording code	2,7 RLL	2,7 RLL	MFM	1,7 RLL	1,7 RLL
Rotational speed (RPM)	3600	3600	3600	4412	4412
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Linear, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.
Average positioning time (msec)	16.5	16.5	18	14	12
Average rotational delay (msec)	8.3	8.3	8.3	6.8	6.8
Average access time (msec)	24.8	24.8	26.3	20.8	18.8
Data transfer rate (KBytes/sec)	1250	1250 synch.	1209	5000 synch. 4000 asynch.	5000 synch. 4000 asynch.
FIRST CUSTOMER SHIPMENT	2Q86		4Q83	1/91	1/91
COMMENTS				41.3 mm high *Varies by zone	41.3 mm high *Varies by zone

MANUFACTURER	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY
DRIVE	ST1480A	ST1480N	ST1481N ST1481ND	ST2383A Wren 6 HH	ST2383E Wren 6 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	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: Heads				Thin Film	Thin Film
Interface	PC AT	SCSI, SCSI-2	SCSI-2	PC AT	ESDI
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	U: 492 F: 426	U: 492 F: 426	U: 492 F: 426	F: 338	U: 383
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	*	*	*	F: 27,648	U: 31,320
Data surfaces per spindle	9	9	9	7	7
Heads per data surface	1	1	1	1	1
Tracks per surface	1478	1478	1476	1747	1747
Track density (TPI)	1760	1760	1760	1459	1459
Maximum linear density (BPI)	36000 BPI 27000 FCI	36000 BPI 27000 FCI	36000 BPI 27000 FCI	31699 BPI 21132 FCI	31699 BPI 21132 FCI
Recording code	1,7 RLL	1,7 RLL	1,7 RLL	2,7 RLL	2,7 RLL
Rotational speed (RPM)	4412	4400	4412	3600	3600
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.
Average positioning time (msec)	14	14	14	16	16
Average rotational delay (msec)	6.8	6.8	6.8	8.3	8.3
Average access time (msec)	20.8	20.8	20.8	24.3	24.3
Data transfer rate (KBytes/sec)	1875-3125*	5000 synch. 4000 asynch.	10000 synch. 4000 asynch.	1875	1875
FIRST CUSTOMER SHIPMENT	1/91	1/91	3Q91	4/89	1/89
COMMENTS	41.3 mm high *Varies by zone	41.3 mm high *Varies by zone	41.3 mm high *Varies by zone	41.3 mm high	41.3 mm high

MANUFACTURER	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY
DRIVE	ST2383N Wren 6 HH	ST3500A	ST3500N	ST4350N Wren 4	ST4376N Wren 4
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	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: Heads	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
Interface	SCSI	PC AT	SCSI-2	SCSI	SCSI
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	U: 383 F: 337	F: 426	F: 426	U: 350 F: 307	U: 376 F: 330
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	*	*	*	*	*
Data surfaces per spindle	7	7	7	9	9
Heads per data surface	1	1	1	1	1
Tracks per surface	1261	1546	1546	1412	1549
Track density (TPI)	1459	2150	2150	1280	1280
Maximum linear density (BPI)	31674 BPI 21116 FCI	46000 BPI 34500 FCI	46000 BPI 34500 FCI	19058 BPI 12705 FCI	19058 BPI 12705 FCI
Recording code	2,7 RLL	1,7 RLL	1,7 RLL	2,7 RLL	2,7 RLL
Rotational speed (RPM)	3600	4500	4500	3600	3600
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.
Average positioning time (msec)	14	9.9 RD/11.4 WR	9.9 RD/11.4 WR	16.5	17.5
Average rotational delay (msec)	8.3	6.7	6.7	8.3	8.3
Average access time (msec)	22.3	16.6/18.1	16.6/18.1	24.8	25.8
Data transfer rate (KBytes/sec)	4700 synch.	4000	10000 synch. 4000 asynch.	1500 synch.	4700 synch.
FIRST CUSTOMER SHIPMENT	7/89	1Q92	1Q92	3/87	10/87
COMMENTS	41.3 mm high *Varies by zone	25.4 mm high *Varies by zone	25.4 mm high *Varies by zone	*Varies by zone	*Varies by zone

MANUFACTURER	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY
DRIVE	ST4383E Wren 5	ST4384E Wren 5	ST4385N Wren Runner	ST4442E Wren 5	ST2502N Wren 6 HH
DISK/TREND GROUP	6	6	6	6	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: Heads	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
Interface	ESDI	ESDI	SCSI	ESDI	SCSI
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	U: 383	U: 383	U: 385 F: 357	U: 442	U: 502 F: 442
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 20,880	U: 20,880	*	U: 20,880	*
Data surfaces per spindle	13	15	15	15	7
Heads per data surface	1	1	1	1	1
Tracks per surface	1412	1224	791	1412	1755
Track density (TPI)	1280	1280	1280	1280	1459
Maximum linear density (BPI)	19600 BPI 13066 FCI	19600 BPI 13066 FCI	22000 BPI 14666 FCI	19600 BPI 13066 FCI	31674 BPI 21116 FCI
Recording code	2,7 RLL	2,7 RLL	2,7 RLL	2,7 RLL	2,7 RLL
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
Servo type	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.
Average positioning time (msec)	18	14.5	10.7	16	16
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	26.3	22.8	19	24.3	24.3
Data transfer rate (KBytes/sec)	1250	1250	4700 synch.	1250	4700 synch.
FIRST CUSTOMER SHIPMENT	2/88	2/88	1Q89	2/88	9/89
COMMENTS			*Varies by zone		41.3 mm high *Varies by zone

MANUFACTURER	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY
DRIVE	ST3600A	ST3600N	ST4702N Wren 5	ST4766E Wren 6	ST4766N Wren 6
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	95 mm OD 25 mm ID	95 mm OD 25 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: Heads	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
Interface	PC AT	SCSI-2	SCSI	ESDI	SCSI
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	U: 600 F: 525	U: 600 F: 525	U: 702 F: 613	U: 766	U: 766 F: 676
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	*	*	*	U: 31,320	F: 28,672
Data surfaces per spindle	7	7	15	15	15
Heads per data surface	1	1	1	1	1
Tracks per surface	1877	1877	1546	1632	1632
Track density (TPI)	2150	2150	1280	1459	1459
Maximum linear density (BPI)	49000 BPI 36750 FCI	49000 BPI 36750 FCI	26000 BPI 17333 FCI	30500 BPI 20333 FCI	30500 BPI 20333 FCI
Recording code	1,7 RLL	1,7 RLL	2,7 RLL	2,7 RLL	2,7 RLL
Rotational speed (RPM)	4500	4500	3600	3600	3600
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.
Average positioning time (msec)	10.5 RD/12 WR	10.5 RD/12 WR	16.5	15.5	16.5
Average rotational delay (msec)	6.7	6.7	8.3	8.3	8.3
Average access time (msec)	17.2/18.7	17.2/18.7	24.8	23.8	24.8
Data transfer rate (KBytes/sec)	4000	10000 synch. 4000 asynch.	4700 synch.	1875	4700 synch.
FIRST CUSTOMER SHIPMENT	1Q92	1Q92	5/88	8/88	9/88
COMMENTS	25.4 mm high *Varies by zone	25.4 mm high *Varies by zone	*Varies by zone		

MANUFACTURER	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY
DRIVE	ST4767E Wren Runner-2	ST4767N Wren Runner-2	ST4769E Wren Runner-2	ST6515 FSD	ST8851J ST8851K Sabre 4
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	230 mm OD 100 mm ID	210 mm OD 100 mm ID
Recording medium	Thin Film	Thin Film	Thin Film	Oxide Coated	Oxide Coated
DRIVE: Heads	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
Interface	ESDI	SCSI-2	ESDI	Mod.SMD,IPI-2	SMD, IPI-2
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	U: 788	U: 767 F: 676	U: 802	U: 516	U: 851
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U:	*	U: 34,450	U: 30,240	U: 41,088
Data surfaces per spindle	15	15	15	12	15
Heads per data surface	1	1	1	2	1
Tracks per surface	1399	1356	1552	1422	1381
Track density (TPI)	1600	1600	1600	960	1089
Maximum linear density (BPI)	30600 BPI 22950 FCI	30600 BPI 22950 FCI	29318 BPI 21988 FCI	15159 BPI 10106 FCI	19816 BPI 13210 FCI
Recording code	1,7 RLL	1,7 RLL	1,7 RLL	2,7 RLL	2,7 RLL
Rotational speed (RPM)	4800	4800	4800	3600	3600
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Linear, Voice Coil	Rotary, Voice Coil
Servo type	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.
Average positioning time (msec)	12.9	11.9	12.9	18	15
Average rotational delay (msec)	6.25	6.25	6.25	8.3	8.3
Average access time (msec)	19.15	18.15	19.15	26.3	23.3
Data transfer rate (KBytes/sec)	3000	4800 synch.	3000	1825	2465
FIRST CUSTOMER SHIPMENT	12/90	3/90	12/90	4Q83	3Q87
COMMENTS		*Varies by zone			

MANUFACTURER	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY
DRIVE	ST8851N Sabre 4	ST11200N	ST41097J Elite 1	ST41200N Wren 7	ST41201J ST41201K Elite 1
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	210 mm OD 100 mm ID	95 mm OD 25 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: Heads	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
Interface	SCSI	SCSI-2	Modified SMD	SCSI-2	Mod. SMD, IPI-2
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	U: 851 F: 727	U: 1,200 F: 1,050	U: 1,097	U: 1,200 F: 1,050	U: 1,200
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 34,816	*	U: 30,800	*	U: 33,600
Data surfaces per spindle	15	15	17	15	17
Heads per data surface	1	1	1	1	1
Tracks per surface	1381	1877	2101	1931	2101
Track density (TPI)	1089	2150	1801	1600	1801
Maximum linear density (BPI)	19816 BPI 13210 FCI	46000 BPI 34500 FCI		32750 BPI 24562 FCI	33344 BPI 22229 FCI
Recording code	2,7 RLL	1,7 RLL	2,7 RLL	1,7 RLL	2,7 RLL
Rotational speed (RPM)	3600	4500	5400	3600	5400
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.
Average positioning time (msec)	15	10.5 RD/12 WR	11.5	15	11.5
Average rotational delay (msec)	8.3	6.7	5.56	8.3	5.56
Average access time (msec)	23.3	17.2/18.7	17.06	23.3	17.06
Data transfer rate (KBytes/sec)	2465	10000 synch. 4000 asynch.	2750	4800 synch.	3000
FIRST CUSTOMER SHIPMENT	3Q87	3Q91	2Q90	5/89	1Q90
COMMENTS		41.3 mm high *Varies by zone		*Varies by zone	

MANUFACTURER	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY
DRIVE	ST41520N ST41520ND Elite 1	ST41600N ST41600ND ST41601N ST41601ND Elite 1	ST41650N ST41650ND Wren 8	ST41651N ST41651ND Wren 8	ST41800K Elite 2
DISK/TREND GROUP	8	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: Heads	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
Interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	IPI-2
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	U: 1,600 F: 1,352	U: 1,600 F: 1,352	U: 1,650 F: 1,420	U: 1,650 F: 1,420	U: 1,986
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	*	*	*	*	U: 84,000
Data surfaces per spindle	17	17	15	15	18
Heads per data surface	1	1	1	1	1
Tracks per surface	2101	2101	2110	2107	2627
Track density (TPI)	1801	1801	1760	1760	
Maximum linear density (BPI)	*	*			
Recording code	2,7 RLL	2,7 RLL	1,7 RLL	1,7 RLL	2,7 RLL
Rotational speed (RPM)	5400	5400	3600	3600	5400
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.
Average positioning time (msec)	11.5	11.5	15	15	11
Average rotational delay (msec)	5.56	5.56	8.3	8.3	5.56
Average access time (msec)	17.06	17.06	23.3	23.3	16.56
Data transfer rate (KBytes/sec)	5000 synch.	5000 synch.	5000 synch.	10000 synch.	7500
FIRST CUSTOMER SHIPMENT	12/90	12/90	12/90	9/91	3Q91
COMMENTS	*Varies by zone	*Varies by zone	*Varies by zone	*Varies by zone	

MANUFACTURER	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY
DRIVE	ST81123J Sabre 5	ST81154K Sabre 5	ST81236J ST81236K Sabre 5	ST81236N Sabre 5	ST42100N ST42100ND Wren 9
DISK/TREND GROUP	8	8	8	8	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 100 mm ID	210 mm OD 100 mm ID	130 mm OD 40 mm ID
Recording medium	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
DRIVE: Heads	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
Interface	Mod. SMD	IPI-2	SMD,SCSI,IPI-2	SCSI	SCSI-2
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	U: 1,123	U: 1,154	U: 1,236	U: 1,236 F: 1,056	U: 2,100 F: 1,830
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 45,792	U: 50,400	U: 50,400	F: 43,008	*
Data surfaces per spindle	15	14	15	15	15
Heads per data surface	1	1	1	1	1
Tracks per surface	1635	1635	1635	1635	2574
Track density (TPI)	1289	1289	1289	1289	2150
Maximum linear density (BPI)	22955 BPI 15303 FCI	25264 BPI 16842 FCI	25264 BPI 16842 FCI	25264 BPI 16842 FCI	
Recording code	2,7 RLL	2,7 RLL	2,7 RLL	2,7 RLL	1,7 RLL
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
Servo type	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.
Average positioning time (msec)	15	15	15	15	12.9
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	23.3	23.3	23.3	23.3	21.2
Data transfer rate (KBytes/sec)	2747	6000	3000	3000	10000 synch.
FIRST CUSTOMER SHIPMENT	3Q88	4Q88	2Q88	2Q88	3Q91
COMMENTS	22 Mhz version of Sabre 5	2 head parallel version of Sabre 5			*Varies by zone

MANUFACTURER	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY
DRIVE	ST42400N ST42400ND Elite 2	ST82030J ST82030K Sabre 6	ST82038J Sabre 6	ST82105K 8 HP	ST82272J Sabre 6
DISK/TREND GROUP	9	9	9	9	9
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	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
DRIVE: Heads	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
Interface	SCSI-2	Mod. SMD, IPI-2	Modified SMD	IPI-2	Modified SMD
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	U: 2,500 F: 2,129	U: 2,030	U: 2,038	U: 2,105	U: 2,272
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	*	U: 50,400	U: 41,088	U: 50,400	U: 45,792
Data surfaces per spindle	19	19	19	16	19
Heads per data surface	1	1	1	1	1
Tracks per surface	2627	2120	2611	2611	2611
Track density (TPI)			1880	1880	1880
Maximum linear density (BPI)					21987 BPI 14658 FCI
Recording code	2,7 RLL	2,7 RLL	2,7 RLL	2,7 RLL	2,7 RLL
Rotational speed (RPM)	5400	3600	3600	3600	3600
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.
Average positioning time (msec)	11	11	12	12	12
Average rotational delay (msec)	5.56	8.3	8.3	8.3	8.3
Average access time (msec)	16.56	19.3	20.3	20.3	20.3
Data transfer rate (KBytes/sec)	5000 synch.	3000	2400	2400	2747
FIRST CUSTOMER SHIPMENT	3Q91	4Q90	3Q90	11/90	1Q90
COMMENTS	*Varies by zone			8 head parallel version of Sabre 6	22 Mhz version of Sabre 6

MANUFACTURER	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY
DRIVE	ST82368K Sabre PTD	ST82500J ST82500K Sabre 6	ST82500N Sabre 6	ST83050K Sabre 7 2HP	ST83220K Sabre 7
DISK/TREND GROUP	9	9	9	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 100 mm ID	210 mm OD 100 mm ID	210 mm OD 100 mm ID
Recording medium	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
DRIVE: Heads	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
Interface	IPI-2	SMD, IPI-2	SCSI	IPI-2	IPI-2
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	U: 2,368	U: 2,500	U: 2,500 F: 2,140	U: 3,050	U: 3,220
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 50,400	U: 50,400	F: 50,400	U: 127,680	U: 63,840
Data surfaces per spindle	18	19	19	18	19
Heads per data surface	1	1	1	1	1
Tracks per surface	2611	2611	2611	2655	2655
Track density (TPI)	1880	1880	1880	1912	1912
Maximum linear density (BPI)	24200 BPI 16133 FCI	25409 BPI 16939 FCI	25409 BPI 16939 FCI	32202 BPI 24151 FCI	32202 BPI 24151 FCI
Recording code	2,7 RLL	2,7 RLL	2,7 RLL	1,7 RLL	1,7 RLL
Rotational speed (RPM)	3600	3600	3600	4365	4365
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.
Average positioning time (msec)	12	12	12	12	12
Average rotational delay (msec)	8.3	8.3	8.3	6.87	6.87
Average access time (msec)	20.3	20.3	20.3	18.87	18.87
Data transfer rate (KBytes/sec)	27000	3000	3000	9340	4670
FIRST CUSTOMER SHIPMENT	3Q90	1Q90	2Q90	3/91	1/91
COMMENTS	9 head parallel version of Sabre 6			2 head parallel version of Sabre 7	

MANUFACTURER	SEQUEL	SEQUEL	SEQUEL	SEQUEL	SONY
DRIVE	7050	803	806	807	SRD2040Z
DISK/TREND GROUP	4	4	5	6	3
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	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	Oxide Coated	Oxide Coated	Thin Film
DRIVE: Heads	Ferrite	Ferrite	Ferrite	Ferrite	
Interface	Priam, SMD	Priam, SMD	Priam,SMD,SCSI	Priam,SMD,SCSI	SCSI
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	U: 70.49	U: 85.68	U: 227	U: 344	F: 42.1
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 13,400	U: 20,160	U: 20,160	U: 20,160	F: 16,900
Data surfaces per spindle	5	5	11	11	4
Heads per data surface	1	1	1	1	1
Tracks per surface	1049	850	1023	1552	624
Track density (TPI)	960	960	1040	1040	980
Maximum linear density (BPI)	6597	9167	9167	12096	25500 BPI 17000 FCI
Recording code	MFM	MFM	MFM	MFM	2,7 RLL
Rotational speed (RPM)	3600	3600	3600	3600	3600
PERFORMANCE					
Actuator type	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil	Rotary, Voice Coil
Servo type	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Optical Encoder
Average positioning time (msec)	42	35	20	25	29
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	50.3	43.3	28.3	33.3	37.3
Data transfer rate (KBytes/sec)	806	1209	1210	1210	1250
FIRST CUSTOMER SHIPMENT	4Q81	9/83	5/84	6/84	1/89
COMMENTS					41.3 mm high

MANUFACTURER	SONY	SONY	SONY	SONY	STORAGE TECHNOLOGY CORPORATION
DRIVE	SRD3040C	SRD3040Z	SRD3080C	SRD3080Z	8380-RXX
DISK/TREND GROUP	3	3	4	4	9
MARKET	OEM	OEM	OEM	OEM	PCM
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	14"
Recording medium	Thin Film	Thin Film	Thin Film	Thin Film	Oxide Coated
DRIVE: Heads					Thin Film
Interface	PC AT	SCSI	PC AT	SCSI	IBM
CAPACITY/RECORDING DENSITY					Subsystem: 10,080 to 30,240 in 2.52 increments
Total capacity (Mbytes) FIXED	F: 42.9	F: 42.9	F: 85.8	F: 85.8	
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	*	*	*	*	F: 47,476
Data surfaces per spindle	2	2	4	4	15/15/19
Heads per data surface	1	1	1	1	2
Tracks per surface	867	867	867	867	1770/3540/4192
Track density (TPI)	1300	1300	1300	1300	800/1400/1650
Maximum linear density (BPI)	31500 BPI 21000 FCI	31500 BPI 21000 FCI	31500 BPI 21000 FCI	31500 BPI 21000 FCI	15240 BPI 10160 FCI
Recording code	2,7 RLL	2,7 RLL	2,7 RLL	2,7 RLL	2,7 RLL
Rotational speed (RPM)	2975	2975	2975	2975	3620
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Dual, Linear, Voice Coil
Servo type	Optical Encoder	Optical Encoder	Optical Encoder	Optical Encoder	Dedicated Surf.
Average positioning time (msec)	18	18	18	18	11/14/16
Average rotational delay (msec)	10.1	10.1	10.1	10.1	8.3
Average access time (msec)	28.1	28.1	28.1	28.1	19.3/22.3/24.3
Data transfer rate (KBytes/sec)	3375 max.	2000 asynch.	3375 max.	2000 asynch.	3000
FIRST CUSTOMER SHIPMENT					1988
COMMENTS	25.4 mm high *Varies by zone	25.4 mm high *Varies by zone	28 mm high *Varies by zone	28 mm high *Varies by zone	PCM 3380J,E,K Subsystem has 8 spindles 1X or 2X or 3X by pairs

MANUFACTURER	STORAGE TECHNOLOGY CORPORATION	SYQUEST TECHNOLOGY	SYQUEST TECHNOLOGY	SYQUEST TECHNOLOGY	SYQUEST TECHNOLOGY
DRIVE	8380F	SQ555	SQ5110	SyDOS 44e SyDOS 44i	SyDOS 88e SyDOS 88i
DISK/TREND GROUP	9	1	1	1	1
MARKET	PCM	OEM, PCM	OEM, PCM	PCM	PCM
MEDIA: Generic type	Fixed	SQ400	SQ800	SQ400	SQ800
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: Heads	Thin Film	Ferrite	Ferrite	Ferrite	Ferrite
Interface	IBM	SCSI	SCSI	SCSI	SCSI
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	F: 3,780	--	--	--	--
REMOVABLE	--	F: 44.39	F: 88.8	F: 44.39	F: 88.8
Capacity per track (Bytes)	F: 47,476	F: 17,408	*	F: 17,408	*
Data surfaces per spindle	19	2	2	2	2
Heads per data surface	2	1	1	1	1
Tracks per surface	4192	1275	1774	1275	1774
Track density (TPI)	1650	1086	1475	1086	1475
Maximum linear density (BPI)	15240 BPI 10160 FCI	23642 BPI 15761 FCI	28546 BPI 19031 FCI	23642 BPI 15761 FCI	28546 BPI 19031 FCI
Recording code	2,7 RLL	2,7 RLL	2,7 RLL	2,7 RLL	2,7 RLL
Rotational speed (RPM)	3620	3220	3220	3220	3220
PERFORMANCE					
Actuator type	Dual, Linear, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Dedicated Surf.	Embedded	Embedded	Embedded	Embedded
Average positioning time (msec)	16	20	20	20	20
Average rotational delay (msec)	8.3	9.32	9.32	9.32	9.32
Average access time (msec)	24.3	29.32	29.32	29.32	29.32
Data transfer rate (KBytes/sec)	3000	1250	4000 synch. 1250 asynch.	4000 synch. 1250 asynch.	4000 synch. 1250 asynch.
FIRST CUSTOMER SHIPMENT	1Q89	1Q88	2/91	7/91	7/91
COMMENTS	PCM 3380K Drive has 2 spindles	41.3 mm high Removable data cartridge	41.3 mm high Removable data cartridge *Varies by zone	41.3 mm high Removable data cartridge	41.3 mm high Removable data cartridge *Varies by zone

MANUFACTURER	TEAC	TEAC	TEAC	TEAC	TEAC
DRIVE	SD-240	SD-340	SD-340H	SD-260	SD-380
DISK/TREND GROUP	3	3	3	4	4
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	65 mm OD 20 mm ID	95 mm OD 25 mm ID	95 mm OD 25 mm ID	65 mm OD 20 mm ID	95 mm OD 25 mm ID
Recording medium	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
DRIVE: Heads	MIG	MIG	MIG	MIG	MIG
Interface	PC AT	SCSI-2, PC AT	SCSI-2, PC AT	PC AT	SCSI-2, PC AT
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	F: 43	F: 43.01	F: 43.01	F: 62.7	F: 86.02
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 21,504	F: 20,480	F: 20,480	F: 25,600	F: 20,480
Data surfaces per spindle	2	2	2	2	4
Heads per data surface	1	1	1	1	1
Tracks per surface	1000	1050	1050	1226	1050
Track density (TPI)	2121	1500	1500	2500	1500
Maximum linear density (BPI)		32155 BPI 21437 FCI	33142 BPI 22095 FCI		32155 BPI 21437 FCI
Recording code		2,7 RLL	2,7 RLL		2,7 RLL
Rotational speed (RPM)	3600	2358	3600	3600	2358
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Embedded	Embedded	Embedded	Embedded	Embedded
Average positioning time (msec)	19	23	19	19	20
Average rotational delay (msec)	8.3	12.7	8.3	8.3	12.7
Average access time (msec)	27.3	35.7	27.3	27.3	32.7
Data transfer rate (KBytes/sec)	4000	4000 synch. 2000 asynch.	4000 synch. 2000 asynch.	4000	4000 synch. 2000 asynch.
FIRST CUSTOMER SHIPMENT	1/92	4Q89	2Q90	1/92	4Q89
COMMENTS	15.2 mm high	25.4 mm high	25.4 mm high	15.2 mm high	25.4 mm high

MANUFACTURER	TEAC	TEAC	TEAC	TOKICO	TOKICO
DRIVE	SD-380H	SD-3105	SD-3210	TD3081C	TD3091A
DISK/TREND GROUP	4	5	5	4	4
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	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
DRIVE: Heads	MIG	MIG	MIG	MIG	MIG
Interface	SCSI-2, PC AT	SCSI-2, PC AT	SCSI-2, PC AT	SCSI	PC AT
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	F: 86.02	F: 105.02	F: 215	F: 80	F: 90
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 20,480	F: 20,480	F: 31,744	F: 17,920	F: 19,968
Data surfaces per spindle	4	4	4	5	5
Heads per data surface	1	1	1	1	1
Tracks per surface	1050	1282	1695	928	928
Track density (TPI)	1500	1814	2170	1175	1175
Maximum linear density (BPI)	33142 BPI 22095 FCI	33087 BPI 22058 FCI		28000 BPI 18666 FCI	30000 BPI 20000 FCI
Recording code	2,7 RLL	2,7 RLL	1,7 RLL	2,7 RLL	2,7 RLL
Rotational speed (RPM)	3600	3600	3600	3600	3296
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Embedded	Embedded	Embedded	Dedicated Surf.	Dedicated Surf.
Average positioning time (msec)	19	19	15	20	20
Average rotational delay (msec)	8.3	8.3	8.3	8.3	9.1
Average access time (msec)	27.3	27.3	23.3	28.3	29.1
Data transfer rate (KBytes/sec)	4000 synch. 2000 asynch.	4000 synch. 2000 asynch.	4000	1250	1250
FIRST CUSTOMER SHIPMENT	2Q90	2Q90	1/92	10/88	4/90
COMMENTS	25.4 mm high	25.4 mm high	25.4 mm high	41.3 mm high	41.3 mm high

MANUFACTURER	TOKICO	TOKICO	TOKICO	TOKICO	TOSHIBA
DRIVE	TD3091C	TD3135A	TD3135C	TD3135Y	MK-1022FC
DISK/TREND GROUP	4	5	5	5	2
MARKET	OEM	OEM	OEM	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	95 mm OD 25 mm ID	65 mm OD 20 mm ID
Recording medium	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film*
DRIVE: Heads	MIG	MIG	MIG	MIG	
Interface	SCSI	PC AT	SCSI	SCSI	PC AT
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	F: 90	F: 130	F: 130	F: 130	F: 22
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 19,968	F: 19,968	F: 19,968	F: 19,968	F: 17,920
Data surfaces per spindle	5	7	7	7	2
Heads per data surface	1	1	1	1	1
Tracks per surface	963	964	963	963	615
Track density (TPI)	1175	1175	1175	1260	1450
Maximum linear density (BPI)	30000 BPI 20000 FCI	30000 BPI 20000 FCI	30000 BPI 20000 FCI	30000 BPI 20000 FCI	39531 BPI 29648 FCI
Recording code	2,7 RLL	2,7 RLL	2,7 RLL	2,7 RLL	1,7 RLL
Rotational speed (RPM)	3296	3296	3296	3296	3200
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Embedded
Average positioning time (msec)	20	20	20	20	23
Average rotational delay (msec)	9.1	9.1	9.1	9.1	9.4
Average access time (msec)	29.1	29.1	29.1	29.1	32.4
Data transfer rate (KBytes/sec)	1250	1250	1250	1250	5000
FIRST CUSTOMER SHIPMENT	10/89	9/90	12/89	12/90	4/91
COMMENTS	41.3 mm high	41.3 mm high	41.3 mm high	41.3 mm high 128 KB cache	17 mm high *Glass disk

MANUFACTURER	TOSHIBA	TOSHIBA	TOSHIBA	TOSHIBA	TOSHIBA
DRIVE	MD-1122FC	MK-232FB MK-232FBS	MK-232FC MK-232FCH	MK-134FA	MK-1032FB
DISK/TREND GROUP	3	3	3	3	4
MARKET	Captive, OEM	OEM	Captive, OEM	Captive, OEM	Captive, OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	65 mm OD 20 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	Thin Film*	Thin Film	Thin Film	Oxide Coated	Thin Film
DRIVE: Heads		Ferrite	Ferrite	Ferrite	
Interface	PC AT	SCSI	PC AT	ST412	SCSI
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	F: 43	F: 45.4	F: 45.4	U: 53.4	F: 53
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 22,016	F: 17,920	F: 17,920	U: 10,416	F: 19,968
Data surfaces per spindle	2	3	3	7	2
Heads per data surface	1	1	1	1	1
Tracks per surface	977	845	845	733	1328
Track density (TPI)	2000	1016	1016	1000	1850
Maximum linear density (BPI)	51891 BPI 38918 FCI	28443 BPI 18962 FCI	28443 BPI 18962 FCI	13600	36080 BPI 27060 FCI
Recording code	1,7 RLL	2,7 RLL	2,7 RLL	MFM	1,7 RLL
Rotational speed (RPM)	3200	3600	3600	3600	3402
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Embedded	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Embedded
Average positioning time (msec)	23	25	25	25	16
Average rotational delay (msec)	9.4	8.3	8.3	8.3	8.8
Average access time (msec)	32.4	33.3	33.3	33.3	24.8
Data transfer rate (KBytes/sec)	5000	1250	3750 (FC) 6250 (FCH)	625	5000 synch. 1500 asynch.
FIRST CUSTOMER SHIPMENT	4/91	1Q89		3Q87	4/91
COMMENTS	17 mm high *Glass disk	41.3 mm high MK-232FBS has 19 msec. average positioning time	41.3 mm high	41.3 mm high	25.4 mm high

MANUFACTURER	TOSHIBA	TOSHIBA	TOSHIBA	TOSHIBA	TOSHIBA
DRIVE	MK-132FC	MK-56FB	MK-1034FB	MK-1034FC	MK-156FA
DISK/TREND GROUP	4	4	5	5	5
MARKET	Captive, OEM	Captive, OEM	Captive, OEM	Captive, OEM	Captive, OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	95 mm OD 25 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	Oxide Coated	Thin Film	Thin Film	Thin Film
DRIVE: Heads		Ferrite			Ferrite
Interface	PC AT	ST412	SCSI	PC AT	ESDI
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	F: 53	U: 86.5	F: 107	F: 107	U: 173.0
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 19,968	U: 10,416	F: 19,968	F: 19,968	U: 20,832
Data surfaces per spindle	2	10	4	4	10
Heads per data surface	1	1	1	1	1
Tracks per surface	1328	830	1345	1345	830
Track density (TPI)	1850	900	1585	1585	900
Maximum linear density (BPI)	36080 BPI 27060 FCI	9383	38730 BPI 25820 FCI	38730 BPI 25820 FCI	18766 BPI 12510 FCI
Recording code	1,7 RLL	MFM	2,7 RLL	2,7 RLL	2,7 RLL
Rotational speed (RPM)	3402	3600	3414	3414	3600
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Embedded	Dedicated Surf.	Embedded	Embedded	Dedicated Surf.
Average positioning time (msec)	16	25	16	16	23
Average rotational delay (msec)	8.8	8.3	8.8	8.8	8.3
Average access time (msec)	24.8	33.3	24.8	24.8	31.3
Data transfer rate (KBytes/sec)	5900	625	5000 synch. 1500 asynch.	6000	1250
FIRST CUSTOMER SHIPMENT	4/91	3/85	4/91	4/91	4/86
COMMENTS	25.4 mm high		25.4 mm high	25.4 mm high	

MANUFACTURER	TOSHIBA	TOSHIBA	TOSHIBA	TOSHIBA	TOSHIBA
DRIVE	MK-156FB	MK-186FB	MK-234FB MK-234FBS	MK-234FC MK-234FCH	MK-288FC
DISK/TREND GROUP	5	5	5	5	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	95 mm OD 25 mm ID	95 mm OD 25 mm ID	210 mm OD 100 mm ID
Recording medium	Thin Film	Oxide Coated	Thin Film	Thin Film	Oxide Coated
DRIVE: Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	SCSI	SMD	SCSI	PC AT	Modified SMD
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	F: 152.1	U: 165.9	F: 106.0	F: 106.0	U: 510.3
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 18,432	U: 20,160	F: 17,920	F: 17,920	U: 41,340
Data surfaces per spindle	10	10	7	7	15
Heads per data surface	1	1	1	1	1
Tracks per surface	830	823	856	856	823
Track density (TPI)	900	900	1100	1100	765
Maximum linear density (BPI)	18766 BPI 12510 FCI	9000 BPI 6000 FCI	28443 BPI 18962 FCI	28443 BPI 18962 FCI	19300 BPI 12867 FCI
Recording code	2,7 RLL	2,7 RLL	2,7 RLL	2,7 RLL	2,7 RLL
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
Servo type	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.
Average positioning time (msec)	23	18	25	25	18
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	26.3
Data transfer rate (KBytes/sec)	1250	1210	1500	4000 (FC) 6250 (FCH)	2480
FIRST CUSTOMER SHIPMENT	9/86	4Q83	1Q89	1Q89	4/86
COMMENTS			41.3 mm high MK-234FBS has 19 msec. average positioning time	41.3 mm high	

MANUFACTURER	TOSHIBA	TOSHIBA	TOSHIBA	WESTERN DIGITAL	WESTERN DIGITAL
DRIVE	MK-358FA	MK-358FB	MK-438FD	WDAB130 Tidbit	WDAB140 Tidbit II
DISK/TREND GROUP	7	7	7	3	3
MARKET	Captive, OEM	Captive, 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	65 mm OD 20 mm ID	65 mm OD 20 mm ID
Recording medium	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
DRIVE: Heads	Ferrite	Ferrite	Thin Film		Thin Film
Interface	ESDI	SCSI	SCSI-2	PC AT/XT	PC AT
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	U: 765	F: 675.3	F: 867	F: 31.4	F: 42.5
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 31,248	F: 26,624	*	*	*
Data surfaces per spindle	15	15	15	2	2
Heads per data surface	1	1	1	1	1
Tracks per surface	1661	1661	1655	1065	1405
Track density (TPI)	1450	1450	1708	1773	2463
Maximum linear density (BPI)	32200 BPI 24150 FCI	32200 BPI 24150 FCI	40900 BPI 30675 FCI	35970 BPI 23980 FCI	36048 BPI 24032 FCI
Recording code	1,7 RLL	1,7 RLL	1,7 RLL	2,7 RLL	2,7 RLL
Rotational speed (RPM)	3600	3600	3600	3383	3383
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Embedded	Embedded
Average positioning time (msec)	16	16	12.5	19	16
Average rotational delay (msec)	8.3	8.3	8.3	8.8	8.8
Average access time (msec)	24.3	24.3	20.8	27.8	24.8
Data transfer rate (KBytes/sec)	1875	5000 synch. 1500 asynch.	10000 synch. 3000 asynch.	4500	4500
FIRST CUSTOMER SHIPMENT	4Q89	4Q89	4Q91	1Q91	4Q91
COMMENTS			41.3 mm high *Varies by zone	15.3 mm high *Varies by zone	15.3 mm high *Varies by zone

MANUFACTURER	WESTERN DIGITAL	WESTERN DIGITAL	WESTERN DIGITAL	WESTERN DIGITAL	WESTERN DIGITAL
DRIVE	WDAC140 Caviar I	WDAC160 Caviar II	WDAC280 Caviar I	WDAH260 Tidbit	WDAH280 Tidbit II
DISK/TREND GROUP	3	4	4	4	4
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	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	65 mm OD 20 mm ID	65 mm OD 20 mm ID
Recording medium	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
DRIVE: Heads	Ferrite	Thin Film	Ferrite		Thin Film
Interface	PC AT	PC AT	PC AT	PC AT/XT	PC AT
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	F: 42.5	F: 62.0	F: 85.1	F: 62.8	F: 85.2
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 19,968	*	F: 19,968	*	*
Data surfaces per spindle	2	2	4	4	4
Heads per data surface	1	1	1	1	1
Tracks per surface	1079	1349	1079	1065	1405
Track density (TPI)	1401	1712	1401	1773	2463
Maximum linear density (BPI)	31576 BPI 21057 FCI	33666 BPI 22444 FCI	31576 BPI 21057 FCI	35970 BPI 23980 FCI	36048 BPI 24032 FCI
Recording code	2,7 RLL	2,7 RLL	2,7 RLL	2,7 RLL	2,7 RLL
Rotational speed (RPM)	3598	3600	3598	3383	3383
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Embedded	Embedded	Embedded	Embedded	Embedded
Average positioning time (msec)	18	15	18	19	16
Average rotational delay (msec)	8.2	8.3	8.2	8.8	8.8
Average access time (msec)	26.2	23.3	26.2	27.8	24.8
Data transfer rate (KBytes/sec)	4000	4500	4000	4500	4500
FIRST CUSTOMER SHIPMENT	4/90	6/91	4/90	1Q91	4Q91
COMMENTS	25.4 mm high	25.4 mm high *Varies by zone	25.4 mm high	19 mm high *Varies by zone	19 mm high *Varies by zone

MANUFACTURER	WESTERN DIGITAL	WESTERN DIGITAL	WESTERN DIGITAL	WESTERN DIGITAL	WESTERN DIGITAL
DRIVE	WDAP4200 Piranha	WDNC2120 Caviar II	WDSP4200 Piranha	WDSC8320 Condor	WDSC8400 Condor
DISK/TREND GROUP	5	5	5	6	6
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
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	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
DRIVE: Heads	Thin Film	Ferrite	Thin Film	MIG	MIG
Interface	PC AT	PC AT	SCSI-2	SCSI-2	SCSI-2
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	F: 212.3	F: 125	F: 209.8	U: 371 F: 320.1	U: 467 F: 400
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 20,480	*	F: 20,480	F: 24,576	F: 24,576
Data surfaces per spindle	8	4	8	14	14
Heads per data surface	1	1	1	1	1
Tracks per surface	1280	1349	1280	949	1199
Track density (TPI)	1557	1712	1557	1201.5	1469
Maximum linear density (BPI)	35574 BPI 23716 FCI	33666 BPI 22444 FCI	35574 BPI 23716 FCI	37341 BPI 28006 FCI	38427 BPI 28820 FCI
Recording code	2,7 RLL	2,7 RLL	2,7 RLL	1,7 RLL	1,7 RLL
Rotational speed (RPM)	3610	3600	3610	4317.8	4317.8
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Embedded	Embedded	Embedded	Dedicated Surf.	Dedicated Surf.
Average positioning time (msec)	15	15	15	12.5	11.5
Average rotational delay (msec)	8.3	8.3	8.3	6.95	6.95
Average access time (msec)	23.3	23.3	23.3	19.45	18.45
Data transfer rate (KBytes/sec)	5000 synch.	4500	5000 synch.	4000 synch. 2000 asynch.	5000 synch. 2000 asynch.
FIRST CUSTOMER SHIPMENT	11/90	6/91	7/90	8/89	7/90
COMMENTS	41.3 mm high	25.4 mm high *Varies by zone	41.3 mm high	41.3 mm high Manufactured by IBM	41.3 mm high Manufactured by IBM

MANUFACTURER	ZENTEK	ZENTEK	ZENTEK	ZENTEK	
DRIVE	ZH 3100	ZH 3140	ZH 3380	ZH 3490	
DISK/TREND GROUP	4	5	6	6	
MARKET	OEM, PCM	OEM, PCM	OEM	OEM	
MEDIA: Generic type	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	
Recording medium	Thin Film	Thin Film	Thin Film	Thin Film	
DRIVE: Heads	MIG	MIG	Thin Film	Thin Film	
Interface	PC AT, SCSI	PC AT, SCSI	PC AT, SCSI	PC AT, SCSI	
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	F: 86	F: 121	F: 332	F: 427	
REMOVABLE	--	--	--	--	
Capacity per track (Bytes)	F: 17,408	F: 17,408	F: 31,586	F: 31,586	
Data surfaces per spindle	3	4	7	9	
Heads per data surface	1	1	1	1	
Tracks per surface	935	935	1495	1495	
Track density (TPI)	1300	1300	1750	1750	
Maximum linear density (BPI)	27500 BPI 18333 FCI	27500 BPI 18333 FCI	38880 BPI 29160 FCI	38880 BPI 29160 FCI	
Recording code	2,7 RLL	2,7 RLL	1,7 RLL	1,7 RLL	
Rotational speed (RPM)	3600	3600	3600	3600	
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	
Servo type	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	Dedicated Surf.	
Average positioning time (msec)	20	20	12	12	
Average rotational delay (msec)	8.3	8.3	8.3	8.3	
Average access time (msec)	28.3	28.3	20.3	20.3	
Data transfer rate (KBytes/sec)	1250	1250	5000 synch. 1500 asynch.	5000 synch. 1500 asynch.	
FIRST CUSTOMER SHIPMENT	3Q91	3Q91	10/91	10/91	
COMMENTS	41.3 mm high	41.3 mm high	41.3 mm high	41.3 mm high	

MANUFACTURER PROFILES

1991 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 "1990 disk sales" refers only to the DISK/TREND estimate of moving head rigid disk drive sales for the calendar year -- no sales of other drive types are included, nor are sales of parts or other related products such as controllers. "1990 total net sales" covers the fiscal year ending December 31, 1990, for each firm unless noted otherwise, or for the parent company if the disk drive manufacturer is a subsidiary that does not report financial data separately. 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 rates for 1990 are used, as reported by the U.S. Federal Reserve Bulletin, and rounded to three significant figures, except that the exchange rate for the Brazilian Cruzeiro which fluctuates widely and which is not covered by the Federal Reserve Bulletin, has been averaged from several published sources.

Country	Currency	Currency units per U.S. dollar
Brazil	Cruzeiro	90.0
France	Franc	5.447
Italy	Lira	1198.27
Japan	Yen	145.0
South Korea	Won	710.64
Taiwan	Dollar	26.918
United Kingdom	Pound	0.561
Germany	Deutsch mark	1.617

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 millisecond average access time, achieved by using 10 heads per data surface. The drive transfers data through 8 parallel channels, achieving a 15 megabyte/second data transfer rate.

AMPEX CORPORATION
401 Broadway
Redwood City, CA 94063

After having manufactured OEM disk drives for 15 years, the firm's small remaining market share became unprofitable, and most production was 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.

AREAL TECHNOLOGY, INC.
2075 Zanker Road
San Jose, CA 95131

Areal Technology was founded in February, 1988 by Jack Swartz, an industry veteran and cofounder of Maxtor. The initial target was development of a 3.5" single disk 105 megabyte drive for production start in the fourth quarter of 1989, followed by a 200 megabyte drive later. A 2.5" 50 megabyte drive was also announced. The drives were to be among the first to use glass substrates. Nippon Sheet Glass is one of Areal's major investors. In 1990, management reorganizations resulted in Swartz leaving the company, along with the 3.5" development effort. Areal is now concentrating on 2.5" drives and moved into a new facility in mid-1990. The firm has entered into an agreement with Sanyo Electric to produce Areal's drives in Japan at its Tottori facility, and Sanyo has acquired an equity position in Areal. Production of a 2.5" single disk 62 megabyte drive began at Areal's factory and at Sanyo in 1991. 120 and 180 megabyte two platter drives were announced in the second half of 1991, with production scheduled for 1992.

ATASI TECHNOLOGY INC.
2323-B Owen Street
Santa Clara, CA 95054

Atasi Technology (no relation to the original Atasi Corporation except for a few employees in common) is following an end-of-life strategy, acquiring the rights to manufacture older disk drive designs and manufacture them as long as demand holds up. Atasi Technology started by purchasing rights to manufacture Priam's 5.25" 190 and 380 megabyte drives and the original Atasi 85 megabyte drive in 1989. Only the Priam designs are currently in production. Atasi Technology's production facilities are in Taiwan and in India. The Indian production is done by Bangalore Disc Tech, which manufactures components that are assembled into drives by Atasi Technology's subsidiary in Taiwan.

AURA ASSOCIATES
12930 Saratoga Avenue
Saratoga, CA 95070

Aura Associates, founded by industry veterans in mid-1986, initially planned to develop a 2.5" drive using multiple actuators and offering very fast access time and transfer rate. An early model of the drive was demonstrated at the 1988 Fall Comdex, but an actual production start up will depend on additional financing. Recent efforts have been aimed at producing a 1.8" drive in conjunction with a Japanese company.

BRAND TECHNOLOGIES, INC.
9559 Irondale Avenue
Chatsworth, CA 91311

Brand Technologies was formed in 1986 by Avi Brand, a veteran of Pertec and Computer Memories, to develop voice coil 5.25" drives. The firm acquired rights to some of CMI's tooling and equipment to speed up the development process for its own drives, and first shipments began in early 1987. Initial products included 85 and 128 megabyte full-size drives. In mid-1987, Brand concluded an agreement with Hyosung Computer, a Korean firm, in which Hyosung obtained a minority interest in Brand and agreed to manufacture drives for Brand in Korea and distribute the drives in the Far East on an exclusive basis. The severe drop in industry pricing levels for 85 megabyte 5.25" drives which occurred in 1988, made distribution in the U.S. impractical, and Brand ceased production of 5.25" drives. The company began production of several models of 3.5" drives in the 170 megabyte to 226 megabyte range in mid-1990, and is now concentrating on the 200 megabyte models.

CARDIFF PERIPHERALS CORPORATION
5421 Avenida Encinas
Carlsbad, CA 92008

Cardiff Peripherals has carried on several years of product development activity, under several organizational and financing arrangements, after being founded by industry veteran Frank Lutz -- first with 5.25" drives, later with 3.5" drives. The firm announced high performance 3.5" drives with up to 127 megabytes capacity in 1987, but that program has been dropped due to component delays and other problems. New 3.5" drives with up to 347 megabyte capacity have now been announced, and the firm is attempting to establish a suitable manufacturing arrangement in Asia.

CERPLEX TECHNOLOGIES
3332 La Palma
Anaheim, CA 92806

Cerplex is the renamed successor of Century Data, Inc. After several years of flat sales, Century Data Systems was sold in mid-1986 by Xerox, and in a complicated restructuring involving Cybernex, the previous thin film head manufacturer, evolved into Century Data, Inc., combining the operations of Century Data Systems, Cybernex Advanced Storage Technology (CAST), Amcodyne, Tecstor, and Ford-Higgins, a subsystem producer. The Century product line had been in transition for years, as newer fixed disk drives gradually replaced products in production before the acquisition by Xerox in 1979. Century pinned its hopes on higher capacity 8" drives with sales emphasis primarily on plug compatible subsystems for the DEC add-on market. The design of the CAST 5.25" product line was licensed in 1988 to Magtron, a Taiwanese start-up producer of disk drives. The change of company name in 1990 reflects another corporate reorganization and a new emphasis on drive refurbishment as a primary line of business, although a few 8" disk drives remain in production at a low level.

CONNER PERIPHERALS, INC.
3081 Zanker Road
San Jose, CA 95134

1990 disk sales: $1,337,300,000
1990 Total net sales: $1,337,593,000 Net income: $130,052,000

By any measure, the rapid growth of Conner Peripherals remains one of the industry's outstanding success stories. The firm is headed by Finis Conner, cofounder of Seagate Technology, and the first product was designed by a development company organized by John Squires, who was a key member of the Miniscribe technical staff until early 1985. Shortly after its founding, the company attracted a minority investment by Compaq Computer and built a production facility to make 3.5" 40 megabyte drives. By

mid-1987, shipments, mostly to Compaq, had reached high levels, and facilities were rapidly expanded. In addition to adding another facility at the original site, Conner established high volume production in Singapore, and in 1989 moved into a new headquarters building. Conner also entered into a joint venture with Olivetti, resulting in construction of a new manufacturing facility in Italy which makes a portion of the Conner product line for captive use by Olivetti and for OEM sale in Europe. Conner increased its share of ownership from 51% to 81% in 1990. Conner also established an additional wholly owned factory in Scotland in 1990. Sales to Compaq have declined to about 15% of the Conner total in recent quarters, reflecting continued success in attracting new OEM business.

By mid-1990, Conner's 3.5" product line had expanded to drives of 544 megabytes capacity, and included 1" and 3/4" high 3.5" drives to 212 megabytes capacity. Conner's 2.5" drives, available early in 1990 in production quantities, extended to 85 megabytes as of mid-1991. Because of the firm's early entrance into the 2.5" market, combined with the ability to deliver large quantities of drives, Conner has achieved a major share of the market for hard disk drives in the notebook computer market.

While Conner Peripherals has indicated its desire to concentrate upon drive assembly rather than become vertically integrated, the firm has made acquisitions of what it believes are key technologies, including the sputtered disk production facilities of bankrupt Domain Technology and a recent purchase of VISqUS Corporation, a development firm working on a method of near-contact recording using a continuous lubrication technique. Conner has sold off its head stack assembly operation, suggesting that vertical integration will be limited to what Conner considers critical strategic component technologies and that the firm will continue to rely on outside procurement of most components.

DIGITAL EQUIPMENT CORPORATION
146 Main Street
Maynard, MA 01754

1990 disk sales: $1,195,500,000
1990 total net sales: $12,942,523,000 (FY ending 7/01/90) Net income: $74,393,000

Digital has maintained internal disk drive manufacturing programs for more than 20 years, initially with disk cartridge drives, but did not venture into designing their own high end drives until 10 years ago. The RA80 series of 14" drives, now out of production, was followed in 1988 by the 9" RA90 series, now approaching end-of-life. The RA70 series of 5.25" drives, also first produced in 1988, have become Digital's highest volume disk drives. In recent years Digital has also been a major customer for OEM 5.25" and 3.5" SCSI drives for use with its engineering workstation systems.

In a major departure from its previous policy of limiting its disk drive activities to captive programs, Digital announced an OEM marketing program

for new high end 5.25" and 3.5" drives in late 1991. The new 2.0 gigabyte 5.25" drive is produced at Digital's manufacturing facility in Kaufbeuren, Germany, and the 852 megabyte 3.5" drive is manufactured at Colorado Springs, with both drives using Digital's internally manufactured thin film heads. The new drives are only the first sample of a renewed Digital effort to stay with the industry leaders in 5.25", 3.5" and 2.5", with reorganized management and manufacturing organizations, and utilizing vertical integration in production of critical components.

DMA TECHNOLOGIES
601 Pine Avenue
Goleta, CA 93117

DMA Systems started shipments of its 5.25" 5/5 megabyte 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. Manufacturing licenses were sold to Memorex and Newbury Data, both of which later discontinued all OEM disk drive operations, and also to Ricoh and MFM, which are both still producing disk cartridge 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 restarted operations as DMA Technologies. A 25.5 megabyte half high drive with removable media was announced in mid-1988.

ECOL.2
421 School Street
Point Arena, CA 95468

After leaving Areal Technology in 1990, Jack Swartz, its founder, started Ecol.2 (short for "Ecology 2000") to work on what is hoped will be the industry's first disk drive using a single 3.5" disk with a capacity of 200 megabytes. The drive will use thin film heads, glass disks and be enclosed in a plastic HDA.

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

1990 disk sales: $402,200,000
1990 total net sales: $13,200,000,000 (FY ending 10/31/90) Net income: $739,000,000

Hewlett-Packard has an extensive manufacturing operation for captive disk drives at Boise, Idaho, established in 1977, supplemented in mid-1983 with a facility in Bristol, England, and by production of 3.5" Winchester

drives at Greeley, Colorado. H-P has made disk cartridge, disk pack, and fixed Winchester disk drives at Boise, which is also the firm's development and manufacturing facility for sputtered disks. During 1987, H-P introduced 5.25" drives with capacities up to 389 megabytes and 8" drives with up to 571 megabytes. Also during 1987, the company launched an OEM sales program for rigid disk drives, spearheaded by the new 5.25" models. The OEM program has proved to be successful for H-P, and the product line has been expanded to include new 5.25" drives with capacities over 2 gigabytes. As of mid-1991, the 3.5" line extended to 422 megabytes. In 1989, H-P startled the industry by announcing 150,000 hour MTBF and a five year warranty for its 5.25" drives, an action which substantially improved H-P's visibility in the OEM market. The MTBF specification on the newest high end 5.25" drives has been extended to 300,000 hours.

IBIS SYSTEMS, INC.
4197 Calle Tesoro
Camarillo, CA 93010

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. 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 data transfer version of the drive.

This plan resulted in Ibis' leadership in parallel transfer drives used with supercomputers and high-end imaging systems, but also exposed Ibis to the ups-and-downs of a volatile marketplace. The firm was forced to cut back employment sharply in 1989 and has consolidated into smaller facilities. Production of disk drives was curtailed in favor of development of subsystems using purchased disk drives. Production of new disk drives ceased in 1990, but the firm is repairing and refurbishing existing drives.

INTEGRAL PERIPHERALS
5775 Flatiron Parkway
Boulder, CO 80301

Integral Peripherals was founded in September, 1990, by engineering and management personnel who previously pioneered in early 2.5" drives at PrairieTek. The company plans to design and manufacture the first 1.8" disk drives. Its initial products are a 20 megabyte drive for which deliveries are planned in 1991 and a 40 megabyte model for which first deliveries are scheduled for the second quarter of 1992. Both 1.8" drives will use ramp loaded MIG heads, and are designed to high operating shock and vibration specifications and low power requirements, in anticipation of

wide usage in sub-notebook computers and other portable computer applications. Integral plans to do its high volume manufacturing in Singapore, starting in mid-1992.

INTERNATIONAL BUSINESS MACHINES CORPORATION
Route 22
Armonk, NY 10504

1990 disk sales: $11,979,100,000
1990 total net sales: $69,018,000,000 Net income: $6,020,000,000

In July, 1990, IBM created the new Storage Systems Products Division, encompassing the previous General Products Division, which held responsibility for more than twenty years for disk and tape drives for mainframe applications, and Low End Disk Operations, established during the 1980's to coordinate IBM's worldwide development and manufacturing operations for disk drives used in personal computers and mid-range systems.

IBM manufactures 14", 10.8", 8", 5.25", 3.5" and 2.5" fixed disk drives at several factories in the United States, Europe, Japan and Brazil. The firm's disk drive revenue leader is clearly high-end drives for mainframe computers, now primarily the 3390, supplemented by 5.25" models. After a flurry of activity during the first half of the 1980's resulted in various 14", 8", 5.25" and 3.5" drives without much distinction, IBM in the last three years introduced several drives which place it in the first tier of mid-range and low-end disk drive manufacturers. These include the 1 gigabyte 3.5" "Corsair", 5.25" 857 megabyte "Redwing" and 1/1.5 gigabyte "Sutter/Sawmill", 1" high 3.5" "Kai" 100 and 200 megabyte drives, and new "Tanba" 2.5" drives, including a .5" high single disk 43 megabyte model introduced in 1991. The venerable 3380 series is scheduled for withdrawal from marketing in March, 1992.

IBM's first significant OEM sales of disk drives were made in 1984, when the firm began selling the 3380 to both Siemens and Honeywell. Some low end 3.5" drives with Microchannel interfaces have been sold to European system manufacturers who chose to offer personal computer models with the Microchannel bus. For disk drives broadly sold on an OEM basis, it has been more difficult for IBM to establish a significant OEM disk drive business, due to tough competition and a rapidly changing market. Despite the difficulties, IBM has had some success in marketing its low-end 3.5" diameter drives in the personal computer aftermarket through distribution. Since mid-1989, the "Lightning/Turbo" 320/400 megabyte 3.5" drive has been resold by Western Digital in the OEM market and through distribution, and has been offered by System Industries in a DEC add-on subsystem. The most important OEM disk drive sale so far for IBM has apparently been a by-product of the newly inspired spirit of cooperation between IBM and Apple Computer -- the planned purchase of 160 megabyte 3.5 "Kazusa" drives by Apple.

KALOK CORPORATION
1287 Anvilwood Avenue
Sunnyvale, CA 94089

1990 disk sales: $75,500,000

Kalok was founded in 1987 by Wayne Lockhart and Steve Kaczeus, a well-known designer of low-end disk drives, to participate in the market for 20 and 40 megabyte 3.5" drives, designed for very low manufacturing cost. Unable to obtain adequate funding from U.S. venture capital sources, the firm negotiated a manufacturing and inventory financing arrangement with Oriental Precision Company of South Korea. OPC started manufacturing Kalok drives in mid-1988 with substantial shipment levels. In order to broaden its production base, Kalok also established a plant in the Philippines, the first hard disk drive producer to do so. Shipments from this facility began in late 1989, but Kalok continued its manufacturing arrangements with OPC, although a change in OPC's ownership in 1991 substantially reduced that firm's commitment to the disk drive business. A 105 megabyte 3.5" drive was added to the product line in 1991.

MAXTOR CORPORATION
150 River Oaks Parkway
San Jose, CA 95134

1990 disk sales: $779,500,000
1990 total net sales: $871,305,000 (FY ending 3/31/91) Net income: ($45,429,000)

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 megabyte capacities while maintaining the standard Seagate transfer rate of five megabits per second -- a strategy which proved successful 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 interface standard, initially widely used for high performance 5.25" drives.

Maxtor maintained its place in the spotlight by announcing a 760 megabyte 5.25" drive, with first shipments in 1987. A 3.5" drive with 200 megabyte capacity was announced in 1988, along with a magneto-optical 5.25" drive produced by a joint venture with Kubota, maintaining the Maxtor role as a leading edge supplier of OEM disk drives. In 1990, Maxtor acquired the Miniscribe product line and manufacturing facilities, providing the firm with a 1" high 3.5" drive product line extending from 40 to 130 megabytes and a 2.5" 85 megabyte drive that was announced in the third quarter of 1991. The departure of several key employees had some impact following the company's management changes in mid-1987, but Maxtor appeared to

return to a growth track when the firm announced 5.25" drives with up to 2.1 gigabyte capacity, and became the first company to announce a 3.5" drive with more than 500 megabytes capacity. However, Maxtor was unable to move the new products rapidly into manufacturing, with a severe negative financial impact, and resulting in further management changes and substantial consolidation of manufacturing facilities in Singapore. The company is currently attempting to reestablish the leading edge product development programs that created its original success, while cutting costs wherever possible to keep its lenders happy.

MEMOREX TELEX CORPORATION
Subsidiary of Memorex/Telex N.V.
4343 S. 118th East Avenue
Tulsa, OK 74146

The pioneer magnetic media and plug compatible disk drive producer originally known as Memorex Corporation was acquired by Burroughs in late 1981, and Burroughs placed all disk drive development and manufacturing responsibility for the entire company in the Memorex organization. In late 1986, however, Burroughs sold the disk drive sales and service operations of Memorex to a group of Memorex executives, retaining only the rigid disk development and manufacturing operations. Telex was acquired by Memorex in early 1988 and the firm adopted its new name. Plug compatible disk drive subsystems now sold and serviced by Memorex Telex use various drive mechanisms manufactured by Fujitsu and Seagate. Memorex, now headquartered in Europe, includes PCM marketing operations, the Memorex Communications Division, and the flexible media operations. The firm is under financial stress, and in mid-1991 announced that it would enter a "prepackaged bankruptcy" arrangement in the Fall of 1991.

MFM TECHNOLOGY, INC.
North Andover, MA 01845

MFM started manufacturing 5.25" disk cartridge drives in 1985 under license from DMA Systems. The firm had previously been involved in providing service for DMA drives, and offered controller development services. A 24 megabyte version of the drive was introduced in 1987.

MICROPOLIS CORPORATION
21123 Nordhoff Street
Chatsworth, CA 91311

1990 disk sales: $368,000,000
1990 total net sales: $380,572,000 Net income: $7,926,000

Known as the originator of what were then considered 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 became 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 170 megabytes, and a close contender for leadership at 380 megabytes, 760 megabytes, and the 1-2 gigabyte range. A half high 180 megabyte drive was announced in late 1987 but suffered production delays during most of 1988. Heavy price competition in lower capacity "cash cow" products and delays in getting newer products into volume production hurt Micropolis' financial results during the last several years and the firm had to cancel its 3.5" development program in order to concentrate on 5.25" drives. After returning to profitability in 1990, Micropolis reentered the 3.5" drive market in 1991 with the first announced 1 gigabyte 3.5" drive.

MICROSCIENCE INTERNATIONAL CORPORATION
90 Headquarters Drive
San Jose, CA 95134

1990 disk sales: $76,700,000
1989 total net sales: $81,666,000 Net income:($7,820,000)

Microscience International, incorporated in 1982, started shipments in mid-1983 for its half high 5.25" drive using plated disks. 3.5" drives were later added to the line, including both OEM and card-mounted versions. Microscience introduced a half high voice coil 5.25" drive with 50 megabytes capacity in early 1986, followed by drives with up to 144 megabytes capacity. A shift in customer demand from 5.25" drives to 3.5" drives hampered growth in 1989, but newer 3.5" drives with capacities to 420 megabytes have been introduced in 1990 and 1991. In 1990, Microscience also expanded its product line by purchasing the rights to manufacture and market the Siemens 5.25" 777 megabyte and 1.2 gigabyte drives. Microscience has established a joint venture, Microscience Shenzen, in the People's Republic of China. Operations began in October of 1990. The firm also joined with Wearnes Brothers, Ltd., to establish a manufacturing facility in Singapore, now in production, and started its own production in Taiwan in 1987 for voice coil drives. Wearnes Brothers is a major investor in Microscience, owning 20% of the U.S. based parent and 59% of Microscience International (Singapore) Ltd. Microscience weathered a management change in 1987, and in 1990 became a publicly owned company. Additional management changes in early 1991 were followed by transfer of all manufacturing to the overseas facilities.

MILTOPE CORPORATION
1770 Walt Whitman Road
Melville, NY 11747

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" models incorporating heads and media in removable cartridges. In 1988, Miltope acquired the disk drive product line of Vermont Research.

MINISTOR PERIPHERALS CORPORATION
2801 Orchard Parkway
San Jose, CA 95134

Founded in 1991 by former Maxtor executives and funded by seed money from venture capitalists, Ministor is developing 1.8" diameter drives, still unannounced. The firm expects to be in production in 1992.

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

1990 disk sales: $59,100,000
1990 total net sales: $6,768,700,000 Net income: $436,000,000

Northern Telecom's Memory Systems Division in Ann Arbor, Michigan, once a growing manufacturer of high performance 8" Winchester drives, has been closed down in 1991. The drives were used for captive applications with Northern Telecom and were supported with an active OEM sales program. In September, 1989, Northern Telecom announced its long-awaited new drives using perpendicular recording, with heads and disks from Censtor, and offering capacities up to 2.2 gigabytes. However, in 1990 Northern Telecom decided that disk drive manufacturing did not fit the firm's strategic direction and elected to shut down production in 1991.

ORCA TECHNOLOGY
1751 Fox Drive
San Jose, CA 95131

Formed in July, 1990, Orca was founded by executives from Maxtor, Priam and Televideo. Orca purchased the rights to manufacture the 3.5" "Shrike" 400 megabyte drive that had been under development by Priam before Priam's demise, as well as rights to the Priam 5.25" 760 megabyte "Falcon" drive, and a considerable amount of Priam's tooling, inventory and fixtures. The firm arranged for manufacture of the 5.25" drives starting in 1991 by Magtron in Taiwan, with sales by both Orca and Magtron, and for production of 3.5" drives by Zentek, with first production scheduled in late 1991. Efforts are also under way to establish production facilities in Eastern Europe that will start up in 1992.

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 and in 1987 by a 40 megabyte model. 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.

The Hardcard 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, but Plus has maintained market leadership through alert marketing and new product introductions, plus competitors' concern about Plus' patent holdings. Saturation of the market for the lower capacity Hardcard models has resulted in Plus adopting a more aggressive pricing strategy and introducing higher capacity drives. The company is also moving towards becoming a general supplier of storage products to the aftermarket. In 1991, Plus was folded into Quantum Commercial Products, a Quantum subsidiary formed to address the reseller market.

PRAIRIETEK CORPORATION
1830 Lefthand Circle
Longmont, CO 80501

1990 disk sales: $38,400,000

Prairietek was established in 1986 by Terry Johnson, founder of Miniscribe, and announced the first of a new breed, the 2.5" rigid disk drive, in late 1988. The capacity of the initial drive was 20 megabytes, with an average 28 millisecond seek time. PrairieTek also announced in late 1989 a follow-on 40 megabyte model, achieved by increasing the capacity on each of two disks to 20 megabytes.

Laptop computers were the initial target market for PrairieTek, with drive height set at 1", but the product achieved little market penetration due to dominance of the laptop market by Conner Peripheral's 1" high 3.5" drives. At Fall Comdex in 1989, the firm announced a 2.5", 20 megabyte drive only 15.4 millimeters high, with a manufacturing arrangement with Alps Electric, in order to launch a new sales campaign, this time aimed at the notebook computer market.

Even though Alps started production in 4th quarter of 1990, the market

shifted again, this time from 20 megabyte 2.5" drives to those with 30-40 megabytes capacity, and PrairieTek's single platter 40 megabyte drives wasn't ready yet. The firm was unable to raise sufficient cash to continue, and ceased operations in the summer of 1991.

QUANTUM CORPORATION
1804 McCarthy Boulevard
Milpitas, CA 95035

1990 disk sales: $710,100,000 (including Plus Development)
1990 total net sales: $877,733,000 (FY ending 3/31/91) Net income: $73,881,000

Quantum's original strategy was to manufacture a low-cost upgrade to the Shugart Associates 8" Winchester drives. The Quantum plan worked 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. First shipment of these drives was late, however, and Quantum's sales growth flattened out.

In 1985, the company established Plus Development as a wholly owned subsidiary, to pioneer development and marketing of unique 3.5" drives for the personal computer market. Growth in shipments of OEM drives resumed in 1987 and 1988, due to the success of new 3.5" drives. Production of 5.25" drives ended in 1989.

While Quantum has designed all of its 3.5" drives, manufacturing of low-end models is done in Japan by Matsushita-Kotobuki Electronics. MKE has rights to distribute the drives it manufactures within Japan, under a Quantum license. High-end 3.5" drives are manufactured in a new, highly automated facility in California. European production is planned in the future. The Quantum-MKE relationship is considered very successful and has contributed to the higher than industry average margins typically enjoyed by Quantum. Quantum's OEM products now include 3.5" drives from 42 to 425 megabytes (formatted) capacity with SCSI and PC/AT interfaces. 2.5" 42 and 86 megabyte drives were introduced in September, 1990, and began shipping in mid-1991. Quantum has emphasized drive intelligence, including such features as selftesting and cache.

In 1991, Quantum further strengthened its efforts to increase sales through distribution, folding Plus Development and its industrial distribution activities into a business unit named Quantum Commercial Products. Quantum also operates a direct marketing subsidiary, LaCie Ltd., which has been attached to the new business unit. About 30% of Quantum's revenue comes from distribution.

SEAGATE TECHNOLOGY
920 Disc Drive
Scotts Valley, CA 95066

1990 disk sales: $2,643,400,000
1990 total net sales: $2,413,178,000 Net income: $117,241,000
(FY ending 6/30/90)

In 1981, Seagate shipped two thirds of the 5.25" drives produced worldwide, with 35,000 units -- and another de facto standard was created. Seagate took 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 stayed profitable, rebuilt its revenues, and starting in 1986 became the worldwide leader in OEM disk drive revenues.

After 1985, a major part of Seagate's growth came from the personal computer aftermarket. IBM cut back purchases of Seagate drives in favor of internal captive production, but Seagate launched a successful campaign to take the business away from IBM at the dealer level, with phenomenal success. But the company was vulnerable to IBM's "bundling" hard disk drives with systems at the factory instead of giving dealers an easy opportunity to upgrade with independent disk drives. The effect of this bundling, plus Seagate's late arrival in the 3.5" marketplace, cut into Seagate's shipment rate. The firm overestimated the market in early 1988, causing excess inventory accumulation and disappointing financial results. However, Seagate demonstrated the resiliency likely to be necessary for future survival, and after an unprofitable 1988 winter quarter, returned to profitability in 1989. However, the economic recession of 1990-91 and Seagate's aging product line for the personal computer market again resulted in flattening revenues and the expectation of further losses.

In October, 1989, Seagate completed an agreement with Control Data to acquire Imprimis Technology in a deal valued at $450 million. There was little overlap between the product lines of Seagate and Imprimis, or between Seagate's predominantly aftermarket distribution and Imprimis' predominantly OEM sales. The Imprimis headquarters function has been completely integrated into Seagate's, and operational control of products and manufacturing has now been divided into "California" and "Oklahoma" operations.

The new Seagate has maintained an aggressive pace of product development and market leadership with the high end 5.25" and 3.5" drives developed at the Oklahoma operations. But because its older 5.25" drives were fading fast, and in order to improve penetration of the OEM market for its small diameter products, Seagate has undertaken a "time to market strategy" in an attempt to catch up with the industry leaders in the 2.5" and low end 3.5" markets. In late 1991, the company remains committed to maintaining its role as the industry's largest independent drive manufacturer, and has made key changes in executive management in an attempt to reassert product leadership.

SEQUEL, INC.
2300 Central Expressway
Santa Clara, CA 95054

Sequel was created in November, 1989 as the result of a management buyout of the Unisys rigid disk drive and media production facilities. Sequel supplies new drives to Unisys as well as refurbishing older drives from Unisys and other manufacturers. The firm also supplies some media on an OEM basis. Shortly after its establishment, Sequel acquired the rights to manufacture several of Priam's product lines. At present, Sequel produces and refurbishes drives in sizes of 8" and larger. Activity in the 5.25" area is confined to repair and refurbishment only.

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

1990 disk sales: $64,400,000
1990 total net sales: $1,140,601,000 Net income: $69,315,000

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 suffered because of the loss of credibility brought on by bankruptcy, but improved with the availability of the STC double capacity 3380 equivalent drive in mid-1986. After a series of complex negotiations with creditors, the firm emerged from bankruptcy in mid-1987.

Orders for STC's innovative 1/2" tape cartridge library system have been strong, and have been instrumental in restoring STC's position in the storage products industry. However, shipments of drives equivalent to IBM's 3380K did not start until 1989, and the firm has never regained its earlier share of the IBM plug compatible market. In 1990, the firm began discussing new products incorporating disk drive arrays to be sold into the PCM marketplace. The low-end of the array product line will incorporate array hardware and software from Array Technology, which will be resold by Storage Technology. The high-end "Iceberg" array project, which uses purchased 5.25" drives, will be available in the first half of 1992.

SYQUEST TECHNOLOGY
47071 Bayside Parkway
Fremont, CA 94538

1990 disk dales: $44,100,000

SyQuest was started in early 1982 to make disk drives using 3.9" (100 mm) plated disks, in both fixed and removable disk configurations. After initial early emphasis on the personal computer aftermarket, SyQuest established significant OEM sales, with major shipments to the segment of the PC market controlled by governmental security requirements. The firm began shipping removable 5.25" drives with formatted capacity of 44 megabytes and embedded SCSI controllers in 1988, achieving significant success in the Macintosh add-on market. In 1989, Syquest began operations in Singapore. The firm established a subsidiary, SyDOS, in 1991 to sell subsystems containing its drives in the IBM PC compatible marketplace. In early 1991, Syquest began shipping an 88 megabyte 5.25" removable drive.

WESTERN DIGITAL CORPORATION
2445 McCabe Way
Irvine, CA 92714

1990 disk sales: $278,200,000
1990 total net sales: $1,070,000,000 (FY ending 6/30/90) Net income: $24,200,000

Western Digital, a major supplier of controllers and specialized semiconductor components, entered the rigid disk drive market by purchasing the rigid disk drive operations of Tandon at the end of 1987. The product line now consists of 3.5" and 2.5" drives in the 30 to 212 megabyte range. The "Tidbit" series of 2.5" drives extending from 30 to 85 megabytes was announced in 1991. Western Digital plans to be a broad-line disk drive producer, and maintains a disk drive development facility in San Jose dedicated to future product designs. In mid-1989, Western Digital started remarketing the IBM "Lightning" 320 megabyte 3.5" drive, later adding the 400 megabyte "Turbo" model.

Asian Manufacturers

(All fiscal years end in March, 1990, unless otherwise noted. Firms are in Japan unless otherwise noted.)

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

1990 total net sales: $2,777,841,000 Net income: $4,903,000

Alps Electric, founded in 1948, is a manufacturer of electronic components and sub-assemblies for television, audio, instruments and computer applications. The firm builds floppy disk drives on an OEM basis, and started production in the U.S. in 1987. In 1988, a facility to make various computer peripherals was established in Ireland. About 15% of Alps' shipments are computer peripherals, mostly floppy disk drives and printers. In 1985, Alps introduced a line of 5.25" half high and 3.5" rigid disk drives and in 1986, Alps became the first manufacturer to announce a 30 mm high 3.5" drive. A 25.4 mm high 20 megabyte drive was announced in 1987, a 50 megabyte version in 1988, and 100 megabyte (formatted) versions in 1990. 20.8 mm high drives in the 40 megabyte range were introduced in 1989 and a 16 mm high version was introduced in 1990.

Alps entered into an agreement with PrairieTek to produce the PrairieTek 2.5" drives on a contract basis, and production under this contract began in 1990. Alps continues to produce the drives, even though PrairieTek has ceased manufacturing operations.

EPSON (See Seiko Epson)

ESPERT CO., LTD. (Previously Peripheral Technology International, Ltd.)
Songnam Building
1358-6 Seocho-dong
Seocho-ku, Seoul
Korea

Peripheral Technology was founded in 1985 to develop a 3.5" drive first shipped in 1986, with founders who had worked together at Dataproducts. 70% of PTI was owned by Haitai International, a Korean consumer products company, but in mid-1987, this interest was sold to Live Systems, a Japanese company serving the medical market and production moved to Korea. In early 1989, control of PTI was assumed by Tongil Machinery Co., a manufacturer of machine tools and auto parts, as a diversification move. In February, 1990, the company was renamed EsPerT. A further change in status occurred in 1991 when the firm was purchased by Daeyoung Electronics Industrial Co., following a financially disastrous year of technical problems with the current EsPerT 41 megabyte 3.5" drive.

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

1990 disk sales: $39,900,000
1990 total net sales: $5,300,703,000 Net income: $95,897,000

Fuji Electric was established in 1923 and is the firm from which Fujitsu was born in 1935. Fuji Electric still owns about 13.5% of Fujitsu (which owns 7% of Fuji Electric). The firm manufactures power generating equipment, electrical equipment for the transportation sector, vending machines and instrumentation. Data storage products include sputtered media (of which Fuji Electric is a significant supplier) and 3.5" disk drives. The firm began selling 3.5" drives under its own name in 1985, but cut back on export sales in 1988, squeezed by exchange rates and low priced competition. 1 inch high 91 megabyte drives were introduced in 1990 and a 43 megabyte 19 millimeter high 2.5" model became available in 1991.

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

1990 disk sales: $1,898,600,000
1990 total net sales: $17,584,641,000 Net income: $598,331,000

Fujitsu derives about 70% of its sales from the computer industry 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 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. Fujitsu is manufacturing some of its high performance drives at a major facility near Portland, Oregon, which is now in full operation, although HDAs are still made in Japan. Intellistor, located in Longmont, Colorado is a Fujitsu subsidiary developing small diameter disk drives and drive arrays. Fujitsu also has 44% ownership in Amdahl.

Fujitsu has marketed most of its captive drives in OEM versions, using industry standard OEM interfaces, and is a leader in the U.S. market for OEM rigid disk drives. Fujitsu is also a major factor in the IBM plug compatible disk drive market with sales first of Eagle series 10.5" drives, and later 8" models, through Amdahl. Particularly effective in the OEM market has been the series of high performance 8" 48/84/168/337/690/824/1000/2000/2600 megabyte drives. Fujitsu's 5.25" product line was extended to 2 gigabytes in 1991, and an extensive 3.5" line ranges from 25 to 513 megabytes. A 90 megabyte 2.5" drive was announced in September, 1991. Fujitsu has joined the "reliability wars" by specifying its high capacity 5.25" and 3.5" drives at 200,000 hours MTBF.

GOLDSTAR TELECOMMUNICATIONS CO., LTD.
20, Yoido-dong
Yongdungpo-gu
Seoul 150, South Korea

1990 total net sales: $244,395,000 Net income: ($39,867,000)

GoldStar Telecommunications is a joint venture between the Lucky GoldStar Group, Siemens, Fuji Electric and DEG, a German firm. The firm's main activities are in telecommunications equipment (76%), computers and peripherals (14.2%) and other electronic equipment (9.8%). GoldStar began manufacturing 3.5" and half high 5.25" rigid disk drives in 1988, but the program remained small.

GREENERY TECHNOLOGY
48 Park Avenue
Science-Based Industrial Park
Hsin Chu
Taiwan

Greenery is producing 3.5" 60 megabyte drives based upon technology developed by ITRI, a government research organization. Production started in late 1990. Additional 3.5" drives with capacities to 105 megabytes have also been announced.

HITACHI, LTD.
4-6 Kanda-Surugadai
Chiyoda-ku, Tokyo 101

1990 disk sales: $1,179,600,000
1990 total net sales: $48,812,793,000 Net income: $1,454,917,000

Hitachi remains Japan's largest manufacturer of electrical and electronic equipment and a major manufacturer of computer systems. The firm currently makes a wide range of Winchester technology fixed disk drives for both captive and non-captive markets. In addition to significant OEM sales of smaller capacity fixed disk drives, Hitachi also sells IBM compatible 3380 equivalent drives through Hitachi Data Systems (formerly National Advanced Systems, before acquisition by Hitachi), and in 1983 started selling 3380 equivalent drives for distribution in the European PCM market through BASF, and currently through Comparex. Hitachi was the first independent disk drive supplier to ship a double capacity drive equivalent to the IBM 3380E, and was an early supplier of 3380K equivalent drives. Current IBM plug compatible drive subsystems utilize Hitachi's 9.5" drives, including a 3390-3 equivalent version announced within a week after IBM's 3390-3 announcement. In the spring of 1987, Hitachi began shipping rigid disk drives from a manufacturing facility in Norman, Oklahoma, which makes high-end rigid drives and a line of 5.25" optical disk drives. Hitachi has announced plans to make large disk drives in France beginning in 1992.

HYOSUNG COMPUTER
Division of Tongyang Nylon Company
183 Hoge-dong
Anyang-si, Kyunggi-do
South Korea

Hyosung was formed in 1979 to help its parent diversify into the computer industry. The firm produces a variety of small systems and specialized terminals. The computers are sold in the U.S. under the Maxar brand. In 1987, Hyosung made a minority investment in Brand Technologies and started production of the Brand full size 5.25" drives, for sale by Hyosung.

JVC (VICTOR COMPANY OF JAPAN, LTD.)
4-8 Nihonbashi-Honcho
Chuo-ku, Tokyo 103

1990 disk sales: $95,200,000
1990 total net sales: $5,976,207,000 Net income $127,055,000

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 consumer electronics now account for 88% of total revenues. Matsushita Electric Industrial holds 52.4% ownership. JVC is now expanding into software and computer peripherals, starting in 1984 with 5.25" floppy disk drives, a program since dropped due to small market share and unfavorable exchange rates. 3.5" rigid drives were first shipped in 1985, and the present 3.5" product line includes 25.4 mm high and 20.8 mm high aimed at the laptop computer market. JVC was an early producer of 20 megabyte 2.5" drives and began shipping 40 megabyte 19 mm high drives in late 1990. JVC and Rodime explored having JVC produce a 120 megabyte drive for Rodime, but the project was dropped.

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

1990 total net sales: $2,903,669,000 Net income: $233,290,000

Kyocera is the world's largest manufacturer of ceramic packages for integrated circuits, and also makes a variety of electronic and optical components. As the result of an investment and manufacturing agreement with LaPine Technology, Kyocera started production in 1986 of LaPine's 3.5" drives and shipped significant quantities until mid-1987. In late 1986, Kyocera and Prudential-Bache, both of which had been minority shareholders in LaPine, purchased the remainder of the firm, with Kyocera obtaining one third ownership and Prudential-Bache two thirds. Due to the shifting exchange rate, Kyocera was not able to meet LaPine's quantity requirements profitably, and a shortfall in shipments occurred. LaPine's operations were subsequently halted, and Kyocera has since been producing the drives

under its own name. In 1990, the firm introduced 40 and 80 megabyte (formatted) 3.5" drives. 120 megabyte 1 inch high 3.5" drives using voice coil actuators were introduced in 1991.

KYUSHU MATSUSHITA ELECTRIC CO., LTD.
4-1-62 Minoshima
Hakata-ku
Fukuoka

1990 total net sales: $1,758,673,000 Net income: $66,188,400

Kyushu Matsushita Electric (KME), a subsidiary of Matsushita Electric Industrial Co. (MEI), was founded in 1951 to supply electrical components for MEI. Its first products were electric transformers and pumps, but the firm has since diversified into factory automation, telecommunication, audio, video and other electric equipment. MEI owns 50.4% of KME.

Perhaps best known in the disk drive industry as one of the world's largest magnetic head suppliers, KME surprised the industry in 1991 when the company introduced a 1" high 210 megabyte 3.5" drive using negative pressure sliders to control head flying height. The drive is scheduled for shipment in the Fall of 1992.

MAGTRON INC.
10F-2, 270 Section 4, Chung Hsiao E. Road
Taipei, Taiwan

Magtron was founded in September, 1988, as Damax, but was subsequently renamed. The firm licensed the CAST 5.25" drive designs and is currently in production at a moderate level. The product line licensed from CAST includes 115, 140, and 170 megabyte half high drives. In 1989, a subsidiary, Pacific/Magtron, was established in the U.S. to market the Magtron products and to serve as a design center for new 40 and 80 megabyte 3.5" drives announced in 1991. Magtron has agreed to make Orca's high capacity 5.25" drives, which range in capacity from 400 megabytes to 1 gigabyte. Production of 400 and 760 megabyte models began in mid-1991, and a 1 gigabyte drive has been announced for delivery in late 1991.

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

1990 total net sales: $2,697,366,000 Net income: $78,979,000

Matsushita Communication Industrial is a member of the Matsushita Electric Industrial group, a worldwide giant in appliances and electronics. MEI holds 56.6% ownership. MCI was the licensee for Shugart Associates' flex-

ible disk drives in Japan. 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. The 3.5" rigid disk product line was extended to 81 megabytes, and MCI entered a joint development agreement with Priam to cooperatively design 3.5" high-end drives. Success proved elusive, and the company ceased production of rigid disk drives in 1990 except for fulfillment of existing customer commitments.

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

1990 total net sales: $1,639,117,000 Net income: $67,572,000

Matsushita-Kotobuki Electronics has concentrated primarily on production of VCRs on an OEM basis for a number of U.S. consumer electronics manufacturers and distributors, as well as for sale under the Matsushita "Panasonic" brand name. Matsushita Electric Industrial owns 57.6% of MKE.

In 1985 Plus Development established a contract manufacturing arrangement with MKE for the Hardcard, which evolved into a manufacturing program for the highly successful 3.5" OEM drives offered by Plus' parent company, Quantum Corporation. MKE has the rights to sell the Quantum drives under license in the Japanese domestic OEM market, and activated a marketing program in 1989. MKE has since made similar manufacturing agreements with other manufacturers of storage products.

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

1990 disk sales: $45,200,000
1990 total net sales: $20,527,034,000 Net income: $529,628,000

In addition to being one of Japan's largest electronic and electrical products manufacturers, Mitsubishi Electric is a leader in the domestic small business systems market. After many years of producing a variety of removable disk drives, plus a later manufacturing program for small diameter fixed disk drives at a highly automated facility near Osaka, most disk drive operations have been discontinued. Captive shipments were the major portion of Mitsubishi's disk drive shipments, and an attempt to garner OEM business in small diameter Winchester drives was not successful. 9" drives with capacities to 630 megabytes for Mitsubishi Electric captive applications are the only rigid disk drives still in production.

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

1990 total net sales: $1,093,848,000 (FY ending 1/31/91) Net income: $10,559,000

Mitsumi is primarily a component manufacturer, but also manufactures floppy drives (about 9% of 1990 sales) and is manufacturing 3.5" 90 megabyte to 130 megabyte rigid disk drives. Mitsumi has had a rigid drive development program in place for some time, but so far has had some difficulties in having products ready to catch the start of the newest product cycles.

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

1990 disk sales: $1,350,000,000
1990 total net sales: $23,752,945,000 Net income: $587,717,000

NEC has defined its product area as communications and computers, with computer products currently accounting for about 49% 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", 9", 8", 5.25" and 3.5" disk diameters, with large scale production for several small diameter 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. NEC, Fujitsu, and NTT jointly developed a 2.2 gigabyte drive using thin film technology. The drives will be packaged to provide capacities as large as 8.8 gigabytes using multiple spindles. 3.5" drives have now reached 426 megabytes, the 5.25" product line has attained 1.4 gigabytes, and the 9" line has been extended to 3 gigabytes. NEC has the distinction of being the first of the major Japanese drive producers to begin producing small form factor rigid disk drives offshore with the establishment of a factory in the Philippines.

ORIENTAL PRECISION COMPANY, LTD.
C.P.O. Box 1301
Seoul, South Korea

1990 total net sales: $167,629,000 (FY ending 12/31/90) Net income: ($5,596,000)

OPC, founded in 1953, is one of Korea's pioneering firms in the electronics industry. It is a major supplier of telecommunications equipment, broadcasting equipment, and a volume producer of small computers and peripherals. In the past, OPC produced a 3.9" cartridge disk drive on a

contract manufacturing basis for SyQuest, as well as 3.5" drives for Peripheral Technology. Most recently, OPC made a minority investment in Kalok, and since mid-1988 has been manufacturing Kalok's 3.5" drives in substantial quantities on a contract basis for sale by Kalok. OPC has the rights to sell the Kalok drive in the Korean OEM drive market, and has been doing so. In 1991, OPC was purchased by Jade Insurance, part of the Korea Chemical group, which is, in turn, a Hyundai group affiliate, and the company's future as a disk drive manufacturer under the new ownership is unclear.

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

1990 total net sales: $5,761,821,000 Net income: $109,455,000

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. About 29% of revenues are derived from information processing products. Its first disk drives 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. An expanded capacity version has since been introduced. When DMA encountered major financial difficulties, Ricoh became the major source for the drive. In 1989, Ricoh introduced a 50 megabyte removable cartridge drive.

SAMSUNG ELECTRONICS CO., LTD.
7, Soonwha-dong
Chung-du
Seoul, South Korea

1990 total net sales: $6,348,810,000 Net income: $102,751,000

Samsung Electronics, founded in 1969, is Korea's largest electronics company, producing a variety of consumer, industrial and computer products. Samsung made a minority investment in Comport, a 1977 U.S. start-up, and manufactured Comport's 3.5" line of disk drives until Comport went out of business. As of mid-1991, Samsung's production of disk drives was entirely in 3.5" models ranging from 50 to 245 megabytes. Samsung maintains an R&D center for disk drive design in San Jose, California.

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

Epson is a member of the privately held Suwa Seikosha/Epson group owned by members of the Hattori family, which also 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 disk drives with capacities to 20 megabytes. Epson has since broadened its product line to include 3.5" drives up to 72 megabytes, but the firm dropped its plans to produce 40 and 80 megabyte 5.25" drives. Current production of rigid drives is on an exclusive basis for other manufacturers.

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

1990 disk sales: $116,200,000
1990 total net sales: $20,312,014,000 Net income: $709,021,000

Sony's growth in the consumer electronics market has become more difficult as saturation looms in sectors of the market, and the firm's management has made it clear that expansion in office products is a major company objective. Several computer systems have been announced in recent years, and the company achieved a worldwide impact with the 3.5" microfloppy, which has become an industry standard. Sony's microfloppy drive and media shipments have grown, first as Hewlett-Packard selected the drive for its personal computers, then as Apple chose the drive for its Macintosh systems. Sony proposed a 2.0 megabyte FDD 3.5" media standard in 1985, which has also become an industry standard with help from IBM, which selected it for the PS/2 product line.

The firm's first entry into the rigid disk drive market came in 1987, with half high 5.25" SCSI drives offering up to 40 megabytes formatted, but Sony decided to withdraw the product due to late market entry. Undiscouraged, Sony introduced a 42 megabyte 3.5" drive in 1989 and was able to obtain a significant contract from Apple Computer. Sony's 3.5" product line, now including 1" high models, extends to 85 megabytes as of mid-1991.

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 made similar drives for Xebec under a contract manufacturing agreement until

the end of 1989. Relatively few were produced and most of these were shipped to Xebec. While not yet in production, Tatung has indicated a desire to enter the 3.5" drive market in the future.

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

1990 total net sales: $762,131,000 Net income: $27,497,000

TEAC has expanded into computer peripherals, in recognition of slow growth in the worldwide market for quality audio tape decks, its previous major product area. Computer peripherals now account for about 73% of sales, mostly in floppy disk drives, with TEAC now the worldwide leader in total shipments of 5.25" and 3.5" floppy drives. 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. After limited success with 5.25" rigid disk drives, the firm began manufacturing 3.5" drives with capacities in the 43 megabyte to 86 megabyte (formatted) range in late 1989. 40 and 60 megabyte 2.5" drives with 15 mm height were announced in 1991 for delivery in early 1992. Shinano Tokki, a subsidiary producing motors for disk drives, was sold in 1989.

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

1990 disk sales: $46,800,000
1990 total net sales: $868,986,000 Net income: $25,103,000

Tokico, a member of the Hitachi group (Hitachi has 21.0% ownership), is a manufacturer of automotive equipment, including shock absorbers, brakes and air compressors. Factory automation is a newly developed product area. The company began disk drive manufacturing with a 5.25" fixed disk drive design derived from the discontinued Nippon Peripherals Ltd. joint venture with Fujitsu, 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. More recently, the 5.25" product line has been discontinued. Tokico began to market its disk drive products under its own name in 1987 and is now concentrating on its 3.5" drive product line, which extends from 80 to 130 megabytes.

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

1990 disk sales: $234,200,000
1990 total net sales: $29,323,814,000 Net income: $909,214,000

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. Disk drives supplied by Toshiba include rigid, floppy and optical drives. Rigid disk drive production is concentrated in newer Winchester technology fixed disk drives in low and mid-range capacities, in 8", 5.25", and 3.5" disk diameters, plus a recently announced 2.5" series. The product line currently extends to 765 megabytes for 5.25" drives and to 867 megabytes for 3.5" drives. Toshiba's presence in the U.S. OEM rigid disk drive market was strongly enhanced when it acquired the OEM disk drive operations of Memorex from Burroughs, and Toshiba has continued to expand its U.S. operations, establishing a design center in Southern California and, in 1991, opening a factory to make high-end 3.5" disk drives in San Jose.

ZENTEK STORAGE, INC.
6, Jen-Te Road, Hu-ku Hsiang
Hsin Chu Hsien
Taiwan

Zentek, which is a joint venture between Universal Scientific Industrial Co., Ltd., and Longshine Electronics, was established in September, 1989. Much of the engineering team comes from Longshine and Priam. USI is a manufacturer of film hybrid integrated circuits. Zentek is preparing to manufacture 60 megabyte and 100 megabyte 3.5" drives based on designs developed by ITRI, a government research agency. Volume production is scheduled for 1991. Zentek also plans to make the Orca 332 and 427 megabyte 3.5" drives. The original design for these drives was done as a joint effort between Priam and Matsushita Communication Industrial. Orca obtained rights to the drive when Priam ceased operations.

European Manufacturers

COMPAREX INFORMATIONSSYSTEME GMBH
Subsidiary of BASF
Gottlieb-Daimler-Strasse 10
D-6800 Mannheim
West Germany

Comparex became operational at the beginning of January, 1987, as a joint venture operation comprising the former BASF and Siemens PCM businesses, marketing systems and peripherals made by Fujitsu and Hitachi. In late 1991, the owners announced BASF's assumption of complete ownership. Current disk drive activities involve only PCM 3380 equivalent drives produced by Hitachi, plus an optical drive produced by LMSI and integrated with a Cygnet jukebox. Semiconductor and cartridge tape systems, both made by third parties, are also offered.

DZU
6000 Stara Zagora
Bulgaria

1990 disk sales: $20,100,000

DZU is the current name for the Bulgarian organization known for many years as ISOT, following a series of reorganizations in 1989 of the governmental structure which manages Bulgarian technology industries.

Under the previous Eastern Bloc Comecon system, disk drives were manufactured since the 1960's by DZU, the Bulgarian state computer organization, and exported throughout Eastern Bloc countries by Isotimpex, the foreign trade organization for Bulgarian computer equipment and other electronic products. DZU, which operates 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. The disintegration of the East Bloc and the movement of all of its old Comecon trading partners to hard currencies as a basis for international trade has left DZU's older products exposed to competition from newer disk drives, and DZU's business in 1990 and 1991 declined as a result.

EZI GMBH
Schmidthuette 9
D-6342 Haiger
Germany

EZI, whose business is primarily in disk drive repair, acquired the rights to manufacture and market Siemens 382 and 310 megabyte 5.25" disk drives. The firm has intentions to further develop the existing design to achieve higher capacities.

KOVO
Jankovcova 2
17088 Praha 7
Czechoslovakia

KOVO is the Czechoslovakian import/export agency with jurisdiction over that country's trade in computers and peripheral equipment, including those manufactured by Zbrojovka Brno and Aritma, both diversified manufacturing operations. 14" disk cartridge and disk pack drives were produced in small quantities until 1990, when production of disk drives finally ceased.

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

1990 disk sales: $92,600,000
1990 total net sales: $93,214,000 (FY ending 9/30/90) Net income: ($12,520,000)

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. With the decline of its older 5.25" models, Rodime's sales increasingly relied on shipments of 3.5" drives, which it was the first to ship in 1983. The company then announced 170 megabyte half high 5.25" drives and high capacity 8" and 3.5" models, but was slow to establish production. In recent years only 3.5" drives have been in production.

Rodime surprised the industry by obtaining patent coverage on the concept of a 3.5" drive -- claiming no new technology, only a reduction in size. The firm then sued Miniscribe and Conner Peripherals for patent infringement. When IBM announced the PS/2 family, which uses 3.5" drives, it sued Rodime to invalidate the patent, and Rodime bravely met the challenge by countersuing IBM for patent infringement. Miniscribe opted out of the legal proceedings by taking a license. In the meantime, after extensive patent office preliminaries, the affair began a long tour of the U.S. federal court system which ended when IBM and Conner took licenses. Fujitsu and Alps Electric have also signed up for Rodime licenses, and several others are in negotiation.

In early 1989, top management was completely overhauled as Rodime came perilously near bankruptcy, and most manufacturing was moved from Glenrothes and Boca Raton to Singapore. Rodime obtained refinancing, and its new management hoped to be able to return Rodime to profitability. The retail disk drive subsystem division, Rodime Systems, was sold to Profit Technology, Inc., in May, 1990. Rodime pursued joint ventures with JVC and companies in Taiwan and Korea for design and manufacturing of new products. However, in mid-1991 Rodime announced that these ventures were

unlikely to come to fruition and that it would file for bankruptcy and cease manufacturing of drives after using up its current inventory of materials. Rodime will remain active to pursue licensing of its 3.5" disk drive patents.

SAGEM
(Societe d'Applications Generales d'Electricite et de Mecanique)
La Ponant, 27, rue Leblanc
75512 Paris CEDEX 15
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. The firm's more recent products have focused upon a line of militarized removable disk drives ranging in capacity from 100 to 200 megabytes.

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

1990 disk sales: $83,800,000
1990 total net sales: $35,102,800,000 (FY ending 9/30/90) Net income: $926,700,000

After many years of producing 14" rigid disk drives of its own design in Munich for captive use with Siemens mainframe systems, Siemens developed a 5.25" Winchester disk drive with capacities up to 300 megabytes, and started deliveries in early 1986. 380 and 770 megabyte models were added in 1988 and a 1.2 gigabyte model in 1989. Siemens sold the drives in non-captive markets as well as in captive systems. Siemens never was able to achieve a production volume permitting profitable operation of its disk drive product line, and in 1990 announced it would withdraw from the 5.25" rigid disk drive business, selling its disk drive product lines to Microscience International and to EZI.

In late 1986, Siemens and BASF agreed to create a joint venture company, Comparex Informationssysteme GmbH, to market the plug compatible IBM mainframe peripherals that BASF and Siemens were purchasing from Japanese manufacturers and remarketing in Europe. Comparex began operations in January, 1987, and in late 1991 Siemens sold its share of Comparex to BASF. In April of 1990, Siemens announced it was purchasing 51% of Nixdorf and planned to merge Nixdorf into its data and information systems group, which then became Siemens/Nixdorf Informationsystems AG.

South American Manufacturers

DIGIREDE INFORMATICA LTDA.
Av. Angelica, 2582
01228 Sao Paulo SP
Brazil

1990 total net sales: $75,000,000 Net income: $6,000,000

Digirede manufactures rigid disk drives, multiuser microcomputers, banking automation equipment, POS systems and industrial automation equipment. The company, which is privately held, was founded in 1977 and has been manufacturing rigid disk drives under an agreement with Maxtor initiated in November of 1985. 1990 rigid disk drives represented about a fifth of Digirede's revenues. The product line includes Maxtor 5.25" designs up to 240 megabytes, using ST506 and RLL controllers. Higher capacity models will be produced in the future. Much of the drive content is locally produced, although media, heads and motors are still imported.

EDISA INFORMATICA S/A
BR 290 Km 75
Distrito Industrial Gravatai
94000 Gravatai RS
Brazil

Edisa Informatica was created in 1989 as a joint venture between Hewlett-Packard and Ioschpe, a large Brazilian firm with interests in construction equipment, pharmaceuticals, paper and electronics. Edisa is best known as a supplier of automated banking equipment, but in 1990 began producing the Hewlett-Packard 380 megabyte 5.25" drive (Coyote I) in its own facility. Production of a 664 megabyte drive is scheduled for the last half of 1991. Key components are purchased from Hewlett-Packard, which also supplied much of the manufacturing equipment used by Edisa.

ELEBRA INFORMATICA
Rua Geraldo Flausino Gomes, 78
04575 Sao Paulo SP
Brazil

1990 total net sales: $129,000,000 Net income: ($12,000,000)

Founded in 1978, Elebra is a producer of minicomputers, defense electronics, industrial control electronics, data communications and peripheral equipment. Minicomputers are made under license from Digital Equipment. The peripheral equipment product line includes rigid and floppy disk drives, printers, and tape drives and accounted for 54% of 1989 revenues. Of the revenues related to peripherals, 11.2% came from rigid disk drives and 23.2% from floppy disk drives. All of the floppy drives are 5.25"

half height types. Manufacturing of rigid disk drives began in 1985. Current drive production includes 9" and 5.25" Wren designs under license from Seagate, but the firm is also developing and manufacturing its own designs for low-end 3.5" drives. Production of 8" drives ceased in 1989. Cost reduced models of current products appeared in 1991.

FLEXDISC TECHNOLOGIA S.A.
Rua Dom Aguirre, 176
04671 Santo Amaro
Sao Paulo SP
Brazil

Flexdisc, a privately held company, was founded in 1979. Floppy disk drives for Apple II computers were the firm's original products, but streamer tape drives, IBM compatible 500 kilobyte and 1.6 megabyte floppy drives, and rigid disk drives have been produced. Rigid drives were first made under license from Seagate in 1983 and then Vertex in 1985. A new 3.5" 20 megabyte stepping motor drive designed by Flexdisc was scheduled for production in 1990 but has been put on hold because of poor economic conditions in Brazil.

ITAUTEC INFORMATICA S.A.
Rua Odorico Mendes, 540
03106 Mooca
Sao Paulo SP
Brazil

Itautec is part of the Itau group, Brazil's second largest bank. Itautec was formed in 1979 to automate the banking systems of its parent organization and went into the computer systems business in 1984. The firm began production of floppy disk drives in 1986 and a 20 megabyte half high rigid drive in 1988. A 96 megabyte version was added in 1990. Both rigid drives are made under license from BASF, which also supplied production equipment for the drives to Itautec.

MICROLAB S/A
Av. Nova York, 381
21041 Bonsucesso
Rio de Janeiro RJ
Brazil

Founded in 1961, Microlab started as a defense contractor for the Brazilian Navy and then diversified into products for the oil industry. Since 1970, the firm has produced military radar and communications equipment as well as process control and power distribution equipment. Rigid disk drive production began in 1985 with a 300 megabyte pack drive licensed from Ampex. The firm has also produced the Megavault 8" drive and Atasi

5.25" 50 megabyte drive under license. The Atasi drive went out of production in 1989, while the Ampex and Megavault designs had their last production year in 1988. Current products are licensed from Seagate and include ST506 and RLL 5.25" drives up to 144 megabyte capacity. 3.5" drives were introduced in 1991.

Because of the weak Brazilian economy in 1990 and 1991, Microlab is currently operating under the Brazilian equivalent of Chapter 11 status, but expects to resume normal operations as conditions improve.

MULTIDIGIT S. A.
BR 290 Km 22
Distrito Industrial Gravatai
94000 Gravatai RS
Brazil

Multidigit was founded in 1979. The firm's first 5.25" drive, a 5 megabyte model, was manufactured in 1983. Multidigit currently manufactures 5.25" flexible disk drives and 5.25" stepper motor rigid disk drives with capacities of 25 to 178 megabytes. The firm also distributed an 8" 330 megabyte drive from Pertec in the early 1980s. In addition to rigid disk drives, Multidigit also produces small quantities of 5.25" flexible disk drives.

PROLOGICA INDUSTRIA E COMERCIO DE MICROCOMPUTADORES LTDA.
Rua Fidencio Ramos, 302
04551 Villa Olimpia
Sao Paulo SP
Brazil

Prologica began as a retail store for electronic components, but soon moved into sales of kits for radios and, eventually, sales of microcomputer kits. The company decided to produce floppy drives in 1982 and started production of an IBM compatible 500 kilobyte drive in 1983. In 1984, the firm established a related company, Microperifericos, to manufacture drives for OEM customers and to do contract manufacturing. Rigid drive production began in 1983 with a 5.25" 5 megabyte CMI look-alike. 3.5" 12 and 25 megabyte drives were produced in mid-1987 and an improved performance version was introduced in 1988. In 1990, the 3.5" family was extended to 105 megabytes capacity. The new drives use voice coil positioning mechanisms rather than the rack and pinion mechanism employed in the older drives.

QUALITRON TECNOLOGIA S.A.
Rua Anhembi, 228, Santa Amaro
CEP 04728 Sao Paulo SP
Brazil

Qualitron, founded in 1986, currently produces 5.25" half high drives ranging from 25 to 77 megabytes capacity. The firm is developing a line of 3.5" disk drives which it plans to provide on an OEM basis to Brazilian system manufacturers.

DISK/TREND ON DISK

1991 DISK/TREND REPORT

INTRODUCTION

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

A file translation program, AutoImport, is available from DISK/TREND to assist in converting the data supplied to the formats of several popular spreadsheet programs.

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

Because the statistical tables are provided in ASCII format, they can be used with any spreadsheet program that can import ASCII text files. However, the specification tables have been prepared specifically in Lotus 1-2-3 format to allow them to be searchable using Lotus 1-2-3 data base commands. If you are using a spreadsheet program other than Lotus 1-2-3 that can translate Lotus WK1 formatted files to its own format, it may be able to import the specification tables.

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

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

Note: Please read the license information on the following page.

DISK/TREND ON DISK
Information License

DISK/TREND supplies diskettes containing selected information from the 1991 DISK/TREND Report as a separately purchased option to subscribers to the corresponding 1991 DISK/TREND Report volume.

YOU MAY:

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

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

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

YOU MAY NOT:

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

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

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

4. Transfer this license to another party.

AUTOIMPORT

Use of AutoImport is subject to the terms and conditions provided by White Crane Systems, Inc.

Trademarks

IBM is a trademark of International Business Machines Corporation.

Lotus and Lotus 1-2-3 are trademarks of Lotus Development Corporation.

MS-DOS is a trademark of Microsoft Corporation.

AutoImport is a trademark of White Crane Systems, Inc.

Getting started

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

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

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

DISK/TREND on Disk for the Rigid Disk Drive Report is normally shipped on 5.25" 1.2 megabyte diskettes. There will be two diskettes in a set, one containing statistical tables and one containing specification tables. You may also request shipment on 3.5" 1.44 megabyte diskettes or 5.25" 360 kilobyte diskettes. If you request the 5.25" 360 kilobyte diskettes, there will be two diskettes containing statistical tables and two diskettes with specification tables. In each case, diskette # 1 contains data for product groups one through five. The remainder is on diskette # 2. Otherwise, there will be one diskette for statistical tables and one for specification tables.

STATISTICAL TABLES

Loading and Installation

1. Place the floppy disk marked 'Tables' in a floppy disk drive able to read 5.25" disks. This is usually drive A, but if you are using a dual floppy only system, use drive B and put the Lotus 1-2-3 system disk in drive A. Use the DOS 'DIR' command to examine the file directory on the 'Tables' disk. If there are any special instructions, they will be in a file named READ.ME. To see these instructions, at the DOS prompt type:

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

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

   TYPE A:READ.ME>PRN

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

   COPY A:?T*.*

   Several utility files should also be copied. The commands are:

   COPY A:*.PRN (if you intend to use Lotus 1-2-3 data parsing)
   COPY A:*.MSK (if you intend to use AutoImport)

   The utility file names of the form FORMLIN?.PRN are specific to use with Lotus 1-2-3 data parsing and are needed only if you prefer not to use AutoImport for file translation.

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

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

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

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

   /FR<filename>

   The file names are in the format XTYY.WK1, where:

   X= Type of data
   F (Flexible disk drive data)
   R (Rigid disk drive data)
   O (Optical disk drive data)

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

   Examples:
   File RT11.WK1 is Rigid Disk Drive Report Table 11
   File FT2.WK1 is Flexible Disk Drive Report Table 2
   File OT1.WK1 is Optical Disk Drive Report Table 1

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

If you don't use AutoImport

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

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

- o FORMLINA.PRN — Used with Table 1 and the Revenue and Unit Shipment tables found in the product group sections of all DISK/TREND reports.
- o FORMLINB.PRN — Used with Table 2.
- o FORMLINF.PRN — Used with Tables 3 and 4.
- o FORMLIND.PRN — Used with Application tables.
- o FORMLINE.PRN — Used with Drive Height, Track Density and Drive Capacity tables in Flexible Disk Drive Report.

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

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

Using AutoImport:

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

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

MASK TABLE

Mask File Name	Rigid Report	Flexible Report	Optical Report
MASKA	<-------- Table 1--------->		Tables 1,2
	<------------ Product Group Revenue ---------->		
	<------------ Product Group Shipment ---------->		
MASKB	<-------- Table 2 -------->		Tables 3,4
MASKC	Tables 3 to 9	Tables 3,4	Tables 5 to 12
MASKD	<----- All Product Group Application Tables ------->		
MASKE	Drive Height	Drive Height, Track Density, Drive Capacity	Write-Once/ Erasable Analysis
MASKF	Applications Summary		
MASKG	N/A*	Product Group Market Share	N/A*

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

TABLE NUMBER TO MASK CROSS-REFERENCE

Table Number	1991 Rigid Report	1990 Flexible Report	1991 Optical Report
1	MASKA	MASKA	MASKA
2	MASKB	MASKB	MASKA
3	MASKC	MASKC	MASKB
4	MASKC	MASKC	MASKB
5	MASKC	--	MASKC
6	MASKC	--	MASKC
7	MASKC	MASKF	MASKC
8	MASKC	MASKA	MASKC
9	MASKC	MASKA	MASKC
10	--	MASKE	MASKC
11	--	MASKD	MASKC
12	MASKA	MASKG	MASKC
13	MASKA	MASKA	--
14	--	MASKA	--
15	--	MASKE	--
16	MASKD	MASKE	--
17	--	MASKD	MASKA
18	MASKA	MASKG	MASKA
19	MASKA	MASKA	--
20	--	MASKA	--
21	--	--	MASKD
22	MASKD	--	--
23	--	MASKE	MASKA
24	MASKA	MASKE	MASKA
25	MASKA	MASKD	--
26	--	MASKG	--
27	--	MASKA	MASKE
28	MASKD	MASKA	MASKD
29	--	--	--
30	MASKA	--	MASKA
31	MASKA	MASKD	MASKA
32	--	MASKG	MASKD
33	--		MASKA
34	MASKD		MASKA
35	--		MASKA
36	MASKA		MASKA
37	MASKA		--
38	--		--
39	--		MASKE
40	MASKD		MASKA
41	--		MASKA
42	MASKA		--
43	MASKA		--
44	--		MASKE
45	--		MASKA
46	MASKD		MASKA
47	--		--

Cross-reference (continued)

Mask File Name	1991 Rigid Report	1990 Flexible Report	1991 Optical Report
48	MASKA		--
49	MASKA		MASKE
50	--		
51	--		
52	MASKD		
53	--		
54	MASKA		
55	MASKA		
56	--		
57	--		
58	MASKD		
59	--		
60	MASKA		
61	MASKA		
62	--		
63	--		
64	--		
65	MASKD		
66	--		

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

Translation using precomputed masks

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

   ```
   COPY A:?T*.*
   COPY A:*.MSK
   ```

   These commands copy the data files and mask files you need.

   If you are using a two floppy disk system, copy the files you want to translate to a second floppy disk along with the mask files. Make sure that no more than half of the floppy disk is filled, because you will need space for the converted files.

2. Now start AutoImport. When the opening screen appears, select the 'TRANSLATE' menu item using the arrow keys or just type 'T'. (The AutoImport menu system works just like the menus in Lotus 1-2-3.)

3. When the next screen appears, enter the name of the mask to use on the top line where the highlighted space is. If a standard mask is being used, see the mask table above to choose the mask file name to enter. If you used a mask previously, the system defaults to the last mask named. Press 'ENTER'.

4. Select the output file name. Type OFT (Output:File:Type-in)

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

   Examples: RT4 FT12 OT14

5. Enter the input file name using the same file naming convention as above. Type IT (Input:Type-in)

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

   Examples: RT4.91R FT12.91F OT14.910

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

7. You are ready to translate. Type 'G' for 'GO' or select 'GO' using the arrow keys. You will see the file being translated scroll by as the translation proceeds.

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

9. When you are done translating, leave AutoImport by typing /Q (Quit) to return to the AutoImport main menu and then /E (Exit) to leave AutoImport and return to DOS. It will save you some keystrokes if you copy your new spreadsheet files to your spreadsheet directory. If you are using a two floppy system, just remove the AutoImport disk from drive A and substitute your spreadsheet disk.

Mask Generation

1. Start AutoImport as above. When the opening screen appears, select 'Mask' using the arrow keys or type 'M'.

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

   Example: RT50.91R

   To name the file, type /FIT (File:Input:Type-in). When the highlighted blank space appears, fill it in with the file name and press 'Enter'. The contents of the file will now appear on the screen.

3. Next define the header lines. These are lines that are translated to the spreadsheet as a single cell of text. Place the cursor at the top of the header area, normally at the left top of the report table. Now type /LH (Line:Header). Using the down arrow key, expand the highlighted area until it extends to just above the first row of numerical data. Press 'Enter'. If there are any footnotes at the bottom, the lines in which they appear can be treated the same way by locating the header at the left margin of the first footnote line, typing /LH, extending the highlight area over the note and pressing 'Enter'.

4. Next, locate the longest left margin label (excluding the header lines) in the table. Position the cursor so that it is at the left margin of the line containing the longest label. Type /AY (Auto:Yes). This step actually creates the mask. Check to be sure all figures have been delineated properly. If not, see below.

   In a few cases, the automatic feature may be confused by a table layout and all values will not be picked for conversion. In these unusual cases, you may be able to get the overlooked values included by repeating this step on another line.

   Another unusual case can occur in which the right-hand part of a label is somehow included in a value occurring in the next column to the right. Deal with this rare case as follows:

   - Place cursor in left margin of offending line. Type /CW to adjust width and then use arrow keys to move right column margin clear of the column of values.

   - Set cursor on last position of column to the right of the left margin labels. Type /DCO to delete this one column from the mask.

   - Now place cursor in first space to the right of the left margin label column. Type /C and then adjust the column width to encompass all places in the values column you have been working with. This will restore the mask column, also.

5. Save the mask in a mask file. Type /FMS (File:Mask:Save). Fill in the name of the mask file.

   Example: RT50MSK

6. Save the output file. Type /FOT (File:Output:Type-in). Now enter the file name.

   Example: RT50. You don't need to enter the file extender.

7. To make more masks, repeat from step 2. To quit the mask function, type /Q (quit). This returns you to the AutoImport main menu. To leave AutoImport, type /E.

Other AutoImport Functions

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

SPECIFICATION TABLES

The rigid disk drive specifications are supplied on two diskettes if 5.25" 360 kilobyte diskettes were supplied to you or one diskette if otherwise. If you are using two diskettes, specification diskette 1 contains the specifications for DISK/TREND product groups one through five. The other diskette contains specifications for groups six through nine. If your computer has enough memory (it may require expanded memory in some cases) you can load the two data bases sequentially into one large data base for ease of data manipulation. See the comments in the Operating Tips section.

Loading

1. Place the floppy disk marked 'Specifications' in a floppy disk drive able to read 5.25" disks. This is usually drive A, but if you are using a dual floppy only system, use drive B and put the spreadsheet system disk in drive A. Use the DOS 'DIR' command to examine the file directory on the 'Tables' disk. If there are any special instructions, they will be in a file named READ.ME. To see these instructions, at the DOS prompt type:

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

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

   TYPE A:READ.ME>PRN

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

   COPY A:?S*.*

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

   /FR<filename>

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

X= F (Flexible disk drive data)
O (Optical disk drive data)
R (Rigid disk drive data)

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

ZZ= Year of report.

Example: RS191 Rigid disk specification table, Groups 1 to 5
RS291 Rigid disk specification table, Groups 6 to 9
RS391 Complete specification table: supplied on 1.2 megabyte 5.25" or 1.44 megabyte 3,5" diskettes only

Note that the specification tables load directly as a data base. You can use the various data base functions of Lotus 1-2-3 to sort, count or otherwise manipulate the data for purposes of special analysis. Other spreadsheets may have similar capabilities.

Using the specification data base

Introduction: If you have not used the Lotus 1-2-3 /DATA QUERY commands, it will be helpful for you to review the sections of the Lotus 1-2-3 reference manual that pertain to their use before proceeding further.

The specification data base fits into a worksheet format of 25 to 30 columns, depending upon whether rigid, optical or floppy drives are involved, and a row count of up to 500 rows. Each row represents a specific record, and is equivalent to a single column in the Specifications section of the DISK/TREND report. Each column represents a specific specification parameter, and is equivalent to one row of the DISK/TREND report.

The data base has been set up for data extraction using Lotus 1-2-3 commands. The Input, Output and Criterion ranges have been predefined, but you, the user, will have to decide how you want the extracted data manipulated and place the appropriate Lotus functions, such as @COUNT, in the appropriate cells. Some rows between the bottom of the input range and the top of the output range have been left empty so that you can do this easily. When the database is first loaded, you will see the top of the input range, showing the first column (manufacturer name) for the first several manufacturers. Use the arrow keys to find other manufacturers or specific product specifications. If you are not using Lotus 1-2-3, use the equivalent procedure for your spreadsheet.

Operating tips

Expanding the input or output ranges: The predefined output range is of a nominal size, and a search with broad parameters may result in overflowing the output range. In such a case, merely extend the output range (add more rows) using the Lotus 1-2-3 /DQEO command. Similarly, it is possible to extend the input range to add more products, but be sure you move the output range so that there is no overlap.

Memory overflow: If you should receive a memory overflow message while manipulating the specification data, it is usually because:

- o There are other 'pop-up' programs resident in the memory of your computer. These should be removed.
- o You have selected too large an output range. Use a smaller output range or delete some of the columns that contain data not relevant to your analysis. If you delete data, be sure that if you save your spreadsheet you use a different file name, otherwise you will overwrite the original file with the modified spreadsheet.
- o If you receive a memory overflow message while loading the data base, the data base is too large for your computer's available memory. You probably will have to remove other resident programs and reload Lotus 1-2-3 and the data base. If your computer doesn't have 640K memory, you will probably get this message.

Combining specification data bases: Lotus 1-2-3 allows you to combine worksheets into a larger worksheet. If you think your computer has enough memory, you can combine the specification data bases by doing the following:

1. Load the worksheet RS190 from the specification diskette (specification diskette 1 if you have 360 kilobyte diskettes) into a new worksheet. Now move the worksheet cursor to column A and the row just under the last manufacturer's name.
2. Load the worksheet from RS290 from the specification diskette (or specification diskette 2) using the Lotus command /FCC.
3. Edit the worksheet to remove the header and criteria range areas that were loaded with the second worksheet.
4. Using the data query (/DQ) command, select the new input range so that it covers the entire worksheet area in which there is data. Remember, the column header row must be included in the input range. Quit the DQ menu.
5. Copy the column header row using the /C command to a row 5 to 10 lines below the input range. Using the /DQ command, select the output range. It should include the header row you just established plus as many rows as you would like, and should extend to the last column of data.

6. Quit the DQ menu. You are ready to use the new worksheet. It would be a good idea to save it to a new file name first so that you can easily reload if you make an unrecoverable alteration.

Saving time

The specification data base is large and takes significant time to recompute or perform other operations. If you are interested in drives that belong to only a few product groups, it will probably save you time in the long run if you extract only those groups you are interested in into a new worksheet and use that for the analysis. Use spreadsheet FILE EXTRACT and FILE COMBINE commands for this purpose.

Another way to save time is to use the SORT capabilities of your spreadsheet to organize the data the way you find it most useful. The most commonly done sorts are by manufacturer name and by DISK/TREND product group, but it would also be possible to sort by average seek time, price, and so on.

Make sure that when you save a worksheet using the FILE SAVE command that you save it in a new file name. If you save it in the file name from which it was loaded, the original copy will be overwritten. If a file is overwritten unintentionally, it can take a long time to recreate.

If you are interested in only a subset of product groups, use the FILE EXTRACT and FILE COMBINE commands to move these records to another file and then use the second file for analysis. The smaller file will take less time to process.

Special data: The specification database contains one category of information not present in the hard copy report. This is the country code field, representing the continental region in which the headquarters of the drive producer is located. A key is located at the top of the adjacent column to the right.

All specification files have been prepared as Lotus 1-2-3 spreadsheets set up for data extraction. Criterion, input, and output ranges are predefined.

File RS191.WK1 contains DISK/TREND Product Groups 1 through 5. File RS291.WK1 contains Product Groups 6 through 9. File RS391.WK1 contains the entire specification data base, but the amount of memory required is large and may not allow enough room for large data extractions.

If file RS390.WK1 is present, you are using a 1.2 or 1.44 megabyte diskette, and should have a computer equipped with expanded memory capability.

In order to make it easier to do sorting or extraction analysis on the data, the contents of certain fields have been modified and are not exactly the same as in the printed report tables. The affected fields have been converted to purely numeric fields as described below. Where multiple values existed, the value representing the highest level of performance or capability has been retained.

Comments and asterisks in the affected fields have been eliminated. A '0' means that no data was available. Asterisks are retained in the comment field so that you will have an indication that one or more characteristics of the drive was referenced to a comment. Check the printed report table for details.

The affected fields are:

Group:	Numeric conversion: Now you can extract a range of groups.
Surfaces per spindle	Numeric conversion: You can now extract a range of values.
Heads per surface	Will be a single numeric value: 1,2, or 10
TPI	Will be a single numeric value, 0 if data not available. If a drive model has several configurations, the highest TPI is used.
RPM	Numeric conversion: You can now extract a range of values.
Tracks per surface	Will be a single numeric value, 0 if data not available. If a drive model has several configurations, the largest value of tracks per surface is used.
Average positioning time	Will be a single numeric value, 0 if data not available. If a drive model is specified as having more than one positioning time, the shortest will be used. Settling time is always included.
Average rotational delay	Numeric conversion: You can now extract a range of values.
Average access time	Same as for average positioning time.

A country code field has been added in the last column of the data base. The code explanation is:

1 = U.S. manufacturer
2 = Asian manufacturer
3 = European manufacturer
4 = South American or other manufacturer

Codes are based upon the location of the manufacturer's headquarters.

First ship date has been modified so that the last two characters will always represent the year of shipment. An entry of ??89 in the criterion field for the First Ship Date column will cause all drives first shipped in 1989 to be extracted.

Technical support

Just about all of your questions regarding the use of DISK/TREND ON DISK should be answered in this manual or in the Lotus 1-2-3 reference manual. However, if you need to contact us to resolve any points of confusion, report errors, or otherwise receive comfort:

In case of questions, contact DISK/TREND.
1925 Landings Drive
Mountain View, CA 94043

415-961-6209 TEL
415-969-2560 FAX
Ask for Technical Support

In order to make this process efficient, when you call--

1. Tell us what is on the diskette label.

2. Have your computer up and displaying the data or operation that is the subject of your call.

3. Have this manual and the Lotus 1-2-3 reference manual handy.

If you have questions about AutoImport as it is used with DISK/TREND ON DISK, contact DISK/TREND at the number above. Questions about other functions of AutoImport should be referred to White Crane Systems.

Apple Macintosh compatibility: While DISK/TREND on DISK has been prepared for use on IBM PC compatible computers, users have reported that they are able to translate files into Macintosh format using Apple Computer software. The specific software reported used is Apple File Exchange.