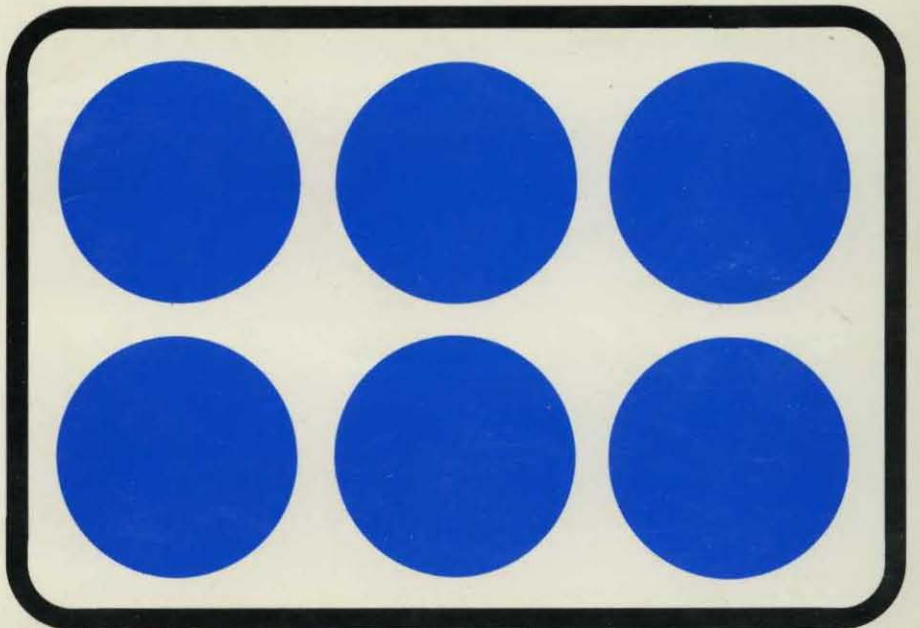


# 1984 DISK/TREND<sup>®</sup> REPORT

RIGID  
DISK  
DRIVES



# 1984 DISK/TREND<sup>®</sup> REPORT

RIGID DISK DRIVES

October, 1984

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## FOREWORD

In its eighth year, the DISK/TREND Report finds much of the industry in a state of turmoil -- but that's not unusual. As on past occasions, nervous industry participants await IBM product introductions, try to understand the impact of additional captive programs, watch the movement of small drive manufacturing to several Asian countries and assess how soon new data storage technologies will affect the market.

This year, however, the industry is bigger than ever (almost thirteen billion in revenues for 1984), and the stakes for some of the players are now more than they would like to think about losing. For those companies which have become adept at flexible planning and quick response the future can be a very good one.

This section of the DISK/TREND Report covers moving head rigid disk drives and optical disk drives. Flexible disk drives will be covered in a separate report to be published in November.

I am always willing to help you at any time by providing additional information on the industry which I may have available in my files. Projects requiring elaborate research and analysis can be addressed on a normal consulting basis if desired.

Your suggestions for improvements in the report are always welcome.

James N. Porter

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INTRODUCTIONWe've made some changes you asked for

As always, the basic formats used in presentation of DISK/TREND information have been retained this year, since we know many users wish to be consistent as they compare our statistics with their own operating results and plans. Please note that we have made these changes in the 1984 DISK/TREND Report, most of which should improve its usefulness:

- \* Tables have been added to most product sections to provide a breakdown by disk diameter for revenues, following the same format already used to show the breakdown by disk diameter for shipments.
- \* A new section on optical disk drives for data storage has been added. We are not providing unit shipment or revenue forecasts for optical disk drives just yet, since the shipments starting this year are still insignificant. We hope that optical disk drive markets will be coherent enough to provide forecasts in the usual DISK/TREND style next year.
- \* We have stopped reporting cumulative unit shipments at the bottom of each product section's unit shipment table. The numbers at that location of each shipment table now show cumulative shipments in each product group. This change was made in recognition of the fact that, with the industry's current complexity and volatility, there is no reasonably accurate way to estimate retirements of previously shipped drives. Accordingly, the shipment tables will no longer contain negative numbers to indicate reductions from the installed base -- all numbers in the shipment tables now show net new shipments.

To avoid confusion, please note these points

- \* All unit totals are given in spindles. A disk drive containing two spindles is counted in DISK/TREND statistics as two spindles.
- \* Prices for most OEM drives sold in the United States are shown, usually at the 100 unit level. Please remember that prices may be changed without notice by the manufacturers.
- \* The value of all leased disk drives is given on an "if sold" basis in all DISK/TREND estimates.

## SUMMARY

### Industry size

1983 was another year of strong worldwide growth for rigid disk drives, with revenues up 23.1%, for a total of \$9,112,400,000. Despite a year of turmoil in several segments of the industry the outlook for 1984 worldwide revenues is even stronger, with the total estimated at \$12,922,700,000, an increase of 41.8%.

Production of captive drives is growing at a healthy rate, but non-captive drive shipments are on an even steeper slope. The greatest percentage increase in revenues is expected to go to plug compatible drives, growing by 183.7% this year with volume shipments of 3380 equivalent drives, after a deep decline in 1983 as the shipment rate for 3350 type drives died. Worldwide OEM revenues are also rising rapidly in 1984, up 56.2%, as all types of fixed disk drives enjoy sharp growth.

Average annual growth in worldwide revenue in the period 1985-1987 is forecasted to slow down to 20.5%, with a higher rate of unit shipments masked by the continuing decline in average unit prices for OEM drives. Also, holding down the overall revenue growth rate are the declining shipments of older removable media drives.

IBM's 39.3% of worldwide industry rigid disk revenues are expected to fall off slightly to 35.5% of the 1987 total, reflecting the growing vigor and diversity of the industry. U.S. manufacturers are projected to retain 73% of 1987's forecasted worldwide revenues of \$22,608,700,000, down from 1983's 76.6%, as Japanese manufacturers of OEM drives continue growth in several product groups.

TABLE 1  
 CONSOLIDATED WORLDWIDE SHIPMENTS  
 ALL EXISTING MOVING HEAD DISK DRIVE GROUPS  
 REVENUE SUMMARY

	-----DISK DRIVE REVENUES, BY SHIPMENT DESTINATION (\$M)-----									
	1983		1984		1985		Forecast		1987	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
<u>U.S. Manufacturers</u>										
IBM Captive	2,158.4	3,579.1	2,899.8	4,618.6	3,584.8	5,676.2	4,252.1	6,746.5	5,079.7	8,018.6
Other U.S. Captive	1,111.9	1,829.8	1,528.1	2,490.5	1,949.4	3,064.6	2,443.9	3,816.2	2,747.3	4,347.1
TOTAL U.S. CAPTIVE	3,270.3	5,408.9	4,427.9	7,109.1	5,534.2	8,740.8	6,696.0	10,562.7	7,827.0	12,365.7
PCM	85.5	149.6	277.2	398.3	313.0	427.8	534.8	679.2	735.4	1,028.7
OEM	1,066.3	1,425.5	1,597.7	2,103.5	1,930.3	2,458.1	2,204.6	2,826.7	2,415.8	3,119.5
TOTAL U.S. NON-CAPTIVE	1,151.8	1,575.1	1,874.9	2,501.8	2,243.3	2,885.9	2,739.4	3,505.9	3,151.2	4,148.2
TOTAL U.S. REVENUES	4,422.1	6,984.0	6,302.8	9,610.9	7,777.5	11,626.7	9,435.4	14,068.6	10,978.2	16,513.9
<u>Non-U.S. Manufacturers</u>										
Captive	18.2	1,476.4	61.5	1,969.3	92.2	2,388.7	214.2	3,071.5	355.6	3,671.3
PCM	85.8	137.0	221.8	414.9	174.0	377.6	130.5	397.3	244.5	502.0
OEM	213.2	515.0	414.5	927.6	584.3	1,230.6	784.6	1,551.0	1,016.2	1,921.5
TOTAL NON-U.S. REVENUES	317.2	2,128.4	697.8	3,311.8	850.5	3,996.9	1,129.3	5,019.8	1,616.3	6,094.8
<u>Worldwide Recap</u>										
TOTAL WORLDWIDE REVENUES	4,739.3	9,112.4	7,000.6	12,922.7	8,628.0	15,623.6	10,564.7	19,088.4	12,594.5	22,608.7

WOW PCM

286.4

813.2

### Marketing channels

The annual DISK/TREND roster of the worldwide rigid disk drive industry shows a net increase of 3 manufacturers since last year, with the total up to 75. During the past year only 7 firms have dropped out of the industry or disposed of their disk drive product lines, down from 9 in the preceding year. 6 U.S. and 3 Japanese companies have entered the market with drives using 5.25" or small disks, and one U.S. firm has acquired an older 14" disk cartridge drive product line.

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

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

During the last few years, sharp growth in small diameter disk drives has pushed OEM drives' share of worldwide revenues up to 23.5% in 1984, but it is believed that this growth is about to flatten, especially for U.S. manufacturers. New captive drive programs by IBM and other leading personal computer manufacturers will limit the future OEM opportunity.

TABLE 2  
 CONSOLIDATED WORLDWIDE SHIPMENTS  
 MARKET CLASS REVIEW  
 REVENUE SUMMARY

WORLDWIDE REVENUES BY MANUFACTURER TYPE	-----1983-----		-----1984-----		-----1985-----		-----Forecast-----		-----1987-----	
	-----Revenues-----									
	\$M	%	\$M	%	\$M	%	\$M	%	\$M	%
<b>U.S. Manufacturers</b>										
IBM Captive	3,579.1	39.2	4,618.6	35.8	5,676.2	36.4	6,746.5	35.4	8,018.6	35.6
Other U.S. Captive	1,829.8	20.1	2,490.5	19.3	3,064.6	19.7	3,816.2	19.9	4,347.1	19.2
PCM	149.6	1.7	398.3	3.0	427.8	2.7	679.2	3.6	1,028.7	4.5
OEM	1,425.5	15.7	2,103.5	16.3	2,458.1	15.7	2,826.7	14.9	3,119.5	13.8
Total U.S. Mfgr's.	6,984.0	76.7	9,610.9	74.4	11,626.7	74.5	14,068.6	73.8	16,513.9	73.1
<b>Non-U.S. Manufacturers</b>										
Captive	1,476.4	16.2	1,969.3	15.2	2,388.7	15.3	3,071.5	16.1	3,671.3	16.3
PCM	137.0	1.5	414.9	3.2	377.6	2.4	397.3	2.0	502.0	2.2
OEM	515.0	5.6	927.6	7.2	1,230.6	7.8	1,551.0	8.1	1,921.5	8.4
Total Non-U.S. Mfgr's.	2,128.4	23.3	3,311.8	25.6	3,996.9	25.5	5,019.8	26.2	6,094.8	26.9
Worldwide Total	9,112.4	100.0	12,922.7	100.0	15,623.6	100.0	19,088.4	100.0	22,608.7	100.0

Product mix

The resolute swing from removable to fixed disk drive configurations continues, driven by IBM's influence, the higher densities made practical by fixed media, and the mechanical complexity of removable disk drives.

The share of worldwide revenues held by the four DISK/TREND removable disk drive groups was 22.1% in 1982, 15.8% in 1983, and forecasted to drop to 8.3% in 1987. Only removable disk cartridge drives over 12 megabytes is expected to increase slightly in share through 1987, as it continues to find favor with minicomputers and specialized systems.

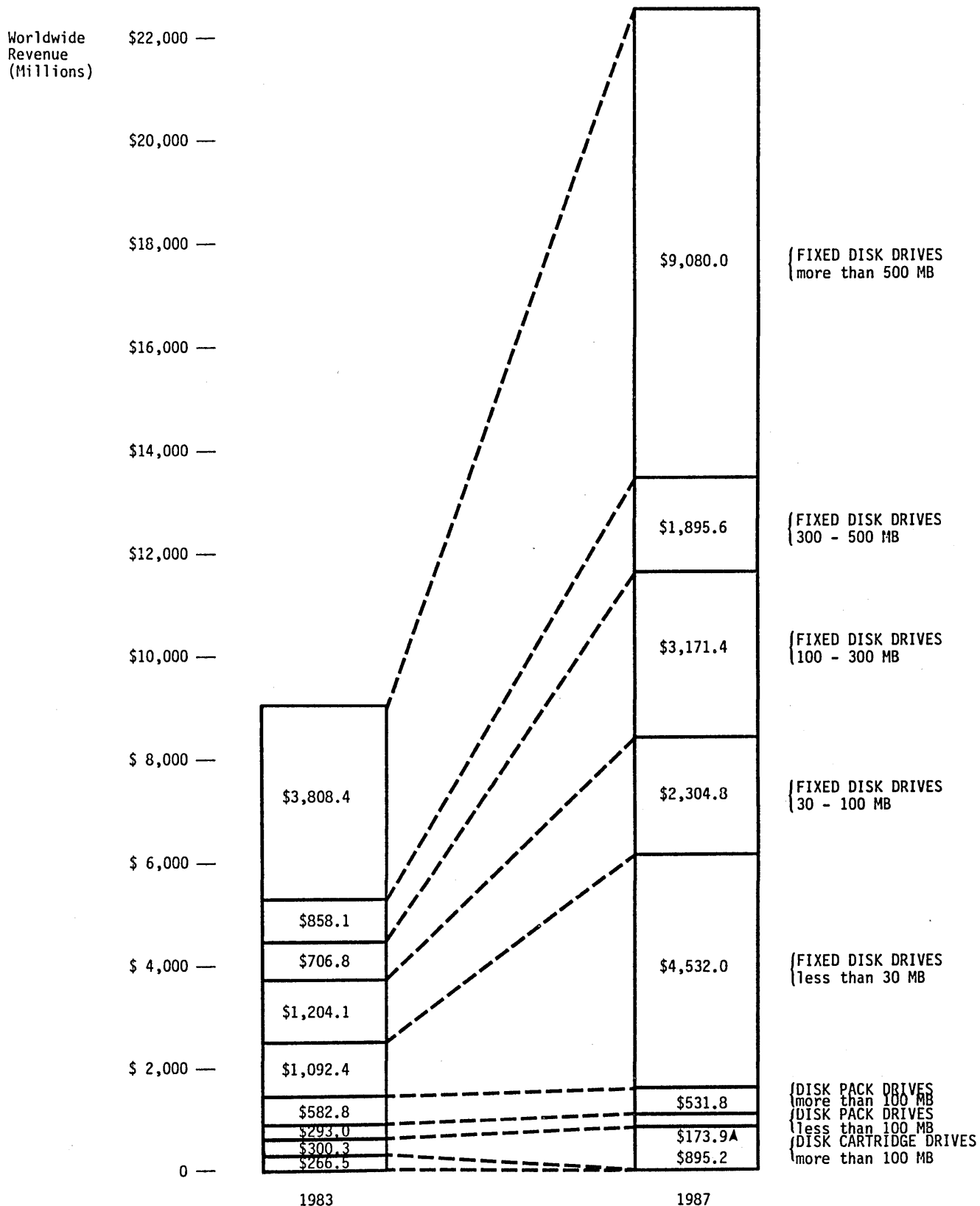
High growth in worldwide revenues is expected for all fixed disk drive groups, but the two groups over 300 megabytes will not increase their share of total revenues. The big growth in relative share of the industry's revenues will go to fixed disk drives less than 30 megabytes and those with 100-300 megabyte capacity.

Fixed disk drives less than 30 megabytes have been growing at a startling rate in recent years, led by 5.25" drives. Shipments of 5.25" drives in this group will be well over 2 million units this year, and the combined total of 5.25" and 3.5" drives forecasted for 1987 is over 6 million units. Worldwide revenues for all drives less than 30 megabytes are expected to be four times larger in 1987, rising to \$4,532,000,000 from the 1983 figure of \$1,092,400,000.

The fixed disk drive 100-300 megabyte group starts with a relatively low base in 1983. Numerous OEM 8" and 5.25" drives should find excellent emerging markets with multiple user microcomputers and local area networks, and IBM's expected programs are also expected to provide a major boost in total revenues.

**1984 DISK/TREND REPORT**

Figure 1  
 CHANGING PRODUCT MIX  
 CONSOLIDATED WORLDWIDE DISK DRIVE SHIPMENTS





OEM market

Worldwide unit shipments of OEM rigid disk drives have undergone explosive growth in the last few years, reaching increases for all OEM drives of 177.7% in 1983 and 103.3% in 1984. But the character of the OEM market is changing, and the average annual increase in worldwide OEM unit shipments for 1985-1987 is expected to average only 31%.

After several years of not being a participant in the low-end segment of the disk drive industry, IBM is expected to launch major manufacturing programs for new 3.5" and 5.25" drives in 1985, plus significant follow-on products to existing 8" and 14" drives. These programs will greatly reduce IBM's recent role as large customer for OEM drives, and IBM's aggressive introduction of new systems will probably hold down the OEM drive market with other system manufacturers, as their own market opportunity is reduced by IBM's competitive inroads.

U.S. manufacturers' share of worldwide OEM shipments is forecasted to fall from 80.9% in 1983 to 62.0% in 1987. The next few years will see several new Japanese manufacturers start production of small rigid disk drives, and most of these firms, plus existing drive manufacturers, will place emphasis on 3.5" and 5.25" drives, with installation of large scale production capabilities. In certain mid-range OEM drive areas, Japanese firms have already passed up U.S. manufacturers, by offering production quantities of certain types of drives first. In the fixed disk drive 100-300 megabyte group, U.S. manufacturers now hold a minority of the 14" and 8" worldwide OEM market, and they are not expected to catch up.

TABLE 3  
 CONSOLIDATED WORLDWIDE SHIPMENTS  
 PRODUCT CATEGORY REVIEW  
 REVENUE SUMMARY

	-----1983-----		-----Forecast-----							
	-----Revenues-----		-----1984-----		-----1985-----		-----1986-----		-----1987-----	
	\$M	%	\$M	%	\$M	%	\$M	%	\$M	%
WORLDWIDE REVENUES ALL MANUFACTURERS										
DISK CARTRIDGE DRIVES less than 12 MB	266.5	2.9	219.0	1.7	123.1	.8	58.0	.3	24.0	.1
DISK CARTRIDGE DRIVES more than 12 MB	300.3	3.3	389.1	3.0	571.5	3.7	731.9	3.8	895.2	4.0
DISK PACK DRIVES less than 100 MB	293.0	3.2	297.4	2.3	243.7	1.6	191.0	1.0	173.9	.8
DISK PACK DRIVES more than 100 MB	582.8 <i>1432.5</i>	6.4	743.6	5.8	716.4	4.6	646.4	3.4	531.8	2.4
FIXED DISK DRIVES less than 30 MB	1,092.4	12.0	1,730.0	13.4	2,402.3	15.4	3,541.1	18.6	4,532.0	20.0
FIXED DISK DRIVES 30 - 100 MB	1,204.1	13.2	1,450.7	11.2	1,657.5	10.6	1,999.8	10.5	2,304.8	10.2
FIXED DISK DRIVES 100 - 300 MB	706.8	7.8	1,385.7	10.7	2,118.0	13.6	2,608.1	13.7	3,171.4	14.0
FIXED DISK DRIVES 300 - 500 MB	858.1	9.4	1,196.2	9.3	1,269.8	8.1	1,533.8	8.0	1,895.6	8.4
FIXED DISK DRIVES more than 500 MB	3,808.4	41.8	5,511.0	42.6	6,521.3	41.6	7,778.3	40.7	9,080.0	40.1
Total Worldwide Revenue	9,112.4	100.0	12,922.7	100.0	15,623.6	100.0	19,088.4	100.0	22,608.7	100.0
% U.S. Mfg.	76.6	--	74.3	--	74.4	--	73.7	--	73.0	--
Annual Growth Rate	--	--	+41.8%		+20.9%		+22.1%		+18.4%	

TABLE 4  
 OEM WORLDWIDE SHIPMENTS  
 PRODUCT CATEGORY REVIEW  
 REVENUE SUMMARY

	-----1983-----		-----Forecast-----							
	Revenues		1984		1985		1986		1987	
	\$M	%	\$M	%	\$M	%	\$M	%	\$M	%
WORLDWIDE REVENUES ALL MANUFACTURERS										
DISK CARTRIDGE DRIVES less than 12 MB	100.8	5.2	105.2	3.5	67.2	1.8	38.0	.9	24.0	.5
DISK CARTRIDGE DRIVES more than 12 MB	173.6	8.9	160.0	5.3	207.1	5.6	242.7	5.5	278.2	5.5
DISK PACK DRIVES less than 100 MB	117.2	6.0	120.4	4.0	125.8	3.4	108.5	2.5	109.2	2.2
DISK PACK DRIVES more than 100 MB	264.0	13.6	287.5	9.5	255.7	6.9	192.8	4.4	136.2	2.7
FIXED DISK DRIVES less than 30 MB	613.7	31.6	914.4	30.2	1,089.1	29.5	1,214.0	27.7	1,408.2	27.9
FIXED DISK DRIVES 30 - 100 MB	306.3	15.8	624.0	20.6	721.0	19.5	778.3	17.8	813.0	16.1
FIXED DISK DRIVES 100 - 300 MB	144.2	7.4	323.9	10.7	489.8	13.3	727.0	16.6	946.7	18.8
FIXED DISK DRIVES 300 - 500 MB	120.8	6.2	298.0	9.8	445.8	12.1	578.0	13.2	679.3	13.5
FIXED DISK DRIVES more than 500 MB	100.0	5.3	197.8	6.4	287.1	7.9	498.4	11.4	646.2	12.8
Total Worldwide Revenue	1,940.6	100.0	3,031.2	100.0	3,688.6	100.0	4,377.7	100.0	5,041.0	100.0
% U.S. Mfg.	73.4	--	69.3	--	66.6	--	64.5	--	61.8	--
Annual Growth Rate	--	--	+56.1%		+21.6%		+18.6%		+15.1%	

TABLE 5  
 OEM WORLDWIDE SHIPMENTS  
 PRODUCT CATEGORY REVIEW  
 UNIT SHIPMENT SUMMARY

WORLDWIDE UNIT SHIPMENTS ALL MANUFACTURERS	-----1983-----		-----FORECAST (000 UNITS)-----							
	---Shipments---		-----1984-----		-----1985-----		-----1986-----		-----1987-----	
	Units	%	Units	%	Units	%	Units	%	Units	%
DISK CARTRIDGE DRIVES less than 12 MB	35.0	2.4	75.5	2.5	48.4	1.2	38.5	.7	31.9	.5
DISK CARTRIDGE DRIVES more than 12 MB	50.3	3.4	61.2	2.0	150.0	3.6	206.5	3.9	261.0	3.9
DISK PACK DRIVES less than 100 MB	22.6	1.5	24.8	.8	27.3	.7	25.5	.5	26.6	.4
DISK PACK DRIVES more than 100 MB	28.9	1.9	32.0	1.1	29.0	.7	22.0	.4	15.6	.2
FIXED DISK DRIVES less than 30 MB	1,136.5	76.6	2,219.1	73.5	3,126.0	74.6	3,964.8	74.6	5,134.5	75.8
FIXED DISK DRIVES 30 - 100 MB	152.5	10.3	459.6	15.2	572.1	13.6	669.0	12.6	750.8	11.1
FIXED DISK DRIVES 100 - 300 MB	35.5	2.4	86.1	2.9	140.0	3.3	236.5	4.5	356.8	5.3
FIXED DISK DRIVES 300 - 500 MB	15.2	1.0	43.6	1.4	75.0	1.8	109.2	2.1	146.6	2.2
FIXED DISK DRIVES more than 500 MB	8.0	.5	16.2	.6	24.1	.5	40.3	.7	52.5	.6
Total Worldwide Shipments	1,484.5	100.0	3,018.1	100.0	4,191.9	100.0	5,312.3	100.0	6,776.3	100.0
% U.S. Mfg.	80.9	--	75.6	--	71.4	--	67.5	--	62.0	--
Annual Growth Rate	--	--	+103.3%		+38.8%		+26.7%		+27.5%	

TABLE 6

1983 ESTIMATED MARKET SHARES  
 WORLDWIDE REVENUES OF ALL MOVING HEAD DISK DRIVES  
 (Value of non-U.S. currencies estimated at July, 1984, rates)

	CAPTIVE		PCM		OEM		TOTAL INDUSTRY	
	\$M	%	\$M	%	\$M	%	\$M	%
<u>U.S. MANUFACTURERS</u>								
Ampex	--	--	--	--	40.8	2.1	40.8	0.4
Burroughs	206.3	3.0	--	--	--	--	206.3	2.3
Century Data Systems	11.0	.2	--	--	49.5	2.6	60.5	.7
Computer Memories	--	--	--	--	40.9	2.1	40.9	.4
Control Data	434.0	6.3	26.8	9.3	576.3	29.7	1037.1	11.4
Data General	88.3	1.3	--	--	--	--	88.3	1.0
Digital Equipment	442.5	6.4	--	--	--	--	442.5	4.9
Hewlett-Packard	269.1	3.9	--	--	--	--	269.1	2.9
IBM	3,579.0	52.0	--	--	--	--	3,579.0	39.3
International Memories	24.3	.4	--	--	40.8	2.1	65.1	0.7
ISS	184.1	2.7	--	--	16.8	.9	200.9	2.2
Memorex	--	--	48.9	17.1	12.0	.6	60.9	.7
Microdata	42.5	.6	--	--	--	--	42.5	.5
Micropolis	--	--	--	--	31.8	1.6	31.8	.3
Miniscribe	--	--	--	--	77.0	4.0	77.0	.8
Priam	--	--	--	--	83.3	4.3	83.3	.9
Quantum	--	--	--	--	60.6	3.1	60.6	.7
Seagate	--	--	--	--	221.7	11.4	221.7	2.4
Shugart	41.8	.6	--	--	14.9	.8	56.7	.6
Storage Technology	--	--	73.9	25.8	7.9	.4	81.8	.9
Tandon	--	--	--	--	48.1	2.5	48.1	.5
Texas Instruments	78.0	1.1	--	--	--	--	78.0	.9
Other U.S.	7.9	.1	--	--	103.2	5.3	111.1	1.2
U.S. Total	5,408.8	78.6	149.6	52.2	1,425.6	73.5	6,984.0	76.6
<u>NON-U.S. MANUFACTURERS</u>								
Bull	64.9	.9	--	--	14.4	.7	79.3	.9
Fujitsu	380.9	5.5	75.0	26.2	237.7	12.3	693.6	7.6
Hitachi	209.9	3.0	34.8	12.1	30.5	1.6	275.2	3.0
ISOT	19.0	.3	--	--	82.4	4.3	101.4	1.1
Mitsubishi	28.7	.4	--	--	6.7	.3	35.4	.4
NEC	385.3	5.6	--	--	33.7	1.7	419.0	4.6
Nippon Peripherals	--	--	27.2	9.5	13.1	.7	40.3	.5
Nixdorf	80.0	1.2	--	--	--	--	80.0	.9
Olivetti	57.9	.8	--	--	4.5	.2	62.4	.7
Rodime	--	--	--	--	35.3	1.8	35.3	.4
Siemens	38.0	.6	--	--	--	--	38.0	.4
Toshiba	176.5	2.6	--	--	8.5	.4	185.0	2.0
Other Non-U.S.	35.1	.5	--	--	48.2	2.5	83.3	.9
Non-U.S. Total	1,476.2	21.4	137.0	47.8	515.0	26.5	2,128.2	23.4
Worldwide Total	6,885.0	100.0	286.6	100.0	1,940.6	100.0	9,112.2	100.0

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

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

TABLE 7  
 CURRENT PRODUCT LINES  
 MANUFACTURERS OF MOVING HEAD MAGNETIC DISK DRIVES

DISK/TREND PRODUCT GROUP:		1	2	3	4	5	6	7	8	9
U.S. Manufacturers	Type	Disk Cartridge Drives <12 MB	Disk Cartridge Drives >12 MB	Disk Pack Drives <100 MB	Disk Pack Drives >100 MB	Fixed Disk Drives <30 MB	Fixed Disk Drives 30-100 MB	Fixed Disk Drives 100-300 MB	Fixed Disk Drives 300-500 MB	Fixed Disk Drives >500 MB
Advanced Storage Technology	0						5	5		
Alpha Data	0						14			
Ancodyne	0		8					8		
Ampex	0			14	14	5		14	14	14
Applied Information Memories	0							5		
Applied Peripheral Systems	0								14	14
Atasi	0						5			
Burroughs	0,C			14	14		14	14		14
Cardiff	0		5							
Century Data Systems	0		8	14	14		14	14	14	14
Cogito	0					5				
Computer Memories	0					5	5			
Control Data	0,C,P	14	8,14	8,14	14	5,14	5	8,14	8,14	8,14
Data General	C				14	8,14	14		14	14
Digital Equipment	C	14	8,14	14	14			14	14	14
Disc Tech One	0					5,8	8,14	14	14	
Disctron	0						8			
DMA Systems	0	5	5							
Hewlett-Packard	C		14	14	14	14	14	14	14	
Ibis	0									14
IBM	C,0					8	8	14	14	14
International Memories	0					5	5			
Josephine County Technology	0					5				
Kennedy	0					8	8,14	8,14		
LaPine Technology	0					3				
Maxtor	0						5	5	5	
Megavault	0						8	8		
Memorex	0,C,P	5	5		14		5			14
Microcomputer Memories	0					3				
Microdata	C,0							14		
Micropolis	0					5,8	5,8	5,8	8	
Microscience International	0					3,5				
Miniscribe	0					5				
New World	0	5								
Northern Telecom	C,0					8	8	8	8	
PerSci	0	14	14							
Priam	0						5,8,14	8,14	8	8
Quantum	0					5,8	5,8			
Qume	0					5	5			
Seagate Technology	0					5		8		
Shugart	C,0					5,8,14				
Sperry	C			14			14	14		14
Storage Technology	0,P								14	14
SyQuest Technology	0	3	3			3	3			
Tandon	0					5	5			
Tecstor	0						14	14	14	
Texas Instruments	C					8	8			
Tulin	0					5	5			
Vermont Research	0	8	8,14							
Vertex Peripherals	0						5			
Western Dynex	0	5,14								
Xebec	0					5				
Japanese Manufacturers										
Fujitsu	C,0,P		14		14	5,8	8,5,14	8,14	8,10,14	10,14
Hitachi	C,0,P					5,8	5,8	5,8	8	8,14
Matsushita Com. Ind.	0					5				
Mitsubishi	C,0					5,8	8	8		
NEC	C,0				14	5,8	8,14	8,14	8,14	8,14
Nippon Electric Industry	0					5	5			
Nippon Peripherals	C,0,P					3,5	5		14	14
Nippon Systemhouse	0	3	3			3	3			
Otari	0					5				
Sord	0					5				
TEAC	0					5				
Tokico	C,0					5				
Toshiba	C,0		14			5,8	8	8		
Victor Company of Japan	0					5				
European Manufacturers										
BASF	0					5	5			
Bull	C,0	10	5,10			5	5,10	10		
ISOT	C,0	14		14	14					
Newbury	0	5,14	14				5,8	5		
Nixdorf	C			14						
Olivetti	C,0					5				
Pertec	0	14	14					8	8	
Rodime	0					3,5	5			
Siemens	C				14					

## TECHNICAL REVIEW

### Competing technologies

High growth levels in the disk drive industry have attracted would-be competitive technologies from the beginning, but only a few remain as likely contenders.

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

Other would-be alternates to magnetic rigid disk recording have found the competition tougher than expected. Magnetic disk technology is frequently described as a "moving target." And as the target moves it becomes continually more cost effective.

The history of magnetic disk recording is one of continually improving recording densities, and this advancement translates directly into lower cost for data storage. Higher density means fewer heads and disks for a given capacity, thus reduced physical size, smaller motors, less heat, lower power, etc. And as densities have been improved, continual development in head positioning techniques has provided faster access to data.

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

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

- \* Non-reversible optical disks: The first optical disk recording systems to enter the market are "non-reversible" or "write-once" systems. Such systems are now starting to be introduced as actual products, after many years of costly development programs by several manufacturers in the United States, Japan and Europe.

Write-once systems are capable of higher areal densities than magnetic recording techniques now in use, with some planned systems providing several gigabytes on a single removable disk, and the promise of mass storage systems which could access large numbers of such disks under system control. Although not yet demonstrated, advocates of the various types of optical disk media technologies believe that their disks will provide archival lives which equal or exceed those of magnetic media.

In broad terms, two kinds of systems will be offered: Document storage and data storage systems. Systems intended to store images of documents are already on the market in Japan, offered by Toshiba and Matsushita Electric. Document storage systems do not require the extremely low error rates demanded for data storage, and can live with the relatively poor error rates common to all optical recording systems. At this time, it does not appear that optical document storage systems will be able to compete on a price per image basis with microfilm for bulk storage of images.



However, the fast and convenient access to stored images provided by optical disk systems will probably create a major place for them in the emerging office automation market, for numerous specialized applications. The early emphasis on optical document storage systems in the Japanese market is explained by the extremely complicated character of the Japanese alphabet. Since most business communication and records are in handwritten characters, the emphasis first on copying machines, then facsimile transmission, and now optical document storage systems is understandable.

Optical data storage systems from a variety of firms, including Storage Technology, Control Data, Xerox, Alcatel Thomson, Hitachi, Toshiba, NEC and Fujitsu are now starting to appear. STC's 7600, with first shipments delayed until first quarter, 1985, is probably the most ambitious of these projects, involving a program intended to rapidly build a major market among users of large IBM mainframes. The disk subsystem carries a list purchase price of \$130,000, uses the STC 8880 controller, and has a transfer rate of 3 megabytes/second, the same as the 3380 magnetic disk drive. Each disk cartridge contains a single 14" disk, is priced from \$140 to \$225, depending on quantity, and has a capacity of four gigabytes. STC has identified a large number of target applications involving databases which are infrequently or never updated, and for which a write once system would not be at a disadvantage -- such as stock market history, legal files, seismic data and banking transaction logs. Replacement of magnetic tape for archival storage is also high on the target list.

The other write-once systems about to enter the market use comparable, but different technologies, with capacities per disk in the range of one to three gigabytes. These systems will be marketed initially as OEM drives, and some will probably be used also in captive systems. Obviously, the market for this generation of optical disk systems will be limited to the niches which can tolerate nonreversability. It is believed that these niches do exist and that the low cost per byte stored will start to open selected markets to optical disk systems. But the markets will be specialized, with system manufacturers slow to act. Little displacement of magnetic disk drives will result in the foreseeable future.

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

Most current magneto-optical development programs involve using a low power laser to change the magnetic state of an amorphous

gadolinium coating on a disk, by raising surface temperatures into the range of the coating's Curie point, while a magnetic field is present. These changes 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.

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.

Advocates of both technologies claim the ability to reverse the state at individual disk locations more times than would ever be necessary, and believe that their disks will be adequately stable for archival storage. Individual firms are also working on other proposed reversible optical recording technologies, but none of these are known to have overcome all of the problems, which have included: Slow completion of the reversal cycle, limitations on the number of reversals before degradation, poor shelf life, and low recording density.

Magneto-optical and phase change technologies have been developed to the point where they both appear to have some hope of becoming reliable, producible products. However, it is believed that the first volume shipments of major erasable optical disk drive systems will take another three to five years. Most of the technical problems may have been overcome by some of the U.S., Japanese or European companies working in the area, but none of these firms are yet known to have committed to the heavy investment required to establish volume production capability.

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

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

So bubbles started to find suitable applications, once they were actually in production and support chips became available. The

largest manufacturing levels are still maintained by Hitachi, with most production used by Nippon Telephone and Telegraph for a variety of telecommunication applications. AT&T, with manufacturing by Western Electric, is believed to be much further behind in developing internal bubble applications, despite the fact that the basic technology was invented at Bell Labs.

The successful bubble program of Intel Magnetics has been instrumental in developing a wide variety of applications. Intel led the market with 1 Mbit chips, the introduction of support circuits and a guaranteed future price reduction policy. The company has attracted a variety of customers in specialized and harsh environment applications -- at least sufficient to establish quantity production, and start down the learning curve. The hottest new market area for bubbles is potentially the largest one: Portable computers. Several of the new portable computer manufacturers have incorporated bubble memories as basic auxiliary memory devices, because of bubbles' advantages of physical size and durability while being transported.

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

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

- \* High capacity flexible disk drives: Ironically, the most likely type of product to displace certain rigid disk drives is the high capacity flexible disk drive. Some new floppy drives, and others to be announced, have the potential to do just that. The market for personal computers is growing at a rapid rate, and shipments of small Winchester disk drives are keeping pace.

The 3.3 MB 5.25" floppies now being shipped by Drivetec and Eastman Kodak are developing markets with specialized systems and in the personal computer add-on market, with a promise to double capacities to 6.6 MB next year. But capacities in this range are only the beginning of the potential expansion of floppy drive capabilities. Two other more significant rival technologies are waiting in the wings to boost floppy capacity.

Perpendicular recording for flexible disks has received considerable attention in recent years, and has the potential to increase capacity for a 5.25" drive to 5-10 MB without significant increases in track density. By using a sputtered thin film

on a Mylar substrate, disks for perpendicular recording could achieve linear densities of at least 50,000 BPI.

It is likely that the largest limitation to the development of markets for such a drive will be media availability. Success would require that media be produced by the millions of units, which would be difficult with today's batch sputtering processes. Vertimag, a Minneapolis firm, plans to solve this problem by the installation of a continuous sputtering process of their own design, with the projected capability to make five million 3.5" flexible disks per year -- enough to get the entire program off to a good start if all goes well. Toshiba, Sony and Matsushita Electric have also revealed programs to develop 3.5" drives and media using perpendicular recording.

The other technology with real promise for improving floppy capacities involves use of very small magnetic particles, very little longer than they are wide. Use of such particles in coatings with conventional binder systems could result in "isotropic" magnetic recording, in which many more flux changes per inch could be obtained than with conventional recording. The big advantage for this technique may be producibility of the media, with little to change in existing floppies but the magnetic particles. Presumably, existing coating lines operated by the several major floppy media suppliers could be used.

Currently, the Spin Physics subsidiary of Eastman Kodak is the principal advocate for this technology, and has provided media samples to manufacturers for evaluation. The principal difficulty with isotropic media to date has been oversensitivity to thermal change, with the potential under some circumstances to lose recorded data. However, several firms are working in this area, and there is a high probability that magnetic particles for coated flexible disks will be produced with the ability to extend linear densities into ranges approaching 50,000 BPI.

#### Disk drive enhancements

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

\* Recording heads: Winchester heads patterned after IBM's 3340/3350 designs still dominate in new fixed media disk drives, except for PCM drives designed to compete against IBM's 3370,

3375 and 3380. The conventional ferrite heads are available from multiple sources, are routinely produced with good manufacturing yields, and are competitively priced. And they will continue to be used for the majority of other captive and OEM drives until thin film heads are widely available and are price competitive with Winchester heads. 1984 saw the beginning of thin film head shipments for small diameter OEM disk drives, and production is expected to gradually increase as more vendors start to master the process and gain control of process yields.

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

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

However, recent years have seen considerable activity in plated disks for the first time, with emphasis on 5.25" drives. Things got started in 1981, with adoption of plated media by Irwin International, IMI, New World, Evotek, SyQuest, and Texas Instruments, all for 5.25" or smaller disk drives, and Ibis, for 14" drives. Ampex was the major supplier for the bulk of the plated disks used through 1983. However several other companies have installed production capacity for high shipment levels, and many more are known to be preparing for plated disk production, also. Some of this activity has been generated because of the higher density potential of plated disks (few of the above drives need more density than oxide disks offer), but most of the early choices were made because of plated disks' better physical durability.

There is now a stampede by numerous established and new firms to establish production capability for plated disks. Most are aiming at the market for 5.25" and smaller disk drives, and the managements involved recognize the need to establish credibility by offering facilities capable of producing large quantities of disks, with adequate process controls, at prices competitive with oxide disks of comparable quality. A second wave of companies planning to use sputtering methods to deposit thin metal films is also underway. And some plan to use both plating and sputtering technologies in multiple layer disks.

- \* Head positioning methods: The industry is not moving forward rapidly with TPI improvements. Several of the highest perfor-

mance drives operate at about 960 TPI, but such precision is too costly for most drives. The industry still has plenty of room for innovation in this area -- the majority of disk drives still operate below 500 TPI. It is likely that IBM will introduce a double density version of the 3380 in the first half of 1985, using higher track density. This drive probably will use at least 1,400 TPI, and will be influential in moving the rest of the industry to higher track densities.

- \* Perpendicular recording: Today's disk drives all use longitudinal recording, making use of long, thin magnetic particles oriented parallel to the surface of the recording medium. Many more flux changes per inch could theoretically be resolved by recording heads if magneticization were oriented in a plane perpendicular to the recording surface. The potential appears to be at least 100,000 BPI.

A very large amount of development activity in perpendicular recording is currently underway in Japan, with application objectives in video and audio recording, as well as for data storage. In the United States, IBM and other established manufacturers have development programs, but it appears that the earliest products may come from small firms. Lanx is now supplying sputtered small diameter disks to manufacturers of existing high performance small drives, with the objective of making significant increases in capacity possible for existing drive mechanisms at modest cost increases. The firm has sold a license to Control Data for this technology, and both companies are cooperating in development of hardware. Although the CDC program will probably take a few years to result in actual products, it is expected that some other firms may find the potential competitive advantages they are looking for in perpendicular recording. Drives using this technology may actually be shipped soon, with a fairly rapid development of the market if production bugs can be kept to a minimum.

## 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 class: Used here, arbitrarily, to differentiate captive, PCM and OEM disk drive marketing activities.

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

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

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

- \* Shipments by Shugart are non-captive, except for drives sold with systems by its parent company or other subsidiaries.
- \* CDC disk drive sales to NCR are non-captive, in that NCR does not share in ownership of MPI, and are included in OEM totals.

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

ably equipped to be connected without additional hardware to systems of all types, including minicomputers and small business systems.

Examples:

- \* Disk pack drives sold by CDC to users of IBM Series/1 systems.
- \* On an arbitrary basis, drives manufactured by Fujitsu, Hitachi, or Nippon Peripherals and resold in the PCM market by other companies are included in PCM totals, in order to avoid distortion of total industry PCM activity.

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

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

Examples:

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

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

Examples:

- \* IBM, Seagate and Hewlett-Packard are considered U.S. manufacturers, even though each firm manufactures some of its disk drives in non-U.S. locations.
- \* Pertec and Northern Telecom are considered non-U.S. manufacturers, since they are subsidiaries of non-U.S. firms.

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



Revenue: Based on sales of disk drives alone, as normally sold by individual manufacturers. Controllers sold as separate units are not included, nor are spare parts or service. When individual disk drive models include integral control functions, such as may be required for the first drive on a string of drives, the actual value of each unit is used. Sale prices are estimated public sale transaction prices, whether at captive end user, PCM or OEM levels. Prices used for leased drives are on an "if sold" basis, at captive or PCM levels, as appropriate. All proposed prices are in 1984 constant dollars.

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

- \* Enhancements such as double density versions of existing configurations and revised encoding schemes are anticipated in DISK/TREND forecasts.
- \* Innovations such as disks in non-standard sizes or new physical configurations may require establishment of new DISK/TREND product groups.

Distribution channels: Shipments of non-captive drives are analyzed by each of the following distribution channels:

Mainframe computer manufacturers: The major computer manufacturers, sometimes popularly known as "mainframers". In the U.S. this group consists of IBM, Sperry, Honeywell, Burroughs, Control Data, and NCR.

Mini/micro computer manufacturers: Computer manufacturers primarily oriented to the minicomputer class, such as DEC, Hewlett-Packard, and Data General, and the manufacturers of microprocessor-based systems, such as Intel and National Semiconductor.

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

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

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

DISK CARTRIDGE DRIVES, LESS THAN 12 MB



DISK CARTRIDGE DRIVES, LESS THAN 12 MEGABYTESCoverage

Examples of disk drives in this group include:

14" disk diameter

Control Data	9427H
Digital Equipment	RL01, RL02
ISOT	CM 5400, CM 5410
Newbury Data	D9427H
Pertec	D3421, D3442
PerSci	VF-2221, VT-2222
Western Dynex	DD-6221

10.5" disk diameter

Bull	D120
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8" disk diameter

Disctron	DP-100
Vermont Research	8010

5.25" disk diameter

DMA Systems	Micro-magnum 5
Memorex	410
New World	Micro-Disc 5/5
Newbury Data	505
Western Dynex	WD-505

3.9" disk diameter

SyQuest Technology	SQ-306RD
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This product group includes all removable-only or fixed/removable disk drives with a total capacity per spindle of less than 12 MB. Each fixed/removable combination drive is counted as one spindle.

Market status

DISK/TREND estimate of total market size:

<u>Worldwide sales (\$M)</u>	<u>1983</u>	<u>1984</u>	<u>1985</u>	<u>1986</u>	<u>1987</u>
U.S. manufacturers	197.3	157.6	78.7	38.3	16.3
All manufacturers	266.5	219.0	123.1	58.0	24.0

14" disk cartridge drives are now in their fourth year of declining shipments. 1983 worldwide shipments of drives using smaller diameter disks were below expectations, but certain drives in this group have increased sharply in shipments for 1984. Overall worldwide unit shipments for the group were 72,500 units in 1983, up 6.2% over the previous year.

14" disk drives in this group have been displaced in small business systems, their largest market, by the flood of 8" and 5.25" fixed disk drives which have become available in the last few years. Shipments of drives using removable disks in these diameters were very small before 1983, due to limited availability. Seagate Technology dropped its announced 5.25" disk cartridge drive before shipment, but DMA Systems has established quantity production and has licensed its drives to Memorex and Newbury Data.

One change in the method of classifying small diameter disk cartridge drives being initiated in this year's DISK/TREND Report will result in fewer drives in the current shipment estimates and forecasts for future years. Combination fixed/removable disk drives with a total capacity over 12 megabytes per spindle, such as some DMA Systems models, are no longer included in this group. The 5.25" and less than 5.25" drives remaining in the group are typically removable-only drives with unformatted capacity in the 6 megabyte range.

Captive drive shipments are mostly Digital Equipment Corporation's

## **1984 DISK/TREND REPORT**

RL01/RL02 14" drives. Shipments of these drives remained high during 1983, primarily because of DEC's delays in introducing the planned replacement product, the 8" "Aztec" drive, with 52 megabytes per spindle. The Aztec, however, has now been introduced as the RC25, and shipments started in late 1983 -- with the expected result that shipments of DEC's 14" disk cartridge drives will now fall off rapidly.

The character of OEM drive shipments has been transformed in the last few years, as the once-large shipments of 14" drives by U.S. manufacturers have dropped to negligible levels. ISOT, the Bulgarian organization which manufactures disk cartridge drives for minicomputers produced in Eastern Bloc countries, maintained its production at the 11,500 drive-per-year level, representing 32.9% of worldwide unit shipments for 1983. Control Data trailed with 19.1%.

#### Marketing trends

DISK/TREND forecasts assume that all production of 14" and 8" drives in this group will stop by 1987. 14" drives have been largely replaced by small diameter fixed disk drives in most new system designs, causing a slowdown for shipments of small diameter disk cartridge drives. OEM and captive shipments of 14" drives by non-U.S. manufacturers are expected to continue at least through 1985, principally for Eastern Bloc consumption.

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

## **1984 DISK/TREND REPORT**

This year's projections for 5.25" disk cartridge drive shipments have been sharply reduced from those in last year's report, due to the emphasis that drive manufacturers are now placing on drives with over 12 megabytes, which will be covered in another product group. The number of drive manufacturers with 5.25" models in this group remains small, composed mainly of DMA Systems and its licensees. There are currently no announced captive 5.25" drives in the group.

The 1987 forecast for 5.25" worldwide OEM unit shipments is only 24,900 drives. These will be mostly 6 megabyte drives, with much smaller market potential than higher capacity models. Most system OEMs have already switched from 6 to 12 megabyte drives for their fixed disk drive requirements, and the majority of those OEMs which need removability are expected to prefer more capacity than the 6 megabytes offered by drives in this group. Some OEMs are also expected to make use of the 5.25 inch flexible disk drives with 6 megabyte capacity which are expected to be available starting in 1985, for applications which do not require the faster access times offered by rigid disk drives.

It is expected that much of the market available to 6 megabyte 5.25" disk cartridge drives will be through subsystem builders active in the personal computer add-on market. The rapid growth of 1984 shipments for SyQuest 3.9" removable disk drives was driven in large part by excellent response from PC users who were not offered any removable media recording device with capacity above 500 kilobytes by IBM or most other PC system manufacturers.

In the second half of 1984 IBM announced availability of 1.6 megabyte floppy drives on the PC AT, but the many PC users with files larger than that capacity are believed to represent a continuing market for various

removable recording devices with capacity in the 5 to 10 megabyte range, including removable rigid disk drives. However, the limited sourcing of drives in this group, combined with the availability of higher capacity disk cartridge drives, will keep most system OEMs away.

### Technical trends

Technology used in the new small disk cartridge drives is adapted from older designs. Heads use variations from 3330 and 3350 designs, in some cases combined with smaller sliders. Disks used in current drives include conventional Winchester oxide coated and plated types.

3M's stretched surface recording technology may be a potential contender in this product group, depending on actual availability and the results of the extensive testing expected before drive manufacturers use it in production drives. SSR disks have the potential to cut media costs sharply and probably would be much more durable than conventional disks in difficult shock and vibration environments or when exposed to contamination, as removable disk cartridges frequently are.

### Forecasting assumptions

1. 14" disk cartridge drives will continue to decline, due to competitive pressure from higher capacity disk cartridge drives and small diameter disk drives, both fixed and disk cartridge types.
2. Shipments of 8" disk cartridge drives in this group will start to top out in 1984, due to competition from smaller drives.
3. Both 5.25" and less than 5.25" drives in this group will be available in quantities adequate to meet demand, starting in 1984.
4. OEM price levels will decline, as shipments of smaller drives become predominant and quantities increase.



TABLE 8  
DISK CARTRIDGE DRIVES, LESS THAN 12 MEGABYTES  
REVENUE SUMMARY

	-----DISK DRIVE REVENUES, BY SHIPMENT DESTINATION (\$M)-----									
	1983		-----Forecast-----							
	Revenues		1984		1985		1986		1987	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
<b>U.S. Manufacturers</b>										
IBM Captive	--	--	--	--	--	--	--	--	--	--
Other U.S. Captive	93.5	154.5	63.8	105.8	30.8	51.3	12.0	20.0	--	--
TOTAL U.S. CAPTIVE	93.5	154.5	63.8	105.8	30.8	51.3	12.0	20.0	--	--
PCM	--	--	--	--	--	--	--	--	--	--
OEM	27.5	42.8	37.8	51.8	21.2	27.5	13.9	18.3	12.2	16.3
TOTAL U.S. NON-CAPTIVE	27.5	42.8	37.8	51.8	21.2	27.5	13.9	18.3	12.2	16.3
<b>TOTAL U.S. REVENUES</b>	<b>121.0</b>	<b>197.3</b>	<b>101.6</b>	<b>157.6</b>	<b>52.0</b>	<b>78.7</b>	<b>25.9</b>	<b>38.3</b>	<b>12.2</b>	<b>16.3</b>
<b>Non-U.S. Manufacturers</b>										
Captive	--	11.2	--	8.0	--	4.7	--	--	--	--
PCM	--	--	--	--	--	--	--	--	--	--
OEM	2.4	58.0	.4	53.4	--	39.7	--	19.7	--	7.7
TOTAL NON-U.S. REVENUES	2.4	69.2	.4	61.4	--	44.4	--	19.7	--	7.7
<b>Worldwide Recap</b>										
TOTAL WORLDWIDE REVENUES	123.4	266.5	102.0	219.0	52.0	123.1	25.9	58.0	12.2	24.0
OEM Average Price (\$000)	2.1	2.8	.9	1.3	.9	1.3	.7	.9	.7	.7

TABLE 9  
DISK CARTRIDGE DRIVES, LESS THAN 12 MB  
UNIT SHIPMENT SUMMARY

	-----DISK DRIVE UNIT SHIPMENTS, BY SHIPMENT DESTINATION (000)-----									
	1983		1984		1985		1986		1987	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers	-----									
IBM Captive	--	--	--	--	--	--	--	--	--	--
Other U.S. Captive	21.4	35.5	15.1	25.1	7.5	12.5	3.0	5.0	--	--
TOTAL U.S. CAPTIVE	21.4	35.5	15.1	25.1	7.5	12.5	3.0	5.0	--	--
PCM	--	--	--	--	--	--	--	--	--	--
OEM	13.2	20.5	41.0	56.6	22.5	29.7	18.2	24.5	16.6	22.4
TOTAL U.S. NON-CAPTIVE	13.2	20.5	41.0	56.6	22.5	29.7	18.2	24.5	16.6	22.4
TOTAL U.S. SHIPMENTS	34.6	56.0	56.1	81.7	30.0	42.2	21.2	29.5	16.6	22.4
Non-U.S. Manufacturers	-----									
Captive	--	2.0	--	1.4	--	.8	--	--	--	--
PCM	--	--	--	--	--	--	--	--	--	--
OEM	.9	14.5	.1	18.9	--	18.7	--	14.0	--	9.5
TOTAL NON-U.S. SHIPMENTS	.9	16.5	.1	20.3	--	19.5	--	14.0	--	9.5
Worldwide Recap	-----									
TOTAL WORLDWIDE SHIPMENTS	35.5	72.5	56.2	102.0	30.0	61.7	21.2	43.5	16.6	31.9
Cumulative Shipments	-----									
IBM Captive	53.3	79.0	53.3	79.0	53.3	79.0	53.3	79.0	53.3	79.0
Non-IBM	523.1	955.5	579.3	1,057.5	609.3	1,119.2	630.5	1,162.7	647.1	1,194.6
WORLDWIDE TOTAL	576.4	1,034.5	632.6	1,136.5	662.6	1,198.2	683.8	1,241.7	700.4	1,273.6

TABLE 10  
DISK CARTRIDGE DRIVES, LESS THAN 12 MEGABYTES  
WORLDWIDE SHIPMENTS (000)  
BREAKDOWN BY DISK DIAMETER

	1983				Forecast															
	Shipments				1984				1985				1986				1987			
	14"	8"	5.25"	<5.25"	14"	8"	5.25"	<5.25"	14"	8"	5.25"	<5.25"	14"	8"	5.25"	<5.25"	14"	8"	5.25"	<5.25"
<b>U.S. MANUFACTURERS</b>																				
IBM Captive	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Other U.S. Captive	35.5	--	--	--	25.1	--	--	--	12.5	--	--	--	5.0	--	--	--	--	--	--	--
OEM	10.5	2.3	4.2	3.5	5.0	6.3	5.3	40.0	1.5	5.3	8.4	14.5	--	1.8	12.7	10.0	18.4	4.0		
TOTAL U.S. SHIPMENTS	46.0	2.3	4.2	3.5	30.1	6.3	5.3	40.0	14.0	5.3	8.4	14.5	5.0	1.8	12.7	10.0	18.4	4.0		
<b>NON-U.S. MANUFACTURERS</b>																				
Captive	.5	1.5	--	--	.5	.9	--	--	.3	.5	--	--	--	--	--	--	--	--	--	--
OEM	13.5	1.0	--	--	12.0	.4	1.5	5.0	8.0	.2	3.5	7.0	3.0	--	5.0	6.0	6.5	3.0		
TOTAL NON-U.S. SHIPMENTS	14.0	2.5	--	--	12.5	1.3	1.5	5.0	8.3	.7	3.5	7.0	3.0	--	5.0	6.0	6.5	3.0		
<b>WORLDWIDE RECAP</b>																				
Total Shipments	60.0	4.8	4.2	3.5	42.6	7.6	6.8	45.0	22.3	6.0	11.9	21.5	8.0	1.8	17.7	16.0	24.9	7.0		
ANNUAL SHARE, BY DIAMETER	82.8%	6.6%	5.8%	4.8%	41.8%	7.5%	6.7%	44.0%	36.1%	9.7%	19.3%	34.9%	18.4%	4.1%	40.7%	36.8%	78.1%	21.9%		

NOTE: 8 inch totals include 10.5 inch drives

TABLE 11  
DISK CARTRIDGE DRIVES, LESS THAN 12 MEGABYTES  
WORLDWIDE REVENUES  
BREAKDOWN BY DISK DIAMETER

	1983				1984				1985				Forecast					
	14"	8"	5.25"	<5.25"	14"	8"	5.25"	<5.25"	14"	8"	5.25"	<5.25"	14"	8"	5.25"	<5.25"	5.25"	<5.25"
<b>U.S. MANUFACTURERS</b>																		
IBM Captive	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Other U.S. Captive	154.5	--	--	--	105.8	--	--	--	51.2	--	--	--	20.0	--	--	--	--	--
OEM	33.2	3.1	4.6	1.7	16.5	8.3	6.9	20.0	4.9	6.8	8.4	7.2	--	2.3	11.4	4.5	14.7	1.6
TOTAL U.S. REVENUES	187.7	3.1	4.6	1.7	122.3	8.3	6.9	20.0	56.2	6.8	8.4	7.2	20.0	2.3	11.4	4.5	14.7	1.6
<b>NON-U.S. MANUFACTURERS</b>																		
Captive	4.0	7.2	--	--	4.0	4.0	--	--	2.4	2.2	--	--	--	--	--	--	--	--
OEM	56.4	1.6	--	--	48.5	.6	1.6	2.5	32.0	.3	3.8	3.5	12.0	--	5.0	2.7	6.5	1.2
TOTAL NON-U.S. REVENUES	60.4	8.8	--	--	52.5	4.6	1.6	2.5	34.4	2.5	3.8	3.5	12.0	--	5.0	2.7	6.5	1.2
<b>WORLDWIDE RECAP</b>																		
Total Revenues	248.1	11.9	4.6	1.7	174.9	13.0	8.5	22.5	90.6	9.4	12.2	10.7	32.0	2.3	16.4	7.2	21.2	2.8
ANNUAL SHARE, BY DIAMETER	93.1%	4.5%	1.7%	.7%	79.9%	6.0%	3.9%	10.2%	73.6%	7.7%	10.0%	8.7%	55.2%	4.0%	28.3%	12.5%	88.3%	11.7%

NOTE: 8 inch totals include 10.5 inch drives

TABLE 12  
DISK CARTRIDGE DRIVES, LESS THAN 12 MEGABYTES  
DISTRIBUTION CHANNEL SUMMARY  
U.S. Non-Captive Disk Drives

Distribution channel	1983 U.S. Net Shipments		FORECAST			
	Units (000)	%	1984 %	1985 %	1986 %	1987 %
Mainframe computer manufacturers	1.6	11.4	3.2	2.7	2.2	1.6
Mini/micro computer manufacturers	3.5	24.8	20.1	18.0	15.3	12.6
System OEMs/systems houses	5.6	39.7	30.1	46.4	60.1	69.5
Independent peripherals suppliers	3.2	22.7	45.5	32.0	21.7	15.7
Distributors, dealers, end users	.2	1.4	1.1	.9	.7	.6
TOTAL	14.1					

TABLE 13  
DISK CARTRIDGE DRIVES, LESS THAN 12 MEGABYTES  
MARKET SHARE SUMMARY  
Worldwide Shipments of Non-Captive Disk Drives

Drive Manufacturers	1983 Net Shipments											
	To United States Destinations					Worldwide						
	Units (000)					%	Units (000)					%
	14"	8"	5.25"	<5.25"	Total		14"	8"	5.25"	<5.25"	Total	
Isot	--	--	--	--	--	--	11.5	--	--	--	11.5	32.9
Control Data	4.4	--	--	--	4.4	31.2	6.7	--	--	--	6.7	19.1
DMA Systems	--	--	2.1	--	2.1	14.9	--	--	4.2	--	4.2	12.0
Syquest	--	--	--	2.5	2.5	17.7	--	--	--	3.5	3.5	10.0
Other U.S.	2.3	1.9	--	--	4.2	29.8	3.8	2.3	--	--	6.1	17.4
Other Non-U.S.*	.4	.5	--	--	.9	6.4	2.0	1.0	--	--	3.0	8.6
TOTAL	7.1	2.4	2.1	2.5	14.1	100.0	24.0	3.3	4.2	3.5	35.0	100.0

\*8 inch totals include 10.5 inch drives

DISK CARTRIDGE DRIVES, MORE THAN 12 MB

**1984 DISK/TREND REPORT**



DISK CARTRIDGE DRIVES, MORE THAN 12 MEGABYTESCoverage

Examples of disk drives in this group include:

14" disk diameter

✓ Ampex	DFR-932, DFR-964, DFR-996
✓ Control Data	9448-32, 9448-64, 9448-96
D - Digital Equipment	RK06, RK07
✓ Fujitsu	<del>M2201, F451</del> F6417
✓ Hewlett-Packard	7906
D - Newbury Data	D9448-32, D9448-64, D9448-96
✓ PerSci	VT-2422
D - Pertec	D3461, D3482
✓ Toshiba	MK-900R-32/64/96
✓ Vermont Research	5017-4

10.5" disk diameter

✓ Bull	D140, D145
--------	------------

8" disk diameter

✓ Amcodyne	Arapahoe 7110
✓ Century Data Systems	C2075, C2120
✓ Control Data	<del>9454, 9455</del> , 9457
D - Vermont Research	8520
	DEC PC25

5.25" disk diameter

✓ Bull	D520
D - Cardiff Technology	D-240
D - DMA Systems	360, 11/11, 11R
D - Memorex	450

3.9" disk diameter

D - Nippon Systemhouse	SQ312RD
✓ SyQuest Technology	SQ312RD

This is a diverse group of drives, all of which use a removable disk cartridge, which is usually, but not always combined with one or more fixed disks in a single drive. Several unique configurations are also included, such as Fujitsu's M-2201 (50 MB removable), DEC's RK06 and



RK07 (up to 27.5 MB in a special two-disk 14" removable cartridge), and Vermont Research's pioneer embedded servo drive, the 5017-4 (14" 26 MB fixed/26 MB removable).

### Market status

DISK/TREND estimate of total market size:

<u>Worldwide sales (\$M)</u>	<u>1983</u>	<u>1984</u>	<u>1985</u>	<u>1986</u>	<u>1987</u>
U.S. manufacturers	237.4	317.2	500.8	666.6	823.1
All manufacturers	300.3	389.1	571.5	731.9	895.2

Although dropping off rapidly in shipment volume, the Control Data "Phoenix" cartridge module drive continued to dominate this product group in 1983. But the trend is clear: Control Data CMD shipments to non-captive customers were 28,500 drives in 1982, dropping to 23,900 in 1983, with a further substantial decline estimated for 1984.

Nevertheless, worldwide unit shipments of drives in this group to all market classes is expected to grow 39% in 1984 over the previous year, due to continuing shipment increases for 8", 5.25" and less than 5.25" drives. Most of the current growth is from U.S. drive manufacturers which have pioneered a variety of new formats in small disk diameter drives.

50,300 OEM drives were shipped worldwide in 1983, with an increase expected to 61,200 in 1984. Control Data accounted for 60.7% of worldwide non-captive unit shipments in 1983, including a combined total of 30,600 units for both 14" and 8" drives. The CDC 8" "Lark" family of drives provided only 6,700 of the above total, representing several years of start-up problems for this program and a reduced level of acceptance among Control Data's broad customer base.

The character of the OEM market for small diameter drives in this

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group is now in a transition period, as newer companies start to achieve some measure of success in introducing small drives. DMA Systems' product line now includes both removable-only and fixed/removable 5.25" drives in this capacity range, and SyQuest's newest removable-only 3.9" drive is also in the group. Amcodyne has been successful in selling its 8" fixed/removable drive with 25 megabytes per disk to major system manufacturers.

Production of captive 14" drives will continue to decline, with the last production of 14" drives in this group in 1983 by Data General, Datapoint, Digital Equipment and Mitsubishi -- and with other programs at reduced levels in 1984. The principal current growth in captive drives is in 8" fixed/removable drives in the 50 megabyte range, led by DEC's long-awaited "Aztec". The Aztec was finally introduced late in 1983 as the RC25, with 26 megabytes on a single removable 8" disk, combined with a fixed disk at the same capacity.

#### Marketing trends

DISK/TREND forecasts for this product area have been increased, reflecting expected excellent growth for 8", 5.25" and less than 5.25" drives. Worldwide shipments of all drives are expected to increase from 63,700 in 1983 to 340,000 in 1987, an average annual growth of 56%.

The last production year for 14" drives is expected to be 1986, as the drives with smaller disk diameters take over OEM markets and 8" drives dominate captive production. 8" drives are expected to find use mainly with minicomputer systems, replacing the older 14" drives now being phased out.

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5.25" fixed/removable drives are expected to find acceptance mostly with general purpose and specialized microcomputer systems, which themselves are now in a rapid growth phase, penetrating the markets previously served by small minicomputers. Removable-only 5.25" and smaller drives will probably find their major market opportunity in add-on subsystems aimed at the high end of the personal computer market. This market, of course, is a volatile one -- with the distinct possibility that the emergence of high capacity flexible disk drives could impact the projected shipment growth for rigid disk cartridge drives.

#### Technical trends

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

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

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

will be high. Changes in heads, filtration systems and seals may be necessary, and plated disks may be used because their surfaces seem to be more durable than oxide coated disks.

#### Forecasting assumptions

1. 8" disk cartridge drives will be widely accepted, due to integral backup capability, small physical size and competitive pricing.
2. 5.25" disk cartridge drives will be available in large production quantities from multiple sources starting in 1985, with good acceptance.
3. Digital Equipment will be able to increase production of its 8" drive without interruption.

TABLE 14  
DISK CARTRIDGE DRIVES, MORE THAN 12 MEGABYTES  
REVENUE SUMMARY

	-----DISK DRIVE REVENUES, BY SHIPMENT DESTINATION (\$M)-----									
	1983		Forecast							
	Revenues		1984		1985		1986		1987	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
<b>U.S. Manufacturers</b>										
IBM Captive	--	--	--	--	--	--	--	--	--	--
Other U.S. Captive	62.3	84.1	128.8	182.6	212.6	325.3	288.3	457.7	356.0	584.0
TOTAL U.S. CAPTIVE	62.3	84.1	128.8	182.6	212.6	325.3	288.3	457.7	356.0	584.0
PCM	1.2	1.2	1.2	1.2	--	--	--	--	--	--
OEM	94.5	152.2	87.9	133.4	129.6	175.5	153.2	208.9	168.1	239.1
TOTAL U.S. NON-CAPTIVE	95.7	153.4	89.1	134.6	129.6	175.5	153.2	208.9	168.1	239.1
TOTAL U.S. REVENUES	158.0	237.4	217.9	317.2	342.2	500.8	441.5	666.6	524.1	823.1
<b>Non-U.S. Manufacturers</b>										
Captive	--	41.4	--	45.3	--	39.1	--	31.5	--	33.0
PCM	--	--	--	--	--	--	--	--	--	--
OEM	5.5	21.5	5.7	26.6	6.1	31.6	6.3	33.8	7.3	39.1
TOTAL NON-U.S. REVENUES	5.5	62.9	5.7	71.9	6.1	70.7	6.3	65.3	7.3	72.1
<b>Worldwide Recap</b>										
TOTAL WORLDWIDE REVENUES	163.5	300.3	223.6	389.1	348.3	571.5	447.8	731.9	531.4	895.2
OEM Average Price (\$000)	3.6	3.4	2.5	2.6	1.3	1.4	1.2	1.2	1.1	1.1

TABLE 15  
DISK CARTRIDGE DRIVES, MORE THAN 12 MB  
UNIT SHIPMENT SUMMARY

	-----DISK DRIVE UNIT SHIPMENTS, BY SHIPMENT DESTINATION (000)-----									
	1983		Forecast							
	Shipments		1984		1985		1986		1987	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
<b>U.S. Manufacturers</b>										
IBM Captive	--	--	--	--	--	--	--	--	--	--
Other U.S. Captive	6.4	8.6	15.0	21.5	25.8	39.5	35.6	56.5	44.5	73.0
TOTAL U.S. CAPTIVE	6.4	8.6	15.0	21.5	25.8	39.5	35.6	56.5	44.5	73.0
PCM	.1	.1	.1	.1	--	--	--	--	--	--
OEM	26.1	44.3	35.4	52.2	100.5	125.5	134.8	170.0	159.2	210.0
TOTAL U.S. NON-CAPTIVE	26.2	44.4	35.5	52.3	100.5	125.5	134.8	170.0	159.2	210.0
TOTAL U.S. SHIPMENTS	32.6	53.0	50.5	73.8	126.3	165.0	170.4	226.5	203.7	283.0
<b>Non-U.S. Manufacturers</b>										
Captive	--	4.7	--	5.9	--	5.5	--	5.0	--	6.0
PCM	--	--	--	--	--	--	--	--	--	--
OEM	1.4	6.0	2.2	9.0	2.9	24.5	3.8	36.5	5.2	51.0
TOTAL NON-U.S. SHIPMENTS	1.4	10.7	2.2	14.9	2.9	30.0	3.8	41.5	5.2	57.0
<b>Worldwide Recap</b>										
TOTAL WORLDWIDE SHIPMENTS	34.0	63.7	52.7	88.7	129.2	195.0	174.2	268.0	208.9	340.0
<b>Cumulative Shipments</b>										
IBM Captive	--	--	--	--	--	--	--	--	--	--
Non-IBM	156.8	284.9	209.5	373.6	338.7	568.6	512.9	836.6	721.8	1,176.6
WORLDWIDE TOTAL	156.8	284.9	209.5	373.6	338.7	568.6	512.9	836.6	721.8	1,176.6

TABLE 16  
DISK CARTRIDGE DRIVES, MORE THAN 12 MEGABYTES  
WORLDWIDE SHIPMENTS (000)  
BREAKDOWN BY DISK DIAMETER

	1983			1984				1985				1986				1987		
	14"	8"	5.25"	14"	8"	5.25"	<5.25"	14"	8"	5.25"	<5.25"	14"	8"	5.25"	<5.25"	8"	5.25"	<5.25"
<b>U.S. MANUFACTURERS</b>																		
Other U.S. Captive	5.5	3.1	--	1.9	19.6	--	--	.5	39.0	--	--	--	56.5	--	--	73.0	--	--
PCM	.1	--	--	.1	--	--	--	--	--	--	--	--	--	--	--	--	--	--
OEM	23.9	7.9	12.5	15.2	12.8	19.2	5.0	8.5	24.0	38.0	55.0	3.0	37.0	63.0	67.0	48.0	85.0	77.0
TOTAL U.S. SHIPMENTS	29.5	11.0	12.5	17.2	32.4	19.2	5.0	9.0	63.0	38.0	55.0	3.0	93.5	63.0	67.0	121.0	85.0	77.0
<b>NON-U.S. MANUFACTURERS</b>																		
Captive	1.7	3.0	--	1.4	3.0	1.5	--	1.0	2.0	2.5	--	.5	.5	4.0	--	--	6.0	--
OEM	4.0	2.0	--	4.0	1.5	3.5	--	2.5	1.0	6.0	15.0	1.0	.5	9.0	26.0	--	13.0	38.0
TOTAL NON-U.S. SHIPMENTS	5.7	5.0	--	5.4	4.5	5.0	--	3.5	3.0	8.5	15.0	1.5	1.0	13.0	26.0	--	19.0	38.0
<b>WORLDWIDE RECAP</b>																		
Total Shipments	35.2	16.0	12.5	22.6	36.9	24.2	5.0	12.5	66.0	46.5	70.0	4.5	94.5	76.0	93.0	121.0	104.0	115.0
ANNUAL SHARE, BY DIAMETER	55.3%	25.1%	19.6%	25.5%	41.6%	27.3%	5.6%	6.4%	33.8%	23.8%	36.0%	1.7%	35.3%	28.4%	34.6%	35.6%	30.6%	33.8%

NOTE: 8 inch totals include 10.5 inch drives

TABLE 17  
DISK CARTRIDGE DRIVES, MORE THAN 12 MEGABYTES  
WORLDWIDE REVENUES  
BREAKDOWN BY DISK DIAMETER

	1983			1984				1985				1986				1987		
	14"	8"	5.25"	14"	8"	5.25"	<5.25"	14"	8"	5.25"	<5.25"	14"	8"	5.25"	<5.25"	8"	5.25"	<5.25"
<b>U.S. MANUFACTURERS</b>																		
Other U.S. Captive	57.7	26.3	--	22.0	160.6	--	--	5.5	319.8	--	--	--	457.6	--	--	584.0	--	--
PCM	1.2	--	--	1.2	--	--	--	--	--	--	--	--	--	--	--	--	--	--
OEM	110.7	25.1	16.2	70.7	40.4	19.2	3.0	39.1	74.4	30.4	31.6	13.8	111.0	47.2	36.8	139.2	59.5	40.4
TOTAL U.S. REVENUES	169.7	51.4	16.2	94.0	201.0	19.2	3.0	44.6	394.2	30.4	31.6	13.8	568.6	47.2	36.8	723.2	59.5	40.4
<b>NON-U.S. MANUFACTURERS</b>																		
Captive	20.3	21.0	--	16.8	19.5	9.0	--	12.0	12.6	14.5	--	6.0	3.1	22.4	--	--	33.0	--
OEM	18.1	3.4	--	18.0	2.5	5.9	--	11.2	1.7	9.6	9.0	4.5	.8	13.5	14.9	--	18.2	20.9
TOTAL NON-U.S. REVENUES	38.4	24.4	--	34.8	22.0	14.9	--	23.2	14.3	24.1	9.0	10.5	3.9	35.9	14.9	--	51.2	20.9
<b>WORLDWIDE RECAP</b>																		
Total Revenues	208.2	75.8	16.2	128.8	223.1	34.1	3.0	67.8	408.5	54.5	40.6	24.3	572.6	83.1	51.8	723.2	110.7	61.3
ANNUAL SHARE, BY DIAMETER	69.3%	25.3%	5.4%	33.1%	57.3%	8.8%	.8%	11.9%	71.5%	9.5%	7.1%	3.3%	78.2%	11.4%	7.1%	80.8%	12.4%	6.8%

NOTE: 8 inch totals include 10.5 inch drives



TABLE 18  
 DISK CARTRIDGE DRIVES, MORE THAN 12 MEGABYTES  
 DISTRIBUTION CHANNEL SUMMARY  
 U.S. Non-Captive Disk Drives

Distribution channel	1983 U.S. Net Shipments		FORECAST			
	Units (000)	%	1984 %	1985 %	1986 %	1987 %
Mainframe computer manufacturers	5.0	18.1	13.2	7.3	6.1	5.3
Mini/micro computer manufacturers	8.6	31.2	17.5	13.6	14.2	15.1
System OEMs/systems houses	12.1	43.8	58.6	35.3	26.5	23.0
Independent peripherals suppliers	1.5	5.4	9.3	42.5	52.0	55.6
Distributors, dealers, end users	.4	1.5	1.4	1.3	1.2	1.0
TOTAL	27.6					

TABLE 19  
 DISK CARTRIDGE DRIVES, MORE THAN 12 MEGABYTES  
 MARKET SHARE SUMMARY  
 Worldwide Shipments of Non-Captive Disk Drives

Drive Manufacturers	1983 Net Shipments									
	To United States Destinations					Worldwide				
	Units (000)				%	Units (000)				%
	14"	8"	5.25"	Total		14"	8"	5.25"	Total	
Control Data	16.0	3.5	--	19.5	70.6	23.9	6.7	--	30.6	60.7
DMA Systems	--	--	5.9	5.9	21.4	--	--	12.5	12.5	24.8
Other U.S.	--	.8	--	.8	2.9	.1	1.2	--	1.3	2.6
Other Non-U.S.*	1.1	.3	--	1.4	5.1	4.0	2.0	--	6.0	11.9
TOTAL	17.1	4.6	5.9	27.6	100.0	28.0	9.9	12.5	50.4	100.0

\*8 Inch Totals Include 10.5 Inch Drives

DISK PACK DRIVES, LESS THAN 100 MB

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DISK PACK DRIVES, LESS THAN 100 MEGABYTESCoverage

Examples of disk drives in this group include:

14" disk diameter

D	— Ampex	DM-980
D	— Burroughs	9484-5
D	— Century Data Systems	T82
✓	Control Data	9762, 271-10
✓	Hewlett-Packard	7920
✓	ISOT	CM 5412
D	— Sperry	8149

9" disk diameter

✓	Control Data	9710
---	--------------	------

The Control Data 9760 series, the original "storage module drives", have exerted broad influence in the industry since their 1974 introduction. "SMD" became the generally used term for drives using 3330 technology in packs with five data surfaces, as well as for the larger 19 data surface disk pack drives using similar interfaces. The SMD interface itself became the dominant industry standard for high performance OEM disk drives. The term SMD is used throughout the DISK/TREND Report as a generic description for these 14" Control Data drives and competitive equivalents.

Control Data's 9" "RSD", or 9710, is functionally similar to the 80 MB SMD in every way except for smaller size and lower price. Its physical size is matched to the 160 MB "FSD" 9" fixed disk drive, which was also introduced at the 1982 NCC.

Market status

DISK/TREND estimate of total market size:

<u>Worldwide sales (\$M)</u>	<u>1983</u>	<u>1984</u>	<u>1985</u>	<u>1986</u>	<u>1987</u>
U.S. manufacturers	202.4	206.8	182.3	147.8	137.4
All manufacturers	293.0	297.4	243.7	191.0	173.9

Unit shipments in this product group have been in decline since 1981, the victim of the general industry trend to fixed disk drives. The only product in the group to move upward in sales is the Control Data 9" RSD, starting modestly in 1983 with 1,100 OEM drives shipped worldwide, but expected to grow to 5,200 units in 1984.

The OEM 14" storage module drives offered by Control Data and a few competitors, which created this product area, continued to drop in 1983, down over 20%, to 20,500 units. The rate of decline for 1984 is not quite as steep, down only to 18,400 OEM units worldwide, reflecting a stronger minicomputer market. In 1983, Control Data continued to dominate worldwide OEM shipments, with 17,100 drives, for 74.3% of the total. Century Data Systems held 13.1% of the market.

Captive shipments of drives in this class are flat for the moment, during 1983-84, with manufacturing programs at several firms continuing until plans for smaller diameter fixed disk drives are implemented. The largest existing captive program in this group is that of Nixdorf, which has been producing 80 megabyte drives under a Control Data license.

Marketing trends

DISK/TREND forecasts for both 14" and 9" drives in this group have been lowered again, in view of the growing availability of 8" and 5.25" fixed disk drives with similar capacities, competition from disk cartridge

drives with over 50 megabyte capacity, and Control Data's continuing status as sole supplier for the 9" disk pack drive.

Growth is forecasted for 9" drives, with total shipments to all customers up to 24,100 units in 1987. But this will not be enough to prevent overall worldwide revenues for the group from declining from \$297,000,000 in 1984 to \$173,900,000 in 1987 -- as captive shipments fade and higher-priced 14" OEM drives are replaced by 9" drives.

### Technical trends

Control Data has used a conservative approach in designing the RSD. Recording density is higher than the SMD, but well below the most advanced drives of today -- leaving adequate design margins for the double density version the firm has told its customers to expect later. Today's RSD is well designed to take advantage of the existing SMD customer base, providing exactly the same capacity, performance, file organization and interface, but in half the space, at a significant price reduction. However, nothing has been heard from Century Data Systems or Ampex, CDC's traditional rivals in the SMD market, about additional 9" disk pack drives. These firms appear to be using all their energies on fixed disk drives of various sizes.

### Forecasting assumptions

1. Captive and OEM shipments of 14" drives in this group will continue to decline through 1987, displaced by smaller disk pack drives and a variety of fixed disk drives.
2. RSD drives will dominate shipments after 1985.
3. The changing product mix in OEM drives in favor of the RSD will cause average OEM prices to continually decline through 1987.
4. CDC will remain the only manufacturer for 9" disk pack drives.

TABLE 20  
DISK PACK DRIVES, LESS THAN 100 MEGABYTES  
REVENUE SUMMARY

	-----DISK DRIVE REVENUES, BY SHIPMENT DESTINATION (\$M)-----									
	1983		-----Forecast-----							
	Revenues		1984		1985		1986		1987	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
<b>U.S. Manufacturers</b> -----										
IBM Captive	--	--	--	--	--	--	--	--	--	--
Other U.S. Captive	39.2	88.3	41.6	93.6	32.1	68.6	28.6	55.7	28.5	51.9
TOTAL U.S. CAPTIVE	39.2	88.3	41.6	93.6	32.1	68.6	28.6	55.7	28.5	51.9
PCM	4.3	4.4	1.9	1.9	1.9	1.9	2.6	3.5	3.4	5.1
OEM	55.8	109.7	57.2	111.3	61.7	111.8	53.8	88.6	49.6	80.4
TOTAL U.S. NON-CAPTIVE	60.1	114.1	59.1	113.2	63.6	113.7	56.4	92.1	53.0	85.5
TOTAL U.S. REVENUES	99.3	202.4	100.7	206.8	95.7	182.3	85.0	147.8	81.5	137.4
<b>Non-U.S. Manufacturers</b> -----										
Captive	--	83.1	--	81.5	--	47.4	--	23.4	--	7.7
PCM	--	--	--	--	--	--	--	--	--	--
OEM	--	7.5	--	9.1	--	14.0	--	19.8	--	28.8
TOTAL NON-U.S. REVENUES	--	90.6	--	90.6	--	61.4	--	43.2	--	36.5
<b>Worldwide Recap</b> -----										
TOTAL WORLDWIDE REVENUES	99.3	293.0	100.7	297.4	95.7	243.7	85.0	191.0	81.5	173.9
OEM Average Price (\$000)	5.1	5.2	4.5	4.9	4.2	4.6	3.7	4.3	3.4	4.1

TABLE 21  
DISK PACK DRIVES, LESS THAN 100 MB  
UNIT SHIPMENT SUMMARY

	-----DISK DRIVE UNIT SHIPMENTS, BY SHIPMENT DESTINATION (000)-----									
	1983		Forecast							
	Shipments		1984		1985		1986		1987	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
<b>U.S. Manufacturers</b>										
IBM Captive	--	--	--	--	--	--	--	--	--	--
Other U.S. Captive	2.9	6.5	3.1	6.9	2.4	5.1	2.3	4.4	2.5	4.5
TOTAL U.S. CAPTIVE	2.9	6.5	3.1	6.9	2.4	5.1	2.3	4.4	2.5	4.5
PCM	.4	.4	.2	.2	.2	.2	.3	.4	.4	.6
OEM	11.0	21.6	12.6	23.6	14.7	25.5	14.4	23.0	14.4	23.0
TOTAL U.S. NON-CAPTIVE	11.4	22.0	12.8	23.8	14.9	25.7	14.7	23.4	14.8	23.6
TOTAL U.S. SHIPMENTS	14.3	28.5	15.9	30.7	17.3	30.8	17.0	27.8	17.3	28.1
<b>Non-U.S. Manufacturers</b>										
Captive	--	5.2	--	5.1	--	3.0	--	1.5	--	.5
PCM	--	--	--	--	--	--	--	--	--	--
OEM	--	1.0	--	1.2	--	1.8	--	2.5	--	3.6
TOTAL NON-U.S. SHIPMENTS	--	6.2	--	6.3	--	4.8	--	4.0	--	4.1
<b>Worldwide Recap</b>										
TOTAL WORLDWIDE SHIPMENTS	14.3	34.7	15.9	37.0	17.3	35.6	17.0	31.8	17.3	32.2
<b>Cumulative Shipments</b>										
IBM Captive	--	--	--	--	--	--	--	--	--	--
Non-IBM	186.9	298.3	202.8	335.3	220.1	370.9	237.1	402.7	254.4	434.9
WORLDWIDE TOTAL	186.9	298.3	202.8	335.3	220.1	370.9	237.1	402.7	254.4	434.9



TABLE 22  
 DISK PACK DRIVES, LESS THAN 100 MEGABYTES  
 WORLDWIDE SHIPMENTS (000)  
 BREAKDOWN BY DISK DIAMETER

	1983		Forecast							
	Shipments		1984		1985		1986		1987	
	14"	8"	14"	8"	14"	8"	14"	8"	14"	8"
<b>U.S. MANUFACTURERS</b>										
Other U.S. Captive	6.5	--	6.9	--	4.8	.3	2.9	1.5	1.0	3.5
PCM	.4	--	.2	--	.2	--	.1	.3	--	.6
OEM	20.5	1.1	18.4	5.2	15.0	10.5	7.0	16.0	3.0	20.0
TOTAL U.S. SHIPMENTS	27.4	1.1	25.5	5.2	20.0	10.8	10.0	17.8	4.0	24.1
<b>NON-U.S. MANUFACTURERS</b>										
Captive	5.2	--	5.1	--	3.0	--	1.5	--	.5	--
PCM	--	--	--	--	--	--	--	--	--	--
OEM	1.0	--	1.2	--	1.8	--	2.5	--	3.6	--
TOTAL NON-U.S. SHIPMENTS	6.2	--	6.3	--	4.8	--	4.0	--	4.1	--
<b>WORLDWIDE RECAP</b>										
Total Shipments	33.6	1.1	31.8	5.2	24.8	10.8	14.0	17.8	8.1	24.1
ANNUAL SHARE, BY DIAMETER	96.8%	3.2%	85.9%	14.1%	69.7%	30.3%	44.0%	56.0%	25.2%	74.8%

NOTE: 8 inch totals include 9 inch drives

TABLE 23  
 DISK PACK DRIVES, LESS THAN 100 MEGABYTES  
 WORLDWIDE REVENUES  
 BREAKDOWN BY DISK DIAMETER

	1983		Forecast							
	Revenues		1984		1985		1986		1987	
	14"	8"	14"	8"	14"	8"	14"	8"	14"	8"
<b>U.S. MANUFACTURERS</b>										
Other U.S. Captive	88.2	--	93.6	--	65.2	3.3	39.1	16.5	13.4	38.5
PCM	4.3	--	1.8	--	1.8	--	.9	2.5	--	5.1
OEM	104.6	5.0	92.6	18.7	75.0	36.7	34.3	54.4	14.4	66.0
TOTAL U.S. REVENUES	197.2	5.0	188.1	18.7	142.1	40.0	74.3	73.4	27.8	109.6
<b>NON-U.S. MANUFACTURERS</b>										
Captive	83.1	--	81.4	--	47.4	--	23.4	--	7.7	--
PCM	--	--	--	--	--	--	--	--	--	--
OEM	7.5	--	9.1	--	14.0	--	19.7	--	28.8	--
TOTAL NON-U.S. REVENUES	90.6	--	90.5	--	61.4	--	43.1	--	36.5	--
<b>WORLDWIDE RECAP</b>										
Total Revenues	287.9	5.0	278.6	18.7	203.6	40.0	117.5	73.4	64.3	109.6
ANNUAL SHARE, BY DIAMETER	98.3%	1.7%	93.7%	6.3%	83.6%	16.4%	61.5%	38.5%	37.0%	63.0%

NOTE: 8 inch totals include 9 inch drives

TABLE 24  
 DISK PACK DRIVES, LESS THAN 100 MEGABYTES  
 DISTRIBUTION CHANNEL SUMMARY  
 U.S. Non-Captive Disk Drives

<u>Distribution channel</u>	1983 U.S. Net Shipments		FORECAST			
	Units (000)	%	1984 %	1985 %	1986 %	1987 %
Mainframe computer manufacturers	1.5	13.2	12.8	12.6	12.4	12.1
Mini/micro computer manufacturers	7.3	64.0	62.9	62.2	60.9	59.9
System OEMs/systems houses	2.2	19.3	21.2	22.7	24.1	25.3
Independent peripherals suppliers	--	--	--	--	--	--
Distributors, dealers, end users	.4	3.5	3.1	2.5	2.6	2.7
TOTAL	11.4					

TABLE 25  
 DISK PACK DRIVES, LESS THAN 100 MEGABYTES  
 MARKET SHARE SUMMARY  
 Worldwide Shipments of Non-Captive Disk Drives

<u>Drive Manufacturers</u>	1983 Net Shipments							
	To United States Destinations				Worldwide			
	Units (000)			%	Units (000)			%
	14"	8"	Total		14"	8"	Total	
Control Data	7.4	.8	8.2	71.9	16.0	1.1	17.1	74.3
Century Data Systems	2.7	--	2.7	23.7	3.0	--	3.0	13.1
Other U.S.	.5	--	.5	4.4	1.9	--	1.9	8.3
Other Non-U.S.	--	--	--	--	1.0	--	1.0	4.3
TOTAL	10.6	.8	11.4	100.0	21.9	1.1	23.0	100.0

DISK PACK DRIVES, MORE THAN 100 MB



DISK PACK DRIVES, MORE THAN 100 MEGABYTESCoverage

Examples of disk drives in this group include:

✓ Ampex	DM-9300
✓ Burroughs	9484- <del>12</del> 13
✓ Century Data Systems	<del>T202, T300</del> T306
✓ Control Data	9766, 270-30
✓ Data General	6060, 6061, 6122
✓ Digital Equipment	RA60
✓ Fujitsu	F479
✓ Hewlett-Packard	<del>7925</del> , 7935H
✓ ISOT	ES 5066, ES 5067.02
✓ NEC	N7745
✓ Siemens	3465, 3468

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

Market status

DISK/TREND estimate of total market size:

<u>Worldwide sales (\$M)</u>	<u>1983</u>	<u>1984</u>	<u>1985</u>	<u>1986</u>	<u>1987</u>
U.S. manufacturers	514.2	689.1	668.5	596.4	485.8
All manufacturers	582.8	743.6	716.4	646.4	531.8

Worldwide shipments of drives in this group did not decline quite as low as expected in 1983, holding at 43,800 spindles -- and shipments of both OEM and captive drives are growing again in 1984. The total this

year is forecasted at 57,600 units.

Captive drives are providing the largest boost in current shipments. Digital Equipment's first full year of production for the RA60 accounts for much of the increase, helped by shipment increases by Burroughs and Hewlett-Packard.

The worldwide OEM market for U.S. manufacturers declined only slightly from a two-year plateau at 27,500 units per year during 1981/82, down to 25,800 spindles. Non-captive worldwide shipments totaled 28,900 units in 1983. Control Data still dominated the market, with 72% of the non-captive total. The outlook for 1984 is a slight increase, fueled by renewed sales of minicomputer systems which had been slowed down for a few years by the recent recession.

#### Marketing trends

Total captive drive shipments in this group are expected to increase slowly until peaking in 1986. During this period DEC's shipments should increase, but most other manufacturers will be gradually phasing out their existing large disk pack drives.

U.S. manufacturers of OEM drives are now expected to see the current renewed growth for SMD type 300 megabyte drives peak this year, with a slight decrease in 1985, and a sharp drop after that. Competition from fixed disk drives, including 8", 10.5" and 14" versions, is simply too effective, considering the improved reliability and lower cost they offer. The fixed disk drives are obviously being designed into most new systems requiring capacities in this range. The increase in shipments of non-U.S. drives is caused by ISOT's production of large disk pack drives for use with Eastern Bloc mainframes and minicomputers.

### Technical trends

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

### Forecasting assumptions

1. The population of IBM and PCM 3330 drives will continue to decline, due to displacement by newer systems and disk drives.
2. New captive drives will cause growth through 1986, but OEM drives will decline after 1984, displaced by large fixed disk drives.



TABLE 26  
DISK PACK DRIVES, MORE THAN 100 MEGABYTES  
REVENUE SUMMARY

	-----DISK DRIVE REVENUES, BY SHIPMENT DESTINATION (\$M)-----									
	1983		Forecast							
	Revenues		1984		1985		1986		1987	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
<u>U.S. Manufacturers</u>										
IBM Captive	--	--	--	--	--	--	--	--	--	--
Other U.S. Captive	133.3	281.6	227.0	439.8	264.0	456.0	270.0	450.0	235.2	392.0
TOTAL U.S. CAPTIVE	133.3	281.6	227.0	439.8	264.0	456.0	270.0	450.0	235.2	392.0
PCM	--	--	1.8	1.8	1.8	1.8	3.6	3.6	3.6	3.6
OEM	147.2	232.6	147.8	247.5	126.4	210.7	85.7	142.8	54.1	90.2
TOTAL U.S. NON-CAPTIVE	147.2	232.6	149.6	249.3	128.2	212.5	89.3	146.4	57.7	93.8
TOTAL U.S. REVENUES	280.5	514.2	376.6	689.1	392.2	668.5	359.3	596.4	292.9	485.8
<u>Non-U.S. Manufacturers</u>										
Captive	--	37.2	--	14.5	--	2.9	--	--	--	--
PCM	--	--	--	--	--	--	--	--	--	--
OEM	--	31.4	--	40.0	--	45.0	--	50.0	--	46.0
TOTAL NON-U.S. REVENUES	--	68.6	--	54.5	--	47.9	--	50.0	--	46.0
<u>Worldwide Recap</u>										
TOTAL WORLDWIDE REVENUES	280.5	582.8	376.6	743.6	392.2	716.4	359.3	646.4	292.9	531.8
OEM Average Price (\$000)	9.0	9.1	8.9	9.0	8.6	8.8	8.4	8.8	8.2	8.7

TABLE 27  
DISK PACK DRIVES, MORE THAN 100 MEGABYTES  
UNIT SHIPMENT SUMMARY

	-----DISK DRIVE UNIT SHIPMENTS, BY SHIPMENT DESTINATION (000)-----									
	1983		1984		1985		Forecast		1987	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
<b>U.S. Manufacturers</b>										
IBM Captive	--	--	--	--	--	--	--	--	--	--
Other U.S. Captive	6.7	13.7	13.4	25.0	16.5	28.5	18.0	30.0	16.8	28.0
TOTAL U.S. CAPTIVE	6.7	13.7	13.4	25.0	16.5	28.5	18.0	30.0	16.8	28.0
PCM	--	--	.1	.1	.1	.1	.2	.2	.2	.2
OEM	16.3	25.8	16.7	28.0	14.7	24.5	10.2	17.0	6.6	11.0
TOTAL U.S. NON-CAPTIVE	16.3	25.8	16.8	28.1	14.8	24.6	10.4	17.2	6.8	11.2
TOTAL U.S. SHIPMENTS	23.0	39.5	30.2	53.1	31.3	53.1	28.4	47.2	23.6	39.2
<b>Non-U.S. Manufacturers</b>										
Captive	--	1.2	--	.5	--	.1	--	--	--	--
PCM	--	--	--	--	--	--	--	--	--	--
OEM	--	3.1	--	4.0	--	4.5	--	5.0	--	4.6
TOTAL NON-U.S. SHIPMENTS	--	4.3	--	4.5	--	4.6	--	5.0	--	4.6
<b>Worldwide Recap</b>										
TOTAL WORLDWIDE SHIPMENTS	23.0	43.8	30.2	57.6	31.3	57.7	28.4	52.2	23.6	43.8
<b>Cumulative Shipments</b>										
IBM Captive	41.3	72.6	41.3	72.6	41.3	72.6	41.3	72.6	41.3	72.6
Non-IBM	216.7	378.0	246.9	435.6	278.2	493.3	306.6	545.5	330.2	589.3
WORLDWIDE TOTAL	258.0	450.6	288.2	508.2	319.5	565.9	347.9	618.1	371.5	661.9

TABLE 28  
 DISK PACK DRIVES, MORE THAN 100 MEGABYTES  
 DISTRIBUTION CHANNEL SUMMARY  
 U.S. Non-Captive Disk Drives

<u>Distribution channel</u>	1983 U.S. Net Shipments		FORECAST			
	Units (000)	%	1984 %	1985 %	1986 %	1987 %
Mainframe computer manufacturers	.9	5.5	3.9	1.7	--	--
Mini/micro computer manufacturers	12.7	77.9	79.5	81.9	83.5	83.7
System OEMs/systems houses	2.0	12.3	12.5	12.7	13.1	13.4
Independent peripherals suppliers	.6	3.7	3.5	3.1	2.6	2.1
Distributors, dealers, end users	<u>.1</u>	.6	.6	.6	.8	.8
TOTAL	16.3					

TABLE 29  
 DISK PACK DRIVES, MORE THAN 100 MEGABYTES  
 MARKET SHARE SUMMARY  
 Worldwide Shipments of Non-Captive Disk Drives

<u>Drive Manufacturers</u>	1983 Net Shipments			
	To United States Destinations		Worldwide	
	Units (000)	%	Units (000)	%
Control Data	11.9	73.0	20.8	72.0
Other U.S.	4.4	27.0	5.0	17.3
Other Non-U.S.	<u>--</u>	<u>--</u>	<u>3.1</u>	<u>10.7</u>
TOTAL	16.3	100.0	28.9	100.0

FIXED DISK DRIVES, LESS THAN 30 MB



FIXED DISK DRIVES, LESS THAN 30 MEGABYTESCoverage

Examples of disk drives in this group include:

14" disk diameter

✓ Control Data	230-10, 240-15
✓ Data General	<del>6098</del> , 6100
✓ Hewlett-Packard	7911
✓ Shugart	SA4004, SA4008

8 disk diameter

	<del>4956-30D</del>
✓ IBM	<del>4963-29</del> , 5247-011
✓ Data General	6220, 6227
D - Disc Tech One	8432
✓ Fujitsu	M2301, M2302
D - Hewlett-Packard	7908
D - Kennedy	6172
D - Micropolis	1202, 1222MII
✓ Mitsubishi	M2860-1
D - NEC	D2220, N7724
D - Northern Telecom	Aspen II
✓ Quantum	Q2010, Q2020
D - Shugart	SA1004
D - Texas Instruments	WD 800-18
✓ Toshiba	MK-80F-10/20

Hitachi DR11-2

5.25" disk diameter

✓ APS BL, DRA010AX DRA020A*	✓ Ampex	Pyxis <del>7</del> , 13, <del>20</del> , 27
✓ EPSON 1-D-830, 1-D-840*	✓ BASF	<del>6182</del> , 6185, 6188*
IBM 5160-087 5170-099	✓ Bull	D505, D506, D510
	✓ Cogito Systems	CG906*, PT912*, PT925*
	✓ Computer Memories	CM3212*, CM3426*, CM6426
	✓ Control Data	9415- <del>1021</del> , 578
	✓ Disc Tech One	5014, 5019, 5026
	✓ Fujitsu	M2232, M2230, M2233*
	✓ Hitachi	DK502-1/2/3, DK503-2*
	D - International Memories	5012
	✓ Josephine County Technology	JCT-100, JCT-110
	✓ Matsushita Communication Ind.	JU-614, JU-616, JU-664*
	D - Micropolis	1302
	✓ Microscience International	HH612*, HH-725*
	✓ Miniscribe	<del>2012</del> , 3212*, 3425*
	✓ Mitsubishi	MR521*, MR522*, MR532-
	✓ NEC	D5244, D5124*
	✓ Nippon Electric Industry	RD-4127, RD-2127*, RD-2255*

5.25" disk diameter (continued)

TOKYO ELECT TD-5512\*  
TD-5836\*

- ✓ Nippon Peripherals
- ✓ Olivetti
- ✓ Otari
- ✓ Quantum
- ↳ Qume
- ✓ Rodime
- ✓ Seagate Technology
- ↳ Shugart
- ✓ Sord
- ✓ Tandon
- ✓ TEAC
- ↳ Tokico
- ✓ Toshiba
- ✓ Tulin
- ↳ Victor Company of Japan
- ✓ Xebec

- NP02-13\*, NP04-26
- HD-562/12, HD563/13, HD661/12\*
- C-514, C-526, PWH-107\* C-226\*
- Q520
- R100, R200
- RO 201, RO 204
- ST212\*, ~~ST412~~, ~~ST425~~ ST 225\*, ST 4026
- S712\*, S724\*
- HD-503, HD-513
- TM503, TM252\*
- SD-412, SD-510\*
- DK502-3, DK503-2\*
- MK-50F
- ~~TL213\*~~, TL226\*
- JD-5012\*
- 4000 Owl

3.9" disk diameter

- ✓ Nippon Systemhouse
- ✓ SyQuest Technology

- SQ325F\*
- SQ325F\*

3.5" disk diameter

PLUS DEN

NEWBURY INT 320\* PENNY  
 HITACHI DK301-1, DK301-2\*  
 MINISCRIBE 8425\*  
 TANDON TM362\*  
 NET G ORIGIN JD-3806M\*  
 JD-3812M\*  
 NAPS R. DRLO10A\*  
 DPMG20A\*  
 FUJITSU M2223A\*, M2224A\*  
 HP 97501A  
 MCI JU-104\*  
 MITSUBISHI MR321\*, M322  
 NEC D3116\*, D3126\*

- ✓ LaPine Technology
- ✓ Microcomputer Memories
- ✓ Microscience International
- ✓ Nippon Peripherals
- ✓ Rodime
- ✓ PERIPHERAL TECHNOLOGY

- 3521\*, ~~3522\*~~ 3512\*, 3525\*
- M-112\*, M-125\*
- HH-312\*, HH-325\*
- NP03-13\*, NP03-20\*
- RO 351\*, R0352\*

PT-325

\*Indicates drives 1.625 inches high (one half the standard height for drives using 5.25" disks), OR VCS

All drives in this group use variations of the technology loosely described as "Winchester". Most use 3340/3350 type ferrite heads, and some use the newer "mini-Winchester" heads which employ ferrite cores in 3370-type sliders. The majority of drives in this group use conventional oxide disks, but a growing number of manufacturers have started to use plated disks.

Most of the 5.25" drives and some of the 8" and 14" drives use head positioning systems driven by stepping motors, with relatively slow average access times, but low costs. The other drives use voice coil or

torque motor actuators, rotary or linear, to produce access times suitable for multiple workstation systems.

Market status

DISK/TREND estimate of total market size:

<u>Worldwide sales (\$M)</u>	<u>1983</u>	<u>1984</u>	<u>1985</u>	<u>1986</u>	<u>1987</u>
U.S. manufacturers	727.6	902.4	1,266.8	1,924.6	2,474.8
All manufacturers	1,092.4	1,730.0	2,402.3	3,541.1	4,532.0

Four years of explosive growth for 5.25" drives below 30 megabytes have transformed a major portion of the disk drive industry. Old product configurations have wilted, and new companies have assumed significant roles.

In 1984, 5.25" drives are expected to account for 95.2% of worldwide unit shipments of all drives in this group, as well as 86.2% of the revenue. Shipments of 8" drives are dropping constantly, and only a few 14" drives remain in limited production. Volume production of 3.5" drives is still confined to a single manufacturer, Rodime -- although several others are expected to start by the end of 1984, and numerous additional firms will announce 3.5" drives this year.

Captive shipments by U.S. companies remain small, with a new internal production program by Apple Computer the only significant captive start-up activity for 5.25" drives. However, several Japanese and two European firms have captive 5.25" drive programs underway, with total production estimated at 214,600 units in 1984.

Although the number of OEM customers for low-end 5.25" drives now is in the hundreds, the actions of IBM -- both as a customer and as a potential captive producer -- dominate the the OEM market. During the

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last two years IBM has purchased a high percentage of the shipments by Seagate, Miniscribe and International Memories for use in the PC XT. IBM has also bought 5.25" Winchester drives as part of the 5550 personal computer designed for the Japanese market, which is manufactured for IBM by Matsushita. And in mid-1984 IBM announced the multiple user PC AT, using 20 megabyte drives manufactured by Computer Memories.

Existing and would-be IBM suppliers are now undergoing considerable anguish, as IBM fine-tunes its plans for the products which will supersede the existing PC XT models, presumably with higher capacity, smaller, and perhaps faster disk drives. The players in this game remain uncertain as to whether IBM is merely conducting marketing research with its current requests for quotation on half high 5.25" drives and 3.5" drives preparatory to unleashing its own internal manufacturing program, or whether the new products will be bought from outside vendors.

Regardless of the effect of IBM's elephantine steps in this segment of the industry, the independent manufacturers are having severe growing pains from other causes. Despite IBM's well publicized cutback in 5.25" drive orders in January, 1984, several major drive manufacturers apparently overestimated the ability of the market to absorb their aggressive production build-up. By summer, growth in production plans was scaled back, contracts for components were abrogated and assembly workers dismissed.

Most of the U.S. drive manufacturers are expecting tough competition from Japanese firms for the half high 5.25" and 3.5" markets. To prepare for the projected low prices, the U.S. firms are establishing their own Asian manufacturing facilities, to obtain benefits in labor rates,

material costs and labor productivity. While the cost savings are attractive, the disruption to organizations is sometimes severe during the transition to off-shore manufacturing.

It has also been difficult for many manufacturers to keep up with the short product life cycles of specific configurations. New products --10 megabyte half high 5.25", 20 megabyte half high 5.25", plus 3.5" in the same capacities -- are essential to holding market share, but some firms have not been able to translate plans into producible products. Lack of key new products was probably a major factor in IMI's decision to withdraw from the disk drive market.

Despite a painful year, most manufacturers of OEM 5.25" drives have shipped more units in 1984 than in 1983. Estimated total shipments for all fixed drives less than 30 megabytes increased 79% for U.S. manufacturers and 177% for non-U.S. manufacturers in 1984. Market share totals for non-captive drives shipped in 1983 show Seagate well in the lead with 39.2% of worldwide shipments, representing 445,300 5.25" drives. Miniscribe and Tandon followed with 14.5% and 8.9%.

### Marketing trends

IBM's continuing role in the development of this product group cannot be overlooked. At this time it appears that IBM's planners will skip completely the stepping motor 5.25" drive as a candidate for internal production. Instead, it is believed that the firm will start a multinational production program for 3.5" drives by the end of 1985, resulting in a displacement of a portion of IBM's current outside purchases of 5.25" drives.

However, even before that program has any effect on the market, it is

likely that new procurements of 20 megabyte half high 5.25" drives will replace the full size drives now used with the PC XT. (It is believed that IBM will stay with the 20 megabyte full size drives used with the PC AT, at least until its own 40 megabyte Winchester is in production.)

In any event, both IBM and the rest of the world will probably be using smaller drives in most newly designed systems. The DISK/TREND forecast for full size 5.25" drives, half high 5.25" drives, and drives less than 5.25" (mostly 3.5") is summarized below:

<u>Worldwide captive &amp; OEM Unit shipments (000)</u>	<u>1983</u>	<u>1984</u>	<u>1985</u>	<u>1986</u>	<u>1987</u>
5.25" full size	1,121.6 97.0%	1,450.9 59.8%	1,562.2 43.5%	1,322.8 26.3%	843.2 12.4%
5.25" half high	33.3 2.9%	915.6 37.8%	1,538.8 42.8%	2,143.2 42.7%	2,276.4 33.6%
Less than 5.25"	1.5 .1%	58.0 2.4%	492.0 13.7%	1,556.6 31.0%	3,662.0 54.0%

This year's DISK/TREND forecast for <5.25" drives reflects the slower-than-expected start in production of 3.5" drives by U.S. manufacturers. Instead of market introductions for 3.5" drives in the fall of 1983, the major producers of 5.25" drives are now expected to make their 3.5" drive introductions in late 1984 -- with 1985 to be the first big production year.

The major changes in the market expected through 1987 will come from the above evolution to drives with smaller box sizes -- plus the growth of captive programs and increased competition by non-U.S. producers of OEM drives. In addition to IBM, captive production is expected from companies such as Apple Computer, Hewlett-Packard and possibly Digital Equipment. Japanese manufacturers are clearly going to be a growing factor in the

market, starting now with half high 5.25" drives and starting in 1985 with 3.5" drives.

### Technical trends

Large production volume and low cost are the key factors addressed in the engineering effort devoted to disk drives in this group. The problem is to achieve the high production volumes despite use of continually higher recording densities, as disk diameters go down and users' appetite for more capacity go up.

Although several initially available 3.5" drives use disks with 40 mm inner diameters, it is expected that 25 mm will be more widely used in order to make available the maximum recording area per disk. The result is linear densities in the 13,000 to 15,000 bits per inch range. Plated, sputtered and high density oxide disks claimed suitable at this density range are available, but have never been used in disk drives produced by the hundreds of thousands per year. Although the bugs will surely be worked out, it will be an interesting time for those charged with manufacturing the drives in high quantity at low cost.

### Forecasting assumptions

1. IBM will initiate production of a 3.5" drive in 1985, for use with single user personal computers and other applications.
2. Half high 5.25" and 3.5" drives will dominate shipments in this group by 1986, accompanied by continual pressure for lower prices.
3. Continued growth in the overall desktop and portable computer market will create very high growth for 5.25" and smaller drives.

TABLE 30  
 FIXED DISK DRIVES, LESS THAN 30 MEGABYTES  
 REVENUE SUMMARY

	-----DISK DRIVE REVENUES, BY SHIPMENT DESTINATION (\$M)-----									
	1983		1984		1985		1986		1987	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
	-----Revenues-----									
	-----Forecast-----									
<b>U.S. Manufacturers</b>	-----									
IBM Captive	68.0	92.0	56.2	76.8	101.7	143.3	251.0	358.3	451.5	645.0
Other U.S. Captive	120.4	144.7	123.2	144.5	280.4	356.9	555.4	760.3	691.6	988.4
<b>TOTAL U.S. CAPTIVE</b>	<b>188.4</b>	<b>236.7</b>	<b>179.4</b>	<b>221.3</b>	<b>382.1</b>	<b>500.2</b>	<b>806.4</b>	<b>1,118.6</b>	<b>1,143.1</b>	<b>1,633.4</b>
PCM	--	--	--	--	--	--	--	--	--	--
OEM	442.2	490.9	620.5	681.1	690.2	766.6	718.0	806.0	749.3	841.4
<b>TOTAL U.S. NON-CAPTIVE</b>	<b>442.2</b>	<b>490.9</b>	<b>620.5</b>	<b>681.1</b>	<b>690.2</b>	<b>766.6</b>	<b>718.0</b>	<b>806.0</b>	<b>749.3</b>	<b>841.4</b>
<b>TOTAL U.S. REVENUES</b>	<b>630.6</b>	<b>727.6</b>	<b>799.9</b>	<b>902.4</b>	<b>1,072.3</b>	<b>1,266.8</b>	<b>1,524.4</b>	<b>1,924.6</b>	<b>1,892.4</b>	<b>2,474.8</b>
<b>Non-U.S. Manufacturers</b>	-----									
Captive	18.2	242.0	59.0	594.4	88.0	813.0	163.5	1,208.5	252.7	1,490.4
PCM	--	--	--	--	--	--	--	--	--	--
OEM	36.3	122.8	69.9	233.2	109.4	322.5	156.9	408.0	235.4	566.8
<b>TOTAL NON-U.S. REVENUES</b>	<b>54.5</b>	<b>364.8</b>	<b>128.9</b>	<b>827.6</b>	<b>197.4</b>	<b>1,135.5</b>	<b>320.4</b>	<b>1,616.5</b>	<b>488.1</b>	<b>2,057.2</b>
<b>Worldwide Recap</b>	-----									
<b>TOTAL WORLDWIDE REVENUES</b>	<b>685.1</b>	<b>1,092.4</b>	<b>928.8</b>	<b>1,730.0</b>	<b>1,269.7</b>	<b>2,402.3</b>	<b>1,844.8</b>	<b>3,541.1</b>	<b>2,380.5</b>	<b>4,532.0</b>
<b>OEM Average Price (\$000)</b>	<b>.512</b>	<b>.540</b>	<b>.402</b>	<b>.412</b>	<b>.345</b>	<b>.348</b>	<b>.305</b>	<b>.306</b>	<b>.274</b>	<b>.274</b>

TABLE 31  
FIXED DISK DRIVES, LESS THAN 30 MB  
UNIT SHIPMENT SUMMARY

	-----DISK DRIVE UNIT SHIPMENTS, BY SHIPMENT DESTINATION (000)-----									
	1983		1984		1985		1986		1987	
	Shipments						Forecast			
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
<b>U.S. Manufacturers</b>										
IBM Captive	8.5	11.5	7.4	10.1	47.3	67.3	151.3	216.1	301.0	430.0
Other U.S. Captive	25.1	30.4	31.9	37.1	99.2	127.2	239.1	328.5	337.7	482.6
TOTAL U.S. CAPTIVE	33.6	41.9	39.3	47.2	146.5	194.5	390.4	544.6	638.7	912.6
PCM	--	--	--	--	--	--	--	--	--	--
OEM	871.0	943.5	1,548.3	1,684.1	1,995.2	2,211.8	2,336.8	2,626.1	2,712.2	3,049.2
TOTAL U.S. NON-CAPTIVE	871.0	943.5	1,548.3	1,684.1	1,995.2	2,211.8	2,336.8	2,626.1	2,712.2	3,049.2
TOTAL U.S. SHIPMENTS	904.6	985.4	1,587.6	1,731.3	2,141.7	2,406.3	2,727.2	3,170.7	3,350.9	3,961.8
<b>Non-U.S. Manufacturers</b>										
Captive	4.0	69.9	21.2	220.6	34.5	310.7	73.1	529.7	125.8	734.5
PCM	--	--	--	--	--	--	--	--	--	--
OEM	62.7	193.0	168.2	535.0	323.8	914.2	529.6	1,338.7	875.4	2,085.3
TOTAL NON-U.S. SHIPMENTS	66.7	262.9	189.4	755.6	358.3	1,224.9	602.7	1,868.4	1,001.2	2,819.8
<b>Worldwide Recap</b>										
TOTAL WORLDWIDE SHIPMENTS	971.3	1,248.3	1,777.0	2,486.9	2,500.0	3,631.2	3,329.9	5,039.1	4,352.1	6,781.6
<b>Cumulative Shipments</b>										
IBM Captive	109.2	148.9	116.6	159.0	163.9	226.3	315.2	442.4	616.2	872.4
Non-IBM	1,427.2	1,894.1	3,196.8	4,370.9	5,649.5	7,934.8	8,828.1	12,757.8	12,879.2	19,109.4
WORLDWIDE TOTAL	1,536.4	2,043.0	3,313.4	4,529.9	5,813.4	8,161.1	9,143.3	13,200.2	13,495.4	19,981.8

TABLE 32  
 FIXED DISK DRIVES, LESS THAN 30 MEGABYTES  
 WORLDWIDE SHIPMENTS (000)  
 BREAKDOWN BY DISK DIAMETER

	1983 Shipments				1984				1985				Forecast			1986		1987	
	14"	8"	5.25"	<5.25"	14"	8"	5.25"	<5.25"	14"	8"	5.25"	<5.25"	8"	5.25"	<5.25"	5.25"	<5.25"		
<b>U.S. MANUFACTURERS</b>																			
IBM Captive	--	11.5	--	--	--	10.1	--	--	--	7.3	--	60.0	6.1	--	210.0	--	430.0		
Other U.S. Captive	8.9	8.0	13.5	--	4.7	6.7	25.7	--	2.4	4.3	92.5	28.0	1.0	163.5	164.0	198.6	284.0		
OEM	1.9	35.1	906.5	--	.6	26.8	1,638.7	18.0	--	15.0	1,969.9	226.9	6.0	2,004.0	616.1	1,601.0	1,448.2		
TOTAL U.S. SHIPMENTS	10.8	54.6	920.0	--	5.3	43.6	1,664.4	18.0	2.4	26.6	2,062.4	314.9	13.1	2,167.5	990.1	1,799.6	2,162.2		
<b>NON-U.S. MANUFACTURERS</b>																			
Captive	--	9.5	60.4	--	--	6.0	214.6	--	--	4.2	274.5	32.0	1.2	355.5	173.0	419.5	315.0		
OEM	.1	16.9	174.5	1.5	--	7.5	487.5	40.0	--	5.0	764.1	145.1	2.2	943.0	393.5	900.5	1,184.8		
TOTAL NON-U.S. SHIPMENTS	.1	26.4	234.9	1.5	--	13.5	702.1	40.0	--	9.2	1,038.6	177.1	3.4	1,298.5	566.5	1,320.0	1,499.8		
<b>WORLDWIDE RECAP</b>																			
Total Shipments	10.9	81.0	1,154.9	1.5	5.3	57.1	2,366.5	58.0	2.4	35.8	3,101.0	492.0	16.5	3,466.0	1,556.6	3,119.6	3,662.0		
ANNUAL SHARE, BY DIAMETER	.9%	6.5%	92.5%	.1%	.2%	2.3%	95.2%	2.3%	.1%	1.0%	85.4%	13.5%	.3%	68.8%	30.9%	46.0%	54.0%		

WW OEM 1082.5  
 OEM % OF TOTAL 93.6%  
 US OEM % OF TOTAL OEM 83.7%

TABLE 33  
 FIXED DISK DRIVES, LESS THAN 30 MEGABYTES  
 WORLDWIDE REVENUES  
 BREAKDOWN BY DISK DIAMETER

	1983				1984				1985				Forecast				
	14"	8"	5.25"	<5.25"	14"	8"	5.25"	<5.25"	14"	8"	5.25"	<5.25"	8"	5.25"	<5.25"	5.25"	<5.25"
<b>U.S. MANUFACTURERS</b>																	
IBM Captive	--	92.0	--	--	--	76.7	--	--	--	53.2	--	90.0	43.3	--	315.0	--	645.0
Other U.S. Captive	57.2	42.7	44.7	--	31.5	35.2	77.7	--	17.2	21.5	253.7	64.4	5.0	410.9	344.4	448.7	539.6
OEM	2.5	39.3	448.9	--	.8	28.0	644.9	7.3	--	16.5	681.5	68.5	6.6	631.2	168.1	469.2	372.1
TOTAL U.S. REVENUES	59.8	174.0	493.6	--	32.4	139.9	722.7	7.3	17.2	91.2	935.2	222.9	54.9	1,042.1	827.5	917.9	1,556.7
<b>NON-U.S. MANUFACTURERS</b>																	
Captive	--	52.1	189.8	--	--	32.5	561.9	--	--	23.1	713.1	76.8	6.6	821.2	380.6	860.4	630.0
OEM	.4	28.6	93.1	.5	--	11.8	206.3	15.0	--	8.0	270.6	43.8	3.5	297.0	107.4	262.2	304.4
TOTAL NON-U.S. REVENUES	.4	80.7	283.0	.5	--	44.3	768.2	15.0	--	31.1	983.7	120.6	10.1	1,118.3	488.0	1,122.7	934.4
<b>WORLDWIDE RECAP</b>																	
Total Revenues	60.2	254.8	776.7	.5	32.4	184.3	1,490.9	22.3	17.2	122.3	1,919.0	343.5	65.0	2,160.4	1,315.6	2,040.7	2,491.2
ANNUAL SHARE, BY DIAMETER	5.5%	23.3%	71.1%	.1%	1.9%	10.7%	86.2%	1.2%	.7%	5.1%	79.9%	14.3%	1.8%	61.0%	37.2%	45.0%	55.0%

1550

1390



TABLE 34  
FIXED DISK DRIVES, LESS THAN 30 MEGABYTES  
DISTRIBUTION CHANNEL SUMMARY  
U.S. Non-Captive Disk Drives

Distribution channel	1983 U.S. Net Shipments		FORECAST			
	Units (000)	%	1984 %	1985 %	1986 %	1987 %
	Mainframe computer manufacturers	371.3	39.8	44.6	41.2	29.6
Mini/micro computer manufacturers	202.6	21.7	18.2	16.7	15.4	14.6
System OEMs/systems houses	213.5	22.8	21.3	26.2	39.0	51.9
Independent peripherals suppliers	74.7	8.0	8.4	8.5	8.8	9.2
Distributors, dealers, end users	<u>71.6</u>	<u>7.7</u>	<u>7.5</u>	<u>7.4</u>	<u>7.2</u>	<u>7.0</u>
TOTAL	933.7					

TABLE 35  
FIXED DISK DRIVES, LESS THAN 30 MEGABYTES  
MARKET SHARE SUMMARY  
Worldwide Shipments of Non-Captive Disk Drives

Drive Manufacturers	1983 Net Shipments											
	To United States Destinations					Worldwide						
	Units (000)					%	Units (000)					%
	14"	8"	5.25"	<5.25"	Total		14"	8"	5.25"	<5.25"	Total	
Seagate Technology	--	--	427.5	--	427.5	45.8	--	--	445.3	--	445.3	39.2
Miniscribe	--	--	156.8	--	156.8	16.8	--	--	165.0	--	165.0	14.5
Tandon	--	--	93.0	--	93.0	10.0	--	--	101.0	--	101.0	8.9
International Memories	--	2.8	69.4	--	72.2	7.7	--	2.9	73.0	--	75.9	6.7
Rodime	--	--	33.0	1.4	34.4	3.7	--	--	60.0	1.5	61.5	5.4
Computer Memories	--	--	57.6	--	57.6	6.1	--	--	60.6	--	60.6	5.3
Nippon Peripherals	--	--	3.0	--	3.0	.3	--	--	30.3	--	30.3	2.7
Fujitsu	--	1.5	7.8	--	9.3	1.0	--	11.0	15.2	--	26.2	2.3
Shugart	1.3	8.5	11.4	--	21.2	2.3	1.4	10.0	12.9	--	24.3	2.1
Other U.S.	.4	6.2	36.1	--	42.7	4.6	.5	22.2	48.7	--	71.4	6.3
Other Non-U.S.	--	.9	<u>15.1</u>	--	<u>16.0</u>	<u>1.7</u>	<u>.1</u>	<u>5.9</u>	<u>69.0</u>	--	<u>75.0</u>	<u>6.6</u>
TOTAL	1.7	19.9	910.7	1.4	933.7	100.0	2.0	52.0	1,081.0	1.5	1,136.5	100.0

FIXED DISK DRIVES, 30-100 MB

**1984 DISK/TREND REPORT**



FIXED DISK DRIVES, 30-100 MEGABYTESCoverage

Examples of disk drives in this group include:

14" disk diameter

✓ Alpha Data	Atlas
D Burroughs	FD 214
D -Century Data Systems	M80
✓ Data General	6234
✓ Disc Tech One	3306
D -Fujitsu	M2280
✓ Hewlett-Packard	7912
D -Kennedy	5380
✓ NEC	D-1245, N7723
✓ Priam	<del>3350</del> , 6650
D -Sperry	8402-50, 8402-75
D -Tecstor	3/83, 3/100

10.5" disk diameter

✓ Bull	D160/4, D160/6
--------	----------------

8" disk diameter

D SC7700 DP-400

✓ IBM	3310, 4963-64, <del>5362-X</del> , 676, 680
✓ Disc Tech One	8533
✓ Fujitsu	M2303, M2312K, M2321K
✓ Hitachi	DK 811-4, DK812S-8
D -Kennedy	7340, 7380, 7173
✓ Megavault	MV83, <del>MV803H</del>
D -Micropolis	1452, 1403SMD
✓ Mitsubishi	M2860-2
✓ NEC	<del>D2236</del> , D2246, D2247
D -Newbury	9412
✓ Northern Telecom	<del>#E</del> /8204X
✓ Priam	3450, 7050, 803
✓ Quantum	Q2030, Q2040, Q2080
D -Texas Instruments	WD 800-43
✓ Toshiba	MK-80F-30, MK-182FB

5.25" disk diameter

✓ Advanced Storage Technology	<del>28060</del> * <del>38095</del> * AST 96202, AST 12202
✓ Atasi	<del>3033</del> , 3046, 3075, <del>3085</del>
✓ BASF	6190-94
✓ Bull	<del>B530</del> , D550, D570, <del>D585</del>
✓ Computer Memories	CM6640, CM7880J

3.5"  
 NEWBURY DATA 340 PLANNING  
 PERIPHERAL TECHNOLOGY PT-338\*

\* = INDICATES . . . .

5.25" disk diameter (continued)

IBM  
 INISRI 6053, 6085  
 MRS533\*  
 MRS533\*  
 DEC DS146\*  
 ST4038  
 ST4057  
 TOSHIBA MK-56FAB

- ✓ Control Data
- ✓ Fujitsu
- ✓ Hitachi
- ✓ Maxtor
- D - Memorex
- ✓ Micropolis
- ✓ Newbury Data
- ✓ Nippon Electric Industry
- ✓ Nippon Peripherals
- ✓ Priam
- ✓ Quantum
- D - Qume
- ✓ Rodime
- ✓ Tandon
- ✓ Tulin
- D - Vertex Peripherals

536  
 -586  
 ?  
 9415-32, 9415B  
 M2241, M2242, M2243  
 DK511-3/5/8, DK572-8  
 XT-1085, XT-2085, EXT 4075  
 512, 513, 514  
~~1303, 1353~~ 1323A, 1325  
 1065  
 RD-4510  
 NP04-36, NP04-50  
 504 V150, V185  
 Q530, Q540, Q250\*, Q280\*  
 R300  
 RO 203E, RO 204E  
 TM703, TM753\*  
 TL 240\*  
 V130, V170, V185

3.9" disk diameter

- ✓ Nippon Systemhouse
- ✓ SyQuest Technology

3  
 SQ328F\*  
 SQ328F\*  
 3

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

Market status

DISK/TREND estimate of total market size:

<u>Worldwide sales (\$M)</u>	<u>1983</u>	<u>1984</u>	<u>1985</u>	<u>1986</u>	<u>1987</u>
U.S. manufacturers	815.5	1,051.6	1,232.2	1,538.1	1,820.0
All manufacturers	1,204.1	1,450.7	1,657.6	1,999.8	2,304.8

During 1984, 5.25" drives became the dominant leader in shipments for this product group, based on strong growth by U.S. manufacturers of OEM drives. Shipments of 5.25" OEM drives by U.S. manufacturers were 39,200 units in 1983, jumping to an estimated 277,200 units in 1984 -- over 80% of the worldwide combined total of all captive and OEM drives.

Priam was the overall leader in OEM worldwide shipments for 1983, with 19.3% of the total, including both 14" and 8" drives. Quantum held 17.7%, representing 8" and 5.25" drives, and Fujitsu shipped 15.1% of the total, all 8" drives. OEM production of 5.25" drives totaled 41,200 units worldwide, spread among numerous manufacturers, with Atasi slightly in the lead.

While the remaining production of 14" drives is in decline as older systems using them are gradually phased out, total production of 8" drives is increasing slightly in 1984, which is expected to be the peak for 8" configurations. Both U.S. and non-U.S. captive shipments of 8" drives are now declining, but increases by U.S. firms such as Quantum, Priam and Micropolis have kept U.S. OEM shipments growing in 1984. Estimated production of 8" drives by IBM continues down.

#### Marketing trends

The heavy hand of IBM's presence in this product group is expected in 1985, with the start of production for a major 5.25" drive, to be manufactured on a multinational basis. It is believed that this drive will be produced in large quantities starting in the first half of 1985, for early application on IBM's PC AT, with about 40 megabytes capacity and moderately fast access time.

Eventually, however, IBM's first 5.25" drive should expand into a family with higher capacities and broader applications. Such drives will probably replace the Piccolo and Spartan 8" units in newer IBM small multiuser systems for several applications, and might become players in the OEM market when IBM has taken care of its higher priority requirements for its own systems.

IBM's apparent plan to rely mostly on internal production for drives in this group will influence the booming market for OEM drives in two ways. IBM will probably not be a major buyer of OEM drives, as was the case for low-end stepping motor 5.25" drives during the last two years, effectively eliminating the largest OEM customer of all. And IBM's multiuser microcomputer systems will probably take major shares of their target markets, displacing shipments by independent system manufacturers and reducing their need for disk drives in this capacity range. Accordingly, DISK/TREND forecasts for worldwide OEM shipments of 5.25" drives assume the 600% increase in unit shipments which occurred in 1984 will be followed by increases through 1987 averaging only 25% per year.

8" drive shipments were down to 34.5% of the worldwide total for all drives in 1984, and are forecasted to continue down to 7.5% in 1987. 14" drives will almost disappear during this period. In the low end of this capacity range, drives with disks less than 5.25" have already started to appear. The early shipments are 3.9" SyQuest drives, but it is believed that 3.5" drives will also be introduced. 11.4% of 1987 worldwide unit shipments are forecasted to be drives with disks less than 5.25".

#### Technical trends

Drive manufacturers have faced a difficult challenge in combining high recording densities and small box sizes into the low cost, and high production volume required for growth in this product group. Most drive manufacturers have experienced severe sourcing problems with media, as they transition to plated, sputtered and high density oxide disks. Although many new disk manufacturers have entered the market, most have

had trouble maintaining consistent quality and several have shut down operations from time to time to solve problems with production processes. In the meantime, drive manufacturers must methodically put each disk through extensive tests before they dare use it.

Although the technology used in recording heads is also changing, both thin film and advanced ferrite heads are usable with the densities now required, and both are in production. Although careful management of sourcing arrangements is needed, drive manufacturers have been able to obtain "mini-sliders", heads using ferrite cores mounted in sliders with contours similar to IBM's 3370/3380 thin film heads. For the first time in 1984 limited quantities of thin film heads are also being used in production disk drives, with more expected as head vendors establish normal production of heads designed for small diameter disks.

Although not settled, the political battles over interface standards are calming down. Most 5.25" drives in this group are still being shipped with 5 megabit transfer rates, using Seagate type interfaces. But a growing number of system manufacturers are planning to use SCSI interfaces and it is expected that the next several years will see many drives being offered with SCSI built in. As the disk and head sourcing problems settle down, 10 megabit per second drives are to be expected, most of which will apparently use ESDI as the drive level interface.

#### Forecasting assumptions

1. IBM will establish high volume production for 5.25" drives in 1985, with usage eventually on several systems.
2. Continued growth for OEM 5.25" drives will be created by strong increases in shipments of multiple user desktop computers and file servers used in local area networks.



TABLE 36  
FIXED DISK DRIVES, 30 - 100 MEGABYTES  
REVENUE SUMMARY

	-----DISK DRIVE REVENUES, BY SHIPMENT DESTINATION (\$M)-----									
	1983		Forecast							
	Revenues		1984		1985		1986		1987	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
<b>U.S. Manufacturers</b>										
IBM Captive	335.3	493.7	268.8	383.2	362.6	520.6	537.6	804.5	744.6	1,065.6
Other U.S. Captive	89.8	134.7	147.3	212.2	126.0	175.2	109.4	146.8	105.1	139.6
TOTAL U.S. CAPTIVE	425.1	628.4	416.1	595.4	488.6	695.8	647.0	951.3	849.7	1,205.2
PCM	1.1	1.1	1.1	1.1	.2	.2	3.0	3.0	3.5	3.5
OEM	147.2	186.0	367.3	455.1	430.9	536.2	458.3	583.8	470.4	611.3
TOTAL U.S. NON-CAPTIVE	148.3	187.1	368.4	456.2	431.1	536.4	461.3	586.8	473.9	614.8
TOTAL U.S. REVENUES	573.4	815.5	784.5	1,051.6	919.7	1,232.2	1,108.3	1,538.1	1,323.6	1,820.0
<b>Non-U.S. Manufacturers</b>										
Captive	--	268.3	2.6	230.2	4.3	240.4	11.8	267.2	19.0	283.1
PCM	--	--	--	--	--	--	--	--	--	--
OEM	62.5	120.3	87.1	168.9	99.1	184.9	111.8	194.5	122.3	201.7
TOTAL NON-U.S. REVENUES	62.5	388.6	89.7	399.1	103.4	425.3	123.6	461.7	141.3	484.8
<b>Worldwide Recap</b>										
TOTAL WORLDWIDE REVENUES	635.9	1,204.1	874.2	1,450.7	1,023.1	1,657.5	1,231.9	1,999.8	1,464.9	2,304.8
OEM Average Price (\$000)	1.9	2.0	1.3	1.4	1.2	1.3	1.2	1.2	1.1	1.1

TABLE 37  
FIXED DISK DRIVES, 30 - 100 MEGABYTES  
UNIT SHIPMENT SUMMARY

	-----DISK DRIVE UNIT SHIPMENTS, BY SHIPMENT DESTINATION (000)-----									
	1983		-----Forecast-----							
	---Shipments---		-----1984-----		-----1985-----		-----1986-----		-----1987-----	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
<b>U.S. Manufacturers</b> -----										
IBM Captive	39.0	57.4	33.6	47.9	78.8	112.9	147.0	214.8	223.4	319.4
Other U.S. Captive	9.7	14.2	20.8	29.1	20.7	28.2	23.4	30.6	28.7	37.6
TOTAL U.S. CAPTIVE	48.7	71.6	54.4	77.0	99.5	141.1	170.4	245.4	252.1	357.0
PCM	.1	.1	.1	.1	.3	.3	.5	.5	.7	.7
OEM	88.3	111.2	296.7	364.5	365.3	452.1	410.4	519.5	444.6	574.3
TOTAL U.S. NON-CAPTIVE	88.4	111.3	296.8	364.6	365.6	452.4	410.9	520.0	445.3	575.0
TOTAL U.S. SHIPMENTS	137.1	182.9	351.2	441.6	465.1	593.5	581.3	765.4	697.4	932.0
<b>Non-U.S. Manufacturers</b> -----										
Captive	--	28.4	.3	26.9	.5	33.1	2.2	51.2	4.3	69.0
PCM	--	--	--	--	--	--	--	--	--	--
OEM	20.6	41.3	46.3	95.1	62.8	120.0	82.4	149.5	104.1	176.5
TOTAL NON-U.S. SHIPMENTS	20.6	69.7	46.6	122.0	63.3	153.1	84.6	200.7	108.4	245.5
<b>Worldwide Recap</b> -----										
TOTAL WORLDWIDE SHIPMENTS	157.7	252.6	397.8	563.6	528.4	746.6	665.9	966.1	805.8	1,177.5
<b>Cumulative Shipments</b> -----										
IBM Captive	180.9	277.5	214.5	325.4	293.3	438.3	440.3	653.1	663.7	972.5
Non-IBM	209.2	365.2	573.4	880.9	1,023.0	1,514.6	1,541.9	2,265.9	2,124.3	3,124.0
WORLDWIDE TOTAL	390.1	642.7	787.9	1,206.3	1,316.3	1,952.9	1,982.2	2,919.0	2,788.0	4,096.5

TABLE 38  
 FIXED DISK DRIVES, 30 - 100 MEGABYTES  
 WORLDWIDE SHIPMENTS (000)  
 BREAKDOWN BY DISK DIAMETER

*22%*

	1983				1984				1985				1986				1987			
	Shipments																			
	14"	8"	5.25"	14"	8"	5.25"	<5.25"	14"	8"	5.25"	<5.25"	14"	8"	5.25"	<5.25"	14"	8"	5.25"	<5.25"	
<b>U.S. MANUFACTURERS</b>																				
IBM Captive	--	57.4	--	--	47.9	--	--	--	37.9	75.0	--	--	34.8	180.0	--	--	24.4	295.0	--	
Other U.S. Captive	6.3	6.8	1.1	7.0	7.0	15.1	--	5.1	4.2	18.9	--	2.8	2.0	20.8	5.0	1.2	--	22.4	14.0	
PCM	.1	--	--	.1	--	--	--	--	--	.3	--	--	--	.5	--	--	--	.7	--	
OEM	15.3	56.7	39.2	11.5	71.8	277.2	4.0	6.8	67.5	368.8	9.0	2.5	57.4	442.6	17.0	--	37.3	509.0	28.0	
TOTAL U.S. SHIPMENTS	21.7	120.9	40.3	18.6	126.7	292.3	4.0	11.9	109.6	463.0	9.0	5.3	94.2	643.9	22.0	1.2	61.7	827.1	42.0	
<b>NON-U.S. MANUFACTURERS</b>																				
Captive	1.3	27.1	--	.6	25.3	1.0	--	.4	20.2	12.5	--	--	14.2	34.0	3.0	--	8.5	51.0	9.5	
OEM	--	39.3	2.0	--	42.7	52.4	--	--	42.0	75.0	3.0	--	36.0	106.5	7.0	--	24.5	138.0	14.0	
TOTAL NON-U.S. SHIPMENTS	1.3	66.4	2.0	.6	68.0	53.4	--	.4	62.2	87.5	3.0	--	50.2	140.5	10.0	--	33.0	189.0	23.5	
<b>WORLDWIDE RECAP</b>																				
Total Shipments	23.0	187.3	42.3	19.2	194.7	345.7	4.0	12.3	171.8	550.5	12.0	5.3	144.4	784.4	32.0	1.2	94.7	1,016.1	65.5	
														<i>+42.5%</i>				<i>+29.5%</i>		
ANNUAL SHARE, BY DIAMETER	9.1%	74.2%	16.7%	3.4%	34.5%	61.3%	.8%	1.6%	22.1%	70.7%	5.6%	.5%	14.2%	76.9%	8.4%	.1%	7.5%	81.0%	11.4%	

NOTE: 8 inch totals include 10.5 inch drives

TABLE 39  
 FIXED DISK DRIVES, 30 - 100 MEGABYTES  
 WORLDWIDE REVENUES  
 BREAKDOWN BY DISK DIAMETER

	1983			1984				1985				1986				1987			
	14"	8"	5.25"	14"	8"	5.25"	<5.25"	14"	8"	5.25"	<5.25"	14"	8"	5.25"	<5.25"	14"	8"	5.25"	<5.25"
U.S. MANUFACTURERS																			
IBM Captive	--	493.6	--	--	383.2	--	--	--	295.6	225.0	--	--	264.4	540.0	--	--	180.5	885.0	--
Other U.S. Captive	69.8	59.4	5.5	75.7	61.0	75.5	--	54.0	36.1	85.0	--	29.1	17.0	83.2	17.5	12.2	--	78.4	49.0
PCM	1.0	--	--	1.0	--	--	--	--	--	.2	--	--	--	3.0	--	--	--	3.5	--
OEM	38.7	103.8	43.4	27.0	124.2	300.3	3.4	14.9	121.5	392.4	7.2	5.2	103.3	461.6	13.6	--	67.1	521.7	22.4
TOTAL U.S. REVENUES	109.6	656.9	48.9	103.8	568.4	375.8	3.4	69.0	453.2	702.7	7.2	34.3	384.8	1,087.8	31.1	12.2	247.7	1,488.6	71.4
NON-U.S. MANUFACTURERS																			
Captive	13.3	254.9	--	6.2	217.9	6.0	--	10.3	173.7	62.5	--	--	120.7	136.0	10.5	--	71.4	178.5	33.2
OEM	--	118.4	1.8	--	113.7	55.1	--	--	96.6	81.8	6.5	--	75.6	113.3	5.6	--	46.5	143.9	11.2
TOTAL NON-U.S. REVENUES	13.3	373.4	1.8	6.2	331.7	61.1	--	10.3	270.3	144.3	6.5	--	196.3	249.3	16.1	--	117.9	322.4	44.4
WORLDWIDE RECAP																			
Total Revenues	122.9	1,030.3	50.7	110.0	900.1	437.0	3.4	79.3	723.5	847.0	13.7	34.3	581.1	1,337.1	47.2	12.2	365.6	1,811.0	115.8
ANNUAL SHARE, BY DIAMETER	10.2%	85.6%	4.2%	7.6%	62.1%	30.1%	.2%	4.2%	38.2%	44.7%	12.9%	1.5%	25.6%	59.0%	13.9%	.5%	14.1%	70.0%	15.4%

NOTE: 8 inch totals include 10.5 inch drives

TABLE 40  
 FIXED DISK DRIVES, 30-100 MEGABYTES  
 DISTRIBUTION CHANNEL SUMMARY  
 U.S. Non-Captive Disk Drives

Distribution channel	1983 U.S. Net Shipments		FORECAST			
	Units (000)	%	1984 %	1985 %	1986 %	1987 %
Mainframe computer manufacturers	2.7	2.5	2.7	3.8	4.4	5.1
Mini/micro computer manufacturers	31.9	29.3	31.1	35.7	39.3	41.2
System OEMs/systems houses	65.3	59.9	57.6	51.7	47.1	44.3
Independent peripherals suppliers	6.2	5.7	6.2	6.7	7.3	7.8
Distributors, dealers, end users	<u>2.9</u>	2.6	2.4	2.1	1.9	1.6
TOTAL	109.0					

TABLE 41  
 FIXED DISK DRIVES, 30-100 MEGABYTES  
 MARKET SHARE SUMMARY  
 Worldwide Shipments of Non-Captive Disk Drives

Drive Manufacturers	1983 Net Shipments									
	To United States Destinations					Worldwide				
	Units (000)				%	Units (000)				%
	14"	8"	5.25"	Total		14"	8"	5.25"	Total	
Priam	11.1	15.3	--	26.4	24.2	11.2	18.3	--	29.5	19.3
Quantum	--	12.5	7.0	19.5	17.9	--	19.8	7.2	27.0	17.7
Fujitsu	--	14.1	--	14.1	12.9	--	23.0	--	23.0	15.1
Micropolis	--	7.8	1.9	9.7	8.9	--	15.6	2.4	18.0	11.8
Control Data	1.5	--	8.2	9.7	8.9	1.6	--	10.3	11.9	7.8
Atasi	--	--	10.9	10.9	10.0	--	--	11.5	11.5	7.5
Other U.S.	2.5	2.5	7.2	12.2	11.2	2.6	3.0	7.8	13.4	8.8
Other Non-U.S.*	--	5.9	.6	6.5	6.0	--	16.3	2.0	18.3	12.0
TOTAL	15.1	58.1	35.8	109.0	100.0	15.4	96.0	41.2	152.6	100.0

\*8 inch totals include 10.5 inch drives

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FIXED DISK DRIVES, 100-300 MEGABYTESCoverage

Examples of disk drives in this group include:

14" disk diameter

✓ IBM	4967-2CX, 5360-BXX
✓ Ampex	Capricorn 165, 165E
D - Burroughs	9494-4
✓ Century Data Systems	M160
✓ Control Data	9730-160, 241
✓ Digital Equipment	RA80, RM80
✓ Disc Tech One	4160, 4230
✓ Fujitsu	M2284, <del>F436, F6411</del>
✓ Hewlett-Packard	7914
D - Kennedy	53160
D - Microdata	Reflex II
✓ NEC	D1280
✓ Priam	15450
D - Sperry	8402-100, 8417
D - Tecstor	3/166, 3/199

10.5" disk diameter

✓ Bull	D160/8
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9" disk diameter

✓ Control Data	9715-160
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8" disk diameter

D - Amcodyne	Comanche 8160, 8220
✓ Fujitsu	M2322K, M2331K
✓ Hitachi	DK812S-12, <del>DK814S-17</del>
D - Kennedy	73160
✓ Megavault	<del>MV116</del> , MV212
D - Micropolis	1406SMD, 1453
✓ Mitsubishi Electric	M4870F
✓ NEC	D2257, D2247E
✓ Northern Telecom	MFD/8208, MFD/8210
✓ Pertec	<del>DX180, DX240</del> <del>DX179</del> , DX265
✓ Priam	806
✓ Toshiba	MK184F, MK186F



\* INDICATES - . . .

5.25" disk diameter

MITSUBISHI MRS310\*  
 PERAM 574, 579  
 SIEMENS 1100, 1200

- ✓ Advanced Storage Technology
- D Applied Information Memories
- ✓ Hitachi
- ✓ Maxtor
- ✓ Micropolis
- ✓ Newbury Data

28100\*      38158\*  
 AST ~~96203~~, AST ~~12333~~  
 Dart 130, Dart 250  
 DK512-17  
 XT-1140, XT-2190, EXT-4280  
 1354, 1355  
 1105, 1140

IBM's 3344, a 280 MB version of the classic 3350, was in production from 1976 through 1981, and preceded all other drives in this group. Currently, IBM's only drive in the group is a recently introduced 200 MB 14" drive used with Series/1 minicomputers and the System/36 business system.

The last two years have seen many new 8" drive introductions, with the start of an expected wave of 5.25" drives. These, as well as the older 14" drives in the group, all use variations of Winchester technology. Disks are mostly oxide coated, but plated and sputtered disks are used on the 5.25" drives. Heads are all ferrite types, and several are "mini" types patterned after the 3370 slider.

Market status

DISK/TREND estimate of total market size:

<u>Worldwide sales (\$M)</u>	<u>1983</u>	<u>1984</u>	<u>1985</u>	<u>1986</u>	<u>1987</u>
U.S. manufacturers	446.4	886.1	1,430.2	1,708.1	2,093.9
All manufacturers	706.8	1,385.7	2,118.0	2,608.1	3,171.4

Although not active in this product group until 1983, IBM now is producing more drives than any other firm, an estimated 25,700 spindles in 1984. Strangely, during a period of rapid growth for 8" drives in OEM markets, IBM's shipments are all attributable to the "Star" 14" drive. With 200 megabyte capacity and conservative use of recording technology,

the Star is clearly intended to be easily producible in large quantities. It's used as a capacity upgrade to the 64 megabyte Piccolo 8" drives produced since 1979 and the Spartan 8" drives originally introduced in 1982 and shipped in 15, 30 and 60 megabyte versions.

14" drives are also the major activity of other U.S. drive manufacturers for both captive and OEM markets, with each expected to account for worldwide shipment of slightly over 20,000 drives in 1984. Non-U.S. drive manufacturers have already moved rapidly to 8" drive configurations, however, with 20,700 captive and 37,000 OEM 8" drives forecasted for 1984 shipment.

Non-U.S. manufacturers have concentrated on 160 megabyte 8 inch drives, in a form factor more-or-less the same as full size 8" floppy drives. One reason for the large numbers of non-U.S. OEM drives now being shipped is availability, with such major Japanese drive manufacturers as Fujitsu, NEC, Hitachi, Mitsubishi and Toshiba all in production. Although Priam, Micropolis, Megavault, Amcodyne and Kennedy all are starting to ship similar 8" drives, Control Data is the only U.S. drive producer to achieve quantity shipments for drives smaller than 14", with its 9" FSD.

In 1983, Control Data held 39.4% of worldwide unit shipments for non-captive drives, including both 14" and 9" drives. Fujitsu shipped 23.1%, consisting of 14" and 8" drives, and Priam had 18.3%, all 14" drives.

#### Marketing trends

DISK/TREND forecasts now anticipate one more year of sharp growth in shipments for IBM's 14" Star drive during 1985, then a gradual decline. Underlying the decline for 14" shipments is an assumption that IBM will place drives with smaller disk diameters in production for newer systems.

## **1984 DISK/TREND REPORT**

First production for 8" drives in this product group is assumed for 1985, followed by a 5.25" drive in 1986. The 5.25" will presumably be an upgraded version of the 5.25" voice coil actuator drive now being developed at IBM's Rochester facility for initial production in 1985, with an estimated capacity in the first models of 40 megabytes.

Total production of 8" (and 9" drives) is now expected to overtake 14" drives in 1984, one year earlier than previously forecasted. 8" drive growth will be greatest in OEM drives, especially from Japanese manufacturers which are already off to a head start in market development. Increases will continue through 1987 for 8" drives, but at a reduced pace toward the end of that period.

U.S. drive manufacturers are expected to place greater emphasis on 5.25" OEM drives in this capacity range, and OEM shipments by U.S. manufacturers are forecasted to reach 164,000 units in 1987, swept along by the general growth in multiple user microcomputers and mid-range minicomputers. Current products by Maxtor and Applied Information Memories will be joined by drives from most of the U.S. manufacturers of high performance 8" and 5.25" drives.

#### Technical trends

This product group continues to be a likely proving ground for new recording technologies with the potential to provide drastic increases in linear recording density. All of the 5.25" drives with capacities over 100 MB offered to date use either plated or sputtered disks, to facilitate the high recording densities used. With thin film heads now starting to be available at prices competitive to high density ferrite heads, some new

drives offered in this product group will probably use them. And it is likely that perpendicular recording will find early application in 5.25" drives in this capacity range, now that production of disks is underway.

Marketability of drives with higher transfer rates will be directly affected by whether the industry reaches an early consensus on interface standards suitable for higher transfer rates, paving the way for availability of appropriate controllers. The marketplace is in the process of settling the issues, but a spirit of compromise among drive manufacturers could facilitate earlier introduction of actual products. In the meantime, most new drives will use existing interface standards in order to make immediate sales possible, and several drive manufacturers are planning to offer optional ESDI or IPI-2 drive level interfaces. On-board SCSI interfaces will also be available from some manufacturers.

#### Forecasting assumptions

1. Current growth of IBM's 14" drive shipments will peak in 1985, impacted by introduction of 8" drives in 1985 and 5.25" drives in 1986.
2. Multiple vendors will successfully start production of 5.25" drives for the OEM market in 1985.
3. Non-U.S. manufacturers will continue to dominate OEM shipments of 8" drives.

TABLE 42  
FIXED DISK DRIVES, 100 - 300 MEGABYTES  
REVENUE SUMMARY

	-----DISK DRIVE REVENUES, BY SHIPMENT DESTINATION (\$M)-----									
	1983		-----Forecast-----							
	Revenues		1984		1985		1986		1987	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
<b>U.S. Manufacturers</b>										
IBM Captive	77.9	102.6	334.8	462.6	633.6	892.8	679.0	970.0	781.4	1,126.0
Other U.S. Captive	160.1	251.1	166.0	267.2	189.7	306.2	244.4	370.5	291.8	442.0
TOTAL U.S. CAPTIVE	238.0	353.7	500.8	729.8	823.3	1,199.0	923.4	1,340.5	1,073.2	1,568.0
PCM	--	--	2.6	2.6	3.8	3.8	4.6	4.6	3.9	5.7
OEM	70.5	92.7	120.6	153.7	184.8	227.4	292.4	363.0	410.6	520.2
TOTAL U.S. NON-CAPTIVE	70.5	92.7	123.2	156.3	188.6	231.2	297.0	367.6	414.5	525.9
TOTAL U.S. REVENUES	308.5	446.4	624.0	886.1	1,011.9	1,430.2	1,220.4	1,708.1	1,487.7	2,093.9
<b>Non-U.S. Manufacturers</b>										
Captive	--	208.9	--	329.4	--	425.4	--	536.0	--	651.0
PCM	--	--	--	--	--	--	--	--	--	--
OEM	31.9	51.5	114.8	170.2	178.1	262.4	245.1	364.0	295.2	426.4
TOTAL NON-U.S. REVENUES	31.9	260.4	114.8	499.6	178.1	687.8	245.1	900.0	295.2	1,077.4
<b>Worldwide Recap</b>										
TOTAL WORLDWIDE REVENUES	340.4	706.8	738.8	1,385.7	1,190.0	2,118.0	1,465.5	2,608.1	1,782.9	3,171.4
OEM Average Price (\$000)	4.0	4.1	3.7	3.8	3.5	3.5	3.1	3.1	2.6	2.7

TABLE 43  
FIXED DISK DRIVES, 100 - 300 MB  
UNIT SHIPMENT SUMMARY

	-----DISK DRIVE UNIT SHIPMENTS, BY SHIPMENT DESTINATION (000)-----									
	1983		1984		1985		1986		1987	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
<b>U.S. Manufacturers</b>	-----									
IBM Captive	4.1	5.4	18.6	25.7	38.7	54.6	53.9	77.0	78.7	113.0
Other U.S. Captive	12.4	19.9	12.8	21.0	15.1	24.4	21.0	31.3	27.0	40.3
TOTAL U.S. CAPTIVE	16.5	25.3	31.4	46.7	53.8	79.0	74.9	108.3	105.7	153.3
PCM	--	--	.2	.2	.3	.3	.4	.4	.4	.6
OEM	18.3	23.6	34.9	43.5	58.8	71.7	106.1	130.7	170.4	214.7
TOTAL U.S. NON-CAPTIVE	18.3	23.6	35.1	43.7	59.1	72.0	106.5	131.1	170.8	215.3
TOTAL U.S. SHIPMENTS	34.8	48.9	66.5	90.4	112.9	151.0	181.4	239.4	276.5	368.6
<b>Non-U.S. Manufacturers</b>	-----									
Captive	--	14.5	--	23.4	--	31.2	--	43.0	--	57.8
PCM	--	--	--	--	--	--	--	--	--	--
OEM	7.4	11.9	29.1	42.6	45.8	68.3	69.8	105.8	97.8	142.1
TOTAL NON-U.S. SHIPMENTS	7.4	26.4	29.1	66.0	45.8	99.5	69.8	148.8	97.8	199.9
<b>Worldwide Recap</b>	-----									
TOTAL WORLDWIDE SHIPMENTS	42.2	75.3	95.6	156.4	158.7	250.5	251.2	388.2	374.3	568.5
<b>Cumulative Shipments</b>	-----									
IBM Captive	8.9	13.4	27.5	39.1	66.2	93.7	120.1	170.7	198.8	283.7
Non-IBM	77.5	137.7	154.5	268.4	274.5	464.3	471.8	775.5	767.4	1,231.0
WORLDWIDE TOTAL	86.4	151.1	182.0	307.5	340.7	558.0	591.9	946.2	966.2	1,514.7

DISPLACED CAPTIVE MOVES  
TO 5.25" OEM

TABLE 44  
FIXED DISK DRIVES, 100 - 300 MEGABYTES  
WORLDWIDE SHIPMENTS (000)  
BREAKDOWN BY DISK DIAMETER

	1983			Forecast											
	Shipments			1984			1985			1986			1987		
	14"	8"	5.25"	14"	8"	5.25"	14"	8"	5.25"	14"	8"	5.25"	14"	8"	5.25"
<b>U.S. MANUFACTURERS</b>															
IBM Captive	5.4	--	--	25.7	--	--	44.6	10.0	--	42.0	20.0	15.0	38.0	35.0	40.0
Other U.S. Captive	19.8	.1	--	20.4	.6	--	22.0	2.4	--	19.8	8.5	3.0	16.8	15.0	8.5
PCM	--	--	--	.2	--	--	.3	--	--	.3	.1	--	.1	.5	--
OEM	19.1	3.5	1.0	20.2	11.8	11.5	17.2	22.5	32.0	13.4	37.1	80.2	9.5	41.2	164.0
TOTAL U.S. SHIPMENTS	44.3	3.6	1.0	66.5	12.4	11.5	84.1	34.9	32.0	75.5	65.7	98.2	64.4	91.7	212.5
<b>NON-U.S. MANUFACTURERS</b>															
Captive	5.1	9.4	--	2.7	20.7	--	1.2	30.0	--	.5	39.0	3.5	--	46.8	11.0
PCM	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
OEM	5.6	6.3	--	5.5	37.0	.1	4.9	57.4	6.0	3.7	74.6	27.5	2.0	82.1	58.0
TOTAL NON-U.S. SHIPMENTS	10.7	15.7	--	8.2	57.7	.1	6.1	87.4	6.0	4.2	113.6	31.0	2.0	128.9	69.0
<b>WORLDWIDE RECAP</b>															
Total Shipments	55.0	19.3	1.0	74.7	70.1	11.6	90.2	122.3	38.0	79.7	179.3	129.2	66.4	220.6	281.5
ANNUAL SHARE, BY DIAMETER	73.1%	25.6%	1.3%	47.8%	44.8%	7.4%	36.0%	48.8%	15.2%	20.5%	46.2%	33.3%	11.7%	38.8%	49.5%

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

TABLE 45  
 FIXED DISK DRIVES, 100 - 300 MEGABYTES  
 WORLDWIDE REVENUES  
 BREAKDOWN BY DISK DIAMETER

	1983			Forecast											
	14"	8"	5.25"	1984			1985			1986			1987		
Revenues	14"	8"	5.25"	14"	8"	5.25"	14"	8"	5.25"	14"	8"	5.25"	14"	8"	5.25"
<b>U.S. MANUFACTURERS</b>															
IBM Captive	102.6	--	--	462.6	--	--	802.8	90.0	--	735.0	160.0	75.0	646.0	280.0	200.0
Other U.S. Captive	249.7	1.3	--	259.3	7.8	--	275.0	31.2	--	243.5	110.5	16.5	203.2	192.0	46.7
PCM	--	--	--	2.6	--	--	3.7	--	--	3.6	1.0	--	1.1	4.5	--
OEM	74.7	15.6	2.3	77.5	49.5	26.6	63.6	90.0	73.8	48.2	137.2	177.4	33.2	144.2	342.8
TOTAL U.S. REVENUES	427.1	16.9	2.3	802.1	57.3	26.6	1,145.1	211.2	73.8	1,030.3	408.7	268.9	883.6	620.7	589.5
<b>NON-U.S. MANUFACTURERS</b>															
Captive	86.7	122.2	--	45.9	283.5	--	20.4	405.0	--	8.0	507.0	21.0	--	585.0	66.0
PCM	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
OEM	26.8	24.6	--	26.4	143.5	.2	23.5	223.8	15.0	17.7	283.4	62.7	9.6	295.5	121.2
TOTAL NON-U.S. REVENUES	113.5	146.8	--	72.3	427.0	.2	43.9	628.8	15.0	25.7	790.4	83.7	9.6	880.5	187.2
<b>WORLDWIDE RECAP</b>															
Total Revenues	540.6	163.7	2.3	874.4	484.3	26.8	1,189.1	840.0	88.8	1,056.1	1,199.2	352.7	893.2	1,501.2	776.8
ANNUAL SHARE, BY DIAMETER	76.5%	23.2%	.3%	63.1%	35.0%	1.9%	56.1%	39.7%	4.2%	40.5%	46.0%	13.5%	28.2%	47.3%	24.5%

NOTE: 8 inch totals include 9 and 10.5 inch drives



TABLE 46  
FIXED DISK DRIVES, 100-300 MEGABYTES  
DISTRIBUTION CHANNEL SUMMARY  
U.S. Non-Captive Disk Drives

<u>Distribution channel</u>	1983 U.S. Net Shipments		FORECAST			
	Units (000)	%	1984 %	1985 %	1986 %	1987 %
Mainframe computer manufacturers	5.7	22.2	17.7	15.1	12.8	10.9
Mini/micro computer manufacturers	7.3	28.4	30.2	31.3	32.2	32.9
System OEMs/systems houses	10.0	38.9	41.7	43.2	44.5	45.5
Independent peripherals suppliers	2.3	8.9	9.2	9.4	9.7	10.0
Distributors, dealers, end users	.4	1.6	1.2	1.0	.8	.7
TOTAL	25.7					

TABLE 47  
FIXED DISK DRIVES, 100-300 MEGABYTES  
MARKET SHARE SUMMARY  
Worldwide Shipments of Non-Captive Disk Drives

<u>Drive Manufacturers</u>	1983 Net Shipments									
	To United States Destinations					Worldwide				
	Units (000)				%	Units (000)				%
	14"	8"	5.25"	Total		14"	8"	5.25"	Total	
Control Data	6.3	2.9	--	9.2	35.8	10.8	3.2	--	14.0	39.4
Fujitsu	3.5	1.0	--	4.5	17.5	5.6	2.6	--	8.2	23.1
Priam	6.3	--	--	6.3	24.5	6.5	--	--	6.5	18.3
Other U.S.	1.6	.3	.9	2.8	10.9	1.8	.3	1.0	3.1	8.8
Other Non-U.S.*	--	2.9	--	2.9	11.3	--	3.7	--	3.7	10.4
TOTAL	17.7	7.1	.9	25.7	100.0	24.7	9.8	1.0	35.5	100.0

\*8 inch totals include 9 inch and 10.5 inch drives

**1984 DISK/TREND REPORT**



FIXED DISK DRIVES, 300-500 MEGABYTESCoverage

Examples of disk drives in this group include:

14" disk diameter

✓ Ampex	Capricorn 330
D Applied Peripheral Systems	4830-2, 4835-3
✓ Century Data Systems	AMS 315
D Control Data	33501, 33801, 819-11
✓ Data General	6236, 6237
✓ Digital Equipment	RA81
✓ Disc Tech One	4300
✓ Fujitsu	M2294, F493
✓ Hewlett-Packard	7933H
D - NEC	D-1510, N7751
✓ Nippon Peripherals	NP25
D - Siemens	3470
D - Storage Technology	8350, 8360
✓ Tecstor	3/315, 3/332

10.5" disk diameter

✓ Fujitsu	M2350A, F6421
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9" disk diameter

Control Data	9715-340
NEC	D 2332

8" disk diameter

<i>UPONAVANT MV330</i>	<i>C2400, C2476</i>
<i>Century Data SVI</i>	M2333K
✓ Fujitsu	DKU-80, DK814S-3Y
✓ Hitachi	1456
D Micropolis	JS4380N, D 2268
✓ NEC	<del>8308</del> , 8310, 8212X
✓ Northern Telecom	<del>DX300</del> DX 332
✓ Pertec	807
✓ Priam	

5.25" disk diameter

✓ Maxtor	EXT-4380
Siemens	1300

Many of the older disk drives in this group are patterned after IBM's 3350, and all are 317.5 MB floor-standing drives are intended for use with mainframes, including both plug compatible applications and captive systems.

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

#### Market status

DISK/TREND estimate of total market size:

<u>Worldwide sales (\$M)</u>	<u>1983</u>	<u>1984</u>	<u>1985</u>	<u>1986</u>	<u>1987</u>
U.S. manufacturers	349.4	597.3	756.9	1,032.7	1,350.9
All manufacturers	858.1	1,196.2	1,269.8	1,533.8	1,895.6

1983 saw the end of IBM's 3350 shipments, the last of a drive which was highly influential in broadening the usage of Winchester technology throughout the industry. U.S. PCM drive producers also produced their last single density (317 megabytes) 3350 equivalent drive in 1983. However, the 10.5" Fujitsu Eagle I remained a significant factor in PCM shipments to U.S. and European customers by Amdahl. For PCM markets this drive is formatted to 317 megabytes, with multiple spindles per box to compete with IBM's 3380 in capacity, performance and price. It is believed that Eagle I shipments for this market are increasing in 1984, due to delays in availability for Fujitsu's Eagle II, which matches the capacity available to each actuator of IBM's 3380.

U.S. captive shipments are expected to increase from 16,100 spindles in 1983 to 30,100 in 1984. Digital Equipment's increased shipments of

RA81 drives are behind a large part of the jump, but higher shipments by Hewlett-Packard and Data General are also making a contribution. Non-U.S. captive shipments are starting to decline, as the Japanese mainframe manufacturers and Siemens move to drives with higher capacities.

OEM markets in this product group are dominated by Fujitsu's Eagle I, the pioneer 10.5" high performance drive which has become widely used in the supermini market and for various specialized applications which need its 15 megabit per second transfer rate. Control Data has never offered a 14" drive in this group, and the firm's 340 megabyte 9" FSD is just starting volume shipments in 1984. 8" drive shipments are also starting this year, from Priam and several Japanese companies which have upgraded their 80/160 megabyte models.

Fujitsu held 72.9% of worldwide non-captive shipments in 1983, with 18,300 units. These totals cover both 14" and 10.5" drives, including PCM models. STC followed with 10% of the worldwide total, consisting mostly of 317 megabyte 3350 compatible drives sold in the PCM market.

#### Marketing trends

It is anticipated that IBM will start production of an 8" captive drive in this capacity range by 1986, with substantial shipments -- to fill the gap in the firm's disk drive product line below the 3370/3375. Other U.S. captive drive producers will continue a modest yearly increase in shipments of 14" drives for minicomputer and superminicomputer applications, while non-U.S. manufacturers will gradually phase out their 14" drive production, which has been used mostly with mainframes. Captive use of 8"-9" drives will increase in both the U.S. and Japan, but probably on a modest basis.

## **1984 DISK/TREND REPORT**

With high volume availability of Fujitsu's Eagle II expected in 1985, plus the assumed introduction of a double density 3380 by IBM, the current PCM shipments of Eagle I drives are expected to fade out in 1985. At this time, no additional PCM activity is expected in this product group.

14" OEM drive shipments are forecasted to peak in 1986, the victim first of 8"-9" lower cost alternatives, then of the 5.25" drives which should be in production in 1985. Because of the lead held by several Japanese firms in 80 and 160 megabyte 8" OEM drives, they are expected to stay in front with drives in the 320 megabyte range. However, it is likely that U.S. firms will hold the lead in 5.25" shipments, due to their earlier start.

### Technical trends

Development activities in this product group will be concentrated on squeezing more capacity into smaller boxes during the next few years. Control Data's 340 MB version of the 9" FSD has been designed to a fairly conservative linear density specification, by today's standards, of 9,492 BPI. The 230 mm disk used with the FSD provides more recording area than the 195-210 mm disks used with 8" drives, allowing use of less ambitious specifications and making it easier to produce the drive in large quantities.

Other development programs now underway for OEM drives target similar capacities for 8" and 5.25" drives, in order to conform to standard form factors established by flexible disk drives. These constraints, combined with transfer rate limitations imposed by de facto interface standards and availability of controllers, have forced manufacturers to seek innovative

8" CDC FUJITSU

design solutions, such as Maxtor's placement of the drive motor inside the inner diameter of the stack of disks.

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

#### Forecasting assumptions

1. IBM will introduce no new 14" drives in this group, but will add 8" drives in 1986.
2. Sustained growth for superminicomputers, large workstation clusters and specialized systems will create significant growth for both captive and OEM drives in this group.
3. Producers of OEM drives will successfully initiate volume production of 5.25" drives in 1985.

*of 8" OEM drives*



TABLE 48  
 FIXED DISK DRIVES, 300 - 500 MEGABYTES  
 REVENUE SUMMARY

	-----DISK DRIVE REVENUES, BY SHIPMENT DESTINATION (\$M)-----									
	1983		-----Forecast-----							
	Revenues		1984		1985		1986		1987	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
<b>U.S. Manufacturers</b>										
IBM Captive	7.5	15.0	--	--	--	--	84.0	140.0	203.0	350.0
Other U.S. Captive	173.2	284.6	318.2	512.5	374.4	604.0	411.6	684.9	429.8	740.4
TOTAL U.S. CAPTIVE	180.7	299.6	318.2	512.5	374.4	604.0	495.6	824.9	632.8	1,090.4
PCM	12.3	25.7	--	--	--	--	--	--	--	--
OEM	16.3	24.1	67.3	84.8	123.2	152.9	164.5	207.8	201.9	260.5
TOTAL U.S. NON-CAPTIVE	28.6	49.8	67.3	84.8	123.2	152.9	164.5	207.8	201.9	260.5
TOTAL U.S. REVENUES	209.3	349.4	385.5	597.3	497.6	756.9	660.1	1,032.7	834.7	1,350.9
<b>Non-U.S. Manufacturers</b>										
Captive	--	335.8	--	290.7	--	180.0	--	130.9	--	125.9
PCM	75.0	76.2	95.0	95.0	40.0	40.0	--	--	--	--
OEM	69.6	96.7	128.8	213.2	172.2	292.9	220.1	370.2	259.4	418.8
TOTAL NON-U.S. REVENUES	144.6	508.7	223.8	598.9	212.2	512.9	220.1	501.1	259.4	544.7
<b>Worldwide Recap</b>										
TOTAL WORLDWIDE REVENUES	353.9	858.1	609.3	1,196.2	709.8	1,269.8	880.2	1,533.8	1,094.1	1,895.6
OEM Average Price (\$000)	7.8	7.9	6.8	6.8	5.9	5.9	5.2	5.3	4.6	4.6

TABLE 49  
FIXED DISK DRIVES, 300 - 500 MB  
UNIT SHIPMENT SUMMARY

	-----DISK DRIVE UNIT SHIPMENTS, BY SHIPMENT DESTINATION (000)-----									
	1983		-----Forecast-----							
	Shipments		1984		1985		1986		1987	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
<b>U.S. Manufacturers</b>										
IBM Captive	.5	1.0	--	--	--	--	6.0	10.0	14.5	25.0
Other U.S. Captive	9.9	16.1	18.9	30.1	22.8	36.8	26.1	43.4	28.4	48.9
TOTAL U.S. CAPTIVE	10.4	17.1	18.9	30.1	22.8	36.8	32.1	53.4	42.9	73.9
PCM	1.1	2.3	--	--	--	--	--	--	--	--
OEM	2.7	3.7	12.4	15.2	25.8	31.7	37.4	46.8	50.5	64.7
TOTAL U.S. NON-CAPTIVE	3.8	6.0	12.4	15.2	25.8	31.7	37.4	46.8	50.5	64.7
TOTAL U.S. SHIPMENTS	14.2	23.1	31.3	45.3	48.6	68.5	69.5	100.2	93.4	138.6
<b>Non-U.S. Manufacturers</b>										
Captive	--	12.7	--	11.4	--	7.8	--	6.6	--	8.8
PCM	7.5	7.6	9.5	9.5	4.0	4.0	--	--	--	--
OEM	8.3	11.5	16.5	28.4	24.3	43.3	36.2	62.4	50.8	81.9
TOTAL NON-U.S. SHIPMENTS	15.8	31.8	26.0	49.3	28.3	55.1	36.2	69.0	50.8	90.7
<b>Worldwide Recap</b>										
TOTAL WORLDWIDE SHIPMENTS	30.0	54.9	57.3	94.6	76.9	123.6	105.7	169.2	144.2	229.3
<b>Cumulative Shipments</b>										
IBM Captive	116.3	198.3	116.3	198.3	116.3	198.3	122.3	208.3	136.8	233.3
Non-IBM	86.5	163.4	143.8	258.0	220.7	381.6	320.4	540.8	450.1	745.1
WORLDWIDE TOTAL	202.8	361.7	260.1	456.3	337.0	579.9	442.7	749.1	586.9	978.4

TABLE 50  
 FIXED DISK DRIVES, 300 - 500 MEGABYTES  
 WORLDWIDE SHIPMENTS (000)  
 BREAKDOWN BY DISK DIAMETER

	1983		Forecast										
	Shipments		1984		1985			1986			1987		
	14"	8"	14"	8"	14"	8"	5.25"	14"	8"	5.25"	14"	8"	5.25"
<b>U.S. MANUFACTURERS</b>													
IBM Captive	1.0	--	--	--	--	--	--	--	10.0	--	--	25.0	--
Other U.S. Captive	16.1	--	30.1	--	36.1	.7	--	41.5	1.9	--	45.7	3.2	--
PCM	2.3	--	--	--	--	--	--	--	--	--	--	--	--
OEM	3.7	--	10.6	4.6	16.4	8.8	6.5	17.3	16.5	13.0	15.2	22.0	27.5
TOTAL U.S. SHIPMENTS	23.1	--	40.7	4.6	52.5	9.5	6.5	58.8	28.4	13.0	60.9	50.2	27.5
<b>NON-U.S. MANUFACTURERS</b>													
Captive	12.6	.1	10.6	.8	6.0	1.8	--	3.5	3.1	--	1.0	7.8	--
PCM	7.6	--	9.5	--	4.0	--	--	--	--	--	--	--	--
OEM	11.3	.2	23.5	4.9	28.5	12.3	2.5	31.5	22.1	8.8	29.0	30.9	22.0
TOTAL NON-U.S. SHIPMENTS	31.5	.3	43.6	5.7	38.5	14.1	2.5	35.0	25.2	8.8	30.0	38.7	22.0
<b>WORLDWIDE RECAP</b>													
Total Shipments	54.6	.3	84.3	10.3	91.0	23.6	9.0	93.8	53.6	21.8	90.9	88.9	49.5
ANNUAL SHARE, BY DIAMETER	99.5%	.5%	89.1%	10.9%	73.6%	19.1%	7.3%	55.4%	31.7%	12.9%	39.6%	38.8%	21.6%

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

TABLE 51  
 FIXED DISK DRIVES, 300 - 500 MEGABYTES  
 WORLDWIDE REVENUES  
 BREAKDOWN BY DISK DIAMETER

	1983		-----Forecast-----										
	Revenues		1984		1985			1986			1987		
	14"	8"	14"	8"	14"	8"	5.25"	14"	8"	5.25"	14"	8"	5.25"
<b>U.S. MANUFACTURERS</b>													
IBM Captive	15.0	--	--	--	--	--	--	--	140.0	--	--	350.0	--
Other U.S. Captive	284.5	--	512.5	--	595.6	8.4	--	664.0	20.9	--	708.3	32.0	--
PCM	25.6	--	--	--	--	--	--	--	--	--	--	--	--
OEM	24.0	--	57.1	27.6	88.5	39.6	24.7	91.6	69.3	46.8	79.0	88.0	93.5
TOTAL U.S. REVENUES	349.3	--	569.6	27.6	684.2	48.0	24.7	755.6	230.2	46.8	787.3	470.0	93.5
<b>NON-U.S. MANUFACTURERS</b>													
Captive	334.1	1.7	276.6	14.1	153.0	27.0	--	87.5	43.4	--	24.5	101.4	--
PCM	76.2	--	95.0	--	40.0	--	--	--	--	--	--	--	--
OEM	94.7	2.0	190.4	22.8	228.0	55.3	9.5	245.7	92.8	31.6	220.4	123.6	74.8
TOTAL NON-U.S. REVENUES	505.0	3.7	562.0	36.9	421.0	82.3	9.5	333.2	136.2	31.6	244.9	225.0	74.8
<b>WORLDWIDE RECAP</b>													
Total Revenues	854.3	3.7	1,131.6	64.5	1,105.2	130.3	34.2	1,088.8	366.4	78.4	1,032.2	695.0	168.3
ANNUAL SHARE, BY DIAMETER	99.6%	.4%	94.6%	5.4%	87.0%	10.3%	2.7%	71.0%	23.9%	5.1%	54.5%	36.7%	8.9%

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

TABLE 52  
 FIXED DISK DRIVES, 300-500 MEGABYTES  
 DISTRIBUTION CHANNEL SUMMARY  
 U.S. Non-Captive Disk Drives

<u>Distribution channel</u>	1983 U.S. Net Shipments		FORECAST			
	Units (000)	%	1984 %	1985 %	1986 %	1987 %
Mainframe computer manufacturers	--	--	--	--	--	--
Mini/micro computer manufacturers	3.0	15.3	23.3	31.2	34.8	36.2
System OEMs/systems houses	5.3	27.0	37.9	46.9	50.0	48.0
Independent peripherals suppliers	2.6	13.3	14.1	14.5	15.2	15.8
Distributors, dealers, end users	<u>8.7</u>	44.4	24.7	7.4	--	--
TOTAL	19.6					

TABLE 53  
 FIXED DISK DRIVES, 300-500 MEGABYTES  
 MARKET SHARE SUMMARY  
 Worldwide Shipments of Non-Captive Disk Drives

<u>Drive Manufacturers</u>	1983 Net Shipments							
	To United States Destinations				Worldwide			
	Units (000)			%	Units (000)			%
	14"	8"	Total		14"	8"	Total	
Fujitsu*	15.8	--	15.8	80.6	18.3	--	18.3	72.9
Storage Technology	1.0	--	1.0	5.1	2.5	--	2.5	10.0
Other U.S.	2.8	--	2.8	14.3	3.5	--	3.5	13.9
Other Non-U.S.	--	--	--	--	.6	.2	.8	3.2
TOTAL	19.6	--	19.6	100.0	24.9	.2	25.1	100.0

\*14 Inch Totals Include 10.5 Inch Drives

FIXED DISK DRIVES, MORE THAN 500 MB



FIXED DISK DRIVES, MORE THAN 500 MEGABYTESCoverage

Examples of disk drives in this group include:

14" disk diameter

<i>ATA Gener. 6239, 6290</i>	✓ IBM	3370, 3375, 3380 D/E
	✓ Ampex	A-660, A-825
	✓ Applied Peripheral Systems	4865
	✓ Burroughs	9494-8/2
	✓ Century Data Systems	AMS 513, AMS 571
	✓ Control Data	<del>3380</del> , 9771, <del>9775</del> → 9772
	✓ Fujitsu	M2298, <del>F496</del>
	✓ Hitachi	DKU-97S, H-8598
	✓ Ibis	1400
	✓ Memorex	3680, <del>3652</del> , 680
	✓ NEC	<del>D1550</del> , N7761, N776J
	✓ Nippon Peripherals	NP-37, NP- <del>755</del> 38
	✓ Sperry	8470, 8480
	✓ Storage Technology	8650, 8380, <del>8775</del> 8380-BEY

10.5" disk diameter

✓ Fujitsu	F6425, F642JL4
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8-9" disk diameter

<i>BAVAULT MV660</i>	✓ Control Data	9715-500
	✓ Hitachi	DK815-5
	✓ NEC	D2351 <sup>2</sup> , N7756
	✓ Priam	808

Until recently, disk drives in this group consisted mostly of PCM, IBM and other captive floor-standing drives intended for use with mainframe systems. The list of OEM drives was expanded during the last few years, however, with the addition of several rack-mounted models intended for sale in the growing superminicomputer market.



Market status

DISK/TREND estimate of total market size:

<u>Worldwide sales (\$M)</u>	<u>1983</u>	<u>1984</u>	<u>1985</u>	<u>1986</u>	<u>1987</u>
U.S. manufacturers	3,494.2	4,803.0	5,510.5	6,416.0	7,311.8
All manufacturers	3,808.6	5,511.0	6,521.6	7,778.5	9,080.1

IBM's products continue to dominate the very large disk drive area completely. Total IBM 1984 revenues for 3370, 3375 and 3380 drives, on an "if sold" basis, are estimated at \$3,696,200,000, almost 29% of worldwide revenues for all types of rigid disk drives. 3380 shipments will be higher than expected in 1984, with an estimated worldwide total of 71,000 spindles (35,500 drives), up from the 51,000 spindles shipped in 1983. 3370 and 3375 shipments should be up slightly in 1984, perhaps the last year of increases for these drives.

PCM shipments of 3380 equivalent drives got off to a delayed start at the end of 1983, with 1,300 spindles worldwide. The estimated 1984 total of 21,300 spindles is lower than the drive manufacturers' hopes, but slightly higher than last year's DISK/TREND forecast. However, as a sign that the PCM market is no longer mainly a U.S. domain, 6,800 spindles included in the total estimate for 1984 will come from Fujitsu and Hitachi. As the result of its failure to start production promptly, Control Data has found itself in a poor position to seek significant market share in the remaining months of the single density 3380 era, and has announced the firm's withdrawal from the PCM disk drive market after production of existing drives is phased out in early 1985.

OEM shipments have been dominated by U.S. manufacturers' shipments of 14" floor-standing drives for several years, but 1984 will see the first production of 14" rack mounted drives, as well as new 8"-9" drives. In

## 1984 DISK/TREND REPORT

1983, Control Data held 34% of worldwide non-captive shipments, the bulk of which were 14" OEM drives. Storage Technology and Memorex held 22.4% and 17.0% of total non-captive unit shipments, most of which were PCM drives with 635 megabyte capacity.

### Marketing trends

DISK/TREND forecasts assume that IBM will use its "mid-life kicker" option and announce a double density version of the 3380 early in 1985, with deliveries starting in second quarter, 1985. Since the changes will affect the head-disk-assembly primarily, it is expected that the production ramp will be fairly steep.

25,000 spindles of the new drive are forecast for 1985 shipment, with a sharp dampening effect on shipments of standard 3380 models. By 1987, shipments of the new drive are projected at 74,000 spindles, with the 3380 down to 15,000 spindles.

Normally, it would be expected that shipments of the older product would be obliterated by that date, but it is probable that a portion of IBM's customers will prefer to stay with the existing 3380. Despite recently announced improvements in the cache memory used with some models of the 3880 controller for the 3380 drive (and presumably also to be used with the new drive), some mainframe users may find it difficult to avoid degradation of system throughput with 1.26 gigabytes accessed by only one actuator.

Because of the timing of IBM's midlife kicker, PCM shipments of 3380 equivalent drives are expected to increase only slightly in 1985, and drop off in following years. Double density drives from the independents will

probably not ship until 1986. However, it is believed that the changes to existing drives required to match IBM's double density drive are well within the abilities of PCM manufacturers, and worldwide 1987 shipments for PCM double density 3380s are forecasted at 34,000 spindles, almost half of IBM's projected shipment level.

14" OEM rack-mounted drives are starting to be shipped by several drive manufacturers, but the big news in the OEM segment of this product group is IBM's success in selling the 3380 on an OEM basis. Siemens will use IBM's drive with its mainframe computers and is reported to be selling IBM's own 3380's as PCM drives to some of IBM's own customers in Europe. And Honeywell has recently acknowledged an OEM agreement signed with IBM in April, 1984, under which IBM 3380's will be introduced in the first half of 1985 for use with Honeywell mainframes. The shipments of OEM 8"-9" drives over 500 megabytes starting in 1984 is expected to grow to 27,000 units in 1987.

#### Technical trends

It is now believed that IBM will finally announce and ship a double density version of the 3380 in the first half of 1985. Instead of improving linear density or making a 40-70% increase in total capacity, per various rumors, it is assumed that the new drive will provide a full doubling of capacity per spindle, with twice the number of tracks per HDA used with current 3380 drives. Track density probably will not be doubled (from the 800 TPI used now), but will increase to the 1,400 TPI range, with an increase in the area covered by the band of recording tracks. Of all the potential methods to provide double capacity, this one will have the least impact on controllers, channels and users' operations.

An increase in track capacity will also be simpler for IBM's competitors to reverse engineer than would be a major increase in linear density, which presumably would require a new generation of media and major changes in heads. DISK/TREND estimates assume that the PCM drive manufacturers will be able to start production of their double density 3380 equivalent drives 12 to 18 months after IBM's first deliveries.

Forecasting assumptions

IBM ADVANTAGE 85" E RAMP  
- 1987 8-10" E RAMP

1. IBM will ship a double density 3380 starting in second quarter, 1985. *SUMMER 86*
2. PCM shipments of drives equivalent to IBM's double density 3380 will start 12-18 months after IBM's FCS.
3. Other captive and OEM products will both experience strong growth, driven by mainframe and supermini markets.

PERFORMANCE DRIVES —  
 — SUMMER DISKS  
 — MULTIPLE ACTUATORS  
 — MULTIPLE HEAD SURFACES  
 — METAL DISKS  
 — HIGH SPEED TAPES

TABLE 54  
FIXED DISK DRIVES, MORE THAN 500 MEGABYTES  
REVENUE SUMMARY

	-----DISK DRIVE REVENUES, BY SHIPMENT DESTINATION (\$M)-----									
	1983		1984		1985		1986		1987	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
<b>U.S. Manufacturers</b>	-----									
IBM Captive	1,669.6	2,875.8	2,240.1	3,696.2	2,486.9	4,119.5	2,700.4	4,473.7	2,899.2	4,832.1
Other U.S. Captive	240.0	406.4	312.4	532.2	439.4	721.2	524.1	870.3	609.4	1,008.9
<b>TOTAL U.S. CAPTIVE</b>	<b>1,909.6</b>	<b>3,282.2</b>	<b>2,552.5</b>	<b>4,228.4</b>	<b>2,926.3</b>	<b>4,840.7</b>	<b>3,224.5</b>	<b>5,344.0</b>	<b>3,508.6</b>	<b>5,841.0</b>
PCM	66.6	117.3	268.7	389.8	305.4	420.2	521.0	664.6	721.1	1,010.9
OEM	65.2	94.7	91.3	184.8	162.4	249.6	265.0	407.4	299.7	459.9
<b>TOTAL U.S. NON-CAPTIVE</b>	<b>131.8</b>	<b>212.0</b>	<b>360.0</b>	<b>574.6</b>	<b>467.8</b>	<b>669.8</b>	<b>786.0</b>	<b>1,072.0</b>	<b>1,020.8</b>	<b>1,470.8</b>
<b>TOTAL U.S. REVENUES</b>	<b>2,041.4</b>	<b>3,494.2</b>	<b>2,912.5</b>	<b>4,803.0</b>	<b>3,394.1</b>	<b>5,510.5</b>	<b>4,010.5</b>	<b>6,416.0</b>	<b>4,529.4</b>	<b>7,311.8</b>
<b>Non-U.S. Manufacturers</b>	-----									
Captive	--	248.4	--	375.2	--	635.8	39.0	874.2	84.0	1,080.0
PCM	10.8	60.8	126.8	319.8	134.0	337.7	130.5	397.3	244.5	502.0
OEM	5.2	5.2	7.8	13.0	19.4	37.6	44.5	91.0	96.6	186.3
<b>TOTAL NON-U.S. REVENUES</b>	<b>16.0</b>	<b>314.4</b>	<b>134.6</b>	<b>708.0</b>	<b>153.4</b>	<b>1,011.1</b>	<b>214.0</b>	<b>1,362.5</b>	<b>425.1</b>	<b>1,768.3</b>
<b>Worldwide Recap</b>	-----									
<b>TOTAL WORLDWIDE REVENUES</b>	<b>2,057.4</b>	<b>3,808.6</b>	<b>3,047.1</b>	<b>5,511.0</b>	<b>3,547.5</b>	<b>6,521.6</b>	<b>4,224.5</b>	<b>7,778.5</b>	<b>4,954.5</b>	<b>9,080.1</b>
<b>OEM Average Price (\$000)</b>	<b>12.4</b>	<b>12.5</b>	<b>10.2</b>	<b>12.2</b>	<b>11.7</b>	<b>11.9</b>	<b>12.2</b>	<b>12.4</b>	<b>12.2</b>	<b>12.3</b>

TABLE 55  
FIXED DISK DRIVES, MORE THAN 500 MB  
UNIT SHIPMENT SUMMARY

	-----DISK DRIVE UNIT SHIPMENTS, BY SHIPMENT DESTINATION (000)-----									
	1983		-----Forecast-----							
	Shipments		1984		1985		1986		1987	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
<b>U.S. Manufacturers</b>										
IBM Captive	45.8	80.5	62.5	105.0	68.7	113.8	69.6	115.3	70.2	117.0
Other U.S. Captive	7.5	12.7	9.9	16.8	13.0	21.2	15.6	25.8	18.4	30.3
TOTAL U.S. CAPTIVE	53.3	93.2	72.4	121.8	81.7	135.0	85.2	141.1	88.6	147.3
PCM	4.7	8.4	10.0	14.5	11.7	16.1	16.7	21.3	20.9	29.3
OEM	5.5	7.8	8.7	14.8	13.6	20.9	21.7	33.4	25.1	38.5
TOTAL U.S. NON-CAPTIVE	10.2	16.2	18.7	29.3	25.3	37.0	38.4	54.7	46.0	67.8
TOTAL U.S. SHIPMENTS	63.5	109.4	91.1	151.1	107.0	172.0	123.6	195.8	134.6	215.1
<b>Non-U.S. Manufacturers</b>										
Captive	--	6.9	--	10.1	--	16.9	1.0	23.2	2.1	28.2
PCM	.5	2.4	4.4	11.2	5.0	12.6	4.5	13.7	7.5	15.4
OEM	.2	.2	1.0	1.4	1.9	3.2	3.6	6.9	7.4	14.0
TOTAL NON-U.S. SHIPMENTS	.7	9.5	5.4	22.7	6.9	32.7	9.1	43.8	17.0	57.6
<b>Worldwide Recap</b>										
TOTAL WORLDWIDE SHIPMENTS	64.2	118.9	96.5	173.8	113.9	204.7	132.7	239.6	151.6	272.7
<b>Cumulative Shipments</b>										
IBM Captive	79.3	149.0	141.8	254.0	210.5	367.8	280.1	483.1	350.3	600.1
Non-IBM	69.4	129.9	103.4	198.7	148.6	289.6	211.7	413.9	293.1	569.6
WORLDWIDE TOTAL	148.7	278.9	245.2	452.7	359.1	657.4	491.8	897.0	643.4	1,169.7

TABLE 56  
 FIXED DISK DRIVES, MORE THAN 500 MEGABYTES  
 WORLDWIDE SHIPMENTS (000)  
 BREAKDOWN BY DISK DIAMETER

	1983		Forecast							
	Shipments		1984		1985		1986		1987	
	14"	8"	14"	8"	14"	8"	14"	8"	14"	8"
<b>U.S. MANUFACTURERS</b>										
IBM Captive	80.5	--	105.0	--	113.8	--	115.3	--	117.0	--
Other U.S. Captive	12.7	--	16.3	.5	19.6	1.6	21.9	3.9	23.7	6.6
PCM	8.4	--	14.5	--	16.1	--	21.3	--	29.3	--
OEM	7.8	--	12.7	2.1	12.6	8.3	17.2	16.2	17.5	21.0
TOTAL U.S. SHIPMENTS	109.4	--	148.5	2.6	162.1	9.9	175.7	20.1	187.5	27.6
<b>NON-U.S. MANUFACTURERS</b>										
Captive	6.9	--	10.1	--	16.5	.4	21.5	1.7	25.8	2.4
PCM	2.4	--	11.2	--	12.6	--	13.7	--	15.4	--
OEM	.2	--	.6	.8	1.6	1.6	3.8	3.1	7.3	6.7
TOTAL NON-U.S. SHIPMENTS	9.5	--	21.9	.8	30.7	2.0	39.0	4.8	48.5	9.1
<b>WORLDWIDE RECAP</b>										
Total Shipments	118.9	--	170.4	3.4	192.8	11.9	214.7	24.9	236.0	36.7
ANNUAL SHARE, BY DIAMETER 100.0%	--	--	98.0%	2.0%	94.2%	5.8%	89.6%	10.4%	86.5%	13.5%

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

TABLE 57  
 FIXED DISK DRIVES, MORE THAN 500 MEGABYTES  
 WORLDWIDE REVENUES  
 BREAKDOWN BY DISK DIAMETER

	1983		Forecast							
	Revenues		1984		1985		1986		1987	
	14"	8"	14"	8"	14"	8"	14"	8"	14"	8"
<b>U.S. MANUFACTURERS</b>										
IBM Captive	2,875.8	--	3,696.2	--	4,119.5	--	4,473.6	--	4,832.1	--
Other U.S. Captive	406.4	--	521.2	11.0	686.0	35.2	788.4	81.9	876.9	132.0
PCM	117.2	--	389.7	--	420.2	--	664.5	--	1,010.8	--
OEM	94.7	--	169.4	15.3	189.0	60.5	292.4	115.0	315.0	144.9
TOTAL U.S. REVENUES	3,494.2	--	4,776.6	26.3	5,414.7	95.7	6,219.0	196.9	7,034.8	276.9
<b>NON-U.S. MANUFACTURERS</b>										
Captive	248.4	--	375.2	--	627.0	8.8	838.5	35.7	1,032.0	48.0
PCM	60.8	--	319.8	--	337.6	--	397.3	--	502.0	--
OEM	5.2	--	6.6	6.4	25.6	12.0	68.4	22.6	138.7	47.5
TOTAL NON-U.S. REVENUES	314.4	--	701.6	6.4	990.2	20.8	1,304.2	58.3	1,672.7	95.5
<b>WORLDWIDE RECAP</b>										
Total Revenues	3,808.6	--	5,478.2	32.7	6,405.0	116.5	7,523.2	255.2	8,707.5	372.4
ANNUAL SHARE, BY DIAMETER	100.0%	--	99.4%	.6%	98.2%	1.8%	96.7%	3.3%	95.9%	4.1%

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



TABLE 58  
 WORLDWIDE SHIPMENTS OF IBM AND PCM FIXED DISK DRIVES FOR MAINFRAMES  
 PRODUCT MIX ANALYSIS

	-----DISK DRIVE SHIPMENTS, BY SHIPMENT DESTINATION (000)-----									
	1983		-----FORECAST-----							
	---Shipments---		---1984---		---1985---		---1986---		---1987---	
	US	WW	US	WW	US	WW	US	WW	US	WW
<b>3350 Type</b>										
IBM 317 MB	.5	1.0	--	--	--	--	--	--	--	--
PCM 317 MB*	8.6	9.9	9.5	9.5	4.0	4.0	--	--	--	--
PCM 635 MB	4.7	8.5	.4	.7	--	--	--	--	--	--
TOTAL	13.8	19.4	9.9	10.2	4.0	4.0	--	--	--	--
<b>3370 Type</b>										
IBM 571 MB	6.6	16.5	--	--	--	--	--	--	--	--
IBM 729 MB	--	--	7.4	18.5	7.1	17.8	6.5	16.3	5.8	14.5
PCM 571/729 MB	--	.8	--	1.3	.2	1.9	.2	1.5	.1	1.0
TOTAL	6.6	17.3	7.4	19.8	7.3	19.7	6.7	17.8	5.9	15.5
<b>3375 Type (819 MB)</b>										
IBM	6.2	13.0	7.1	15.5	7.2	16.0	6.6	15.0	5.8	13.5
PCM	--	.2	.6	2.4	.9	2.8	.7	2.5	.4	1.7
TOTAL	6.2	13.2	7.7	17.9	8.1	18.8	7.3	17.5	6.2	15.2
<b>3380 Type (1260 MB)</b>										
IBM	33.0	51.0	48.0	71.0	36.9	55.0	21.1	32.0	9.8	15.0
PCM**	.5	1.3	13.4	21.3	15.6	24.0	10.5	17.0	4.8	8.0
TOTAL	33.5	52.3	61.4	92.3	52.5	79.0	31.6	49.0	14.6	23.0
<b>2 x 3380 Type (2520 MB)</b>										
IBM	--	--	--	--	17.5	25.0	35.4	52.0	48.8	74.0
PCM	--	--	--	--	--	--	9.8	14.0	23.1	34.0
TOTAL	--	--	--	--	17.5	25.0	45.2	66.0	71.9	108.0
TOTAL SPINDLES	60.1	102.2	86.4	140.2	89.4	146.5	90.8	150.3	98.6	161.7
TOTAL CAPACITY (Terabytes)		95.5		148.8		193.6		255.4		324.9
		+48%		+56%		+32%		+32%		+27%

\*Includes 10.5" drives in 317 MB 3350 format.

\*\*Includes 10.5" drives, counted as equivalent to IBM 3380 (two 10.5" spindles = one IBM 3380 spindle)

TABLE 59

## FIXED DISK DRIVES, MORE THAN 500 MEGABYTES

## DISTRIBUTION CHANNEL SUMMARY

## U.S. Non-Captive Disk Drives

<u>Distribution channel</u>	1983 U.S. Net Shipments		FORECAST			
	Units (000)	%	1984 %	1985 %	1986 %	1987 %
Mainframe computer manufacturers	1.1	10.1	9.6	8.8	7.0	5.3
Mini/micro computer manufacturers	3.0	27.5	19.8	23.8	26.6	24.5
System OEMs/systems houses	1.4	12.9	8.5	12.8	17.7	20.1
Independent peripherals suppliers	.2	1.8	2.3	2.7	3.1	3.5
Distributors, dealers, end users	<u>5.2</u>	47.7	59.8	51.9	45.6	46.6
TOTAL	10.9					

TABLE 60

## FIXED DISK DRIVES, MORE THAN 500 MEGABYTES

## MARKET SHARE SUMMARY

## Worldwide Shipments of Non-Captive Disk Drives

<u>Drive Manufacturers</u>	1983 Net Shipments			
	<u>To United States Destinations</u>		<u>Worldwide</u>	
	Units (000)	%	Units (000)	%
Control Data	4.0	36.7	6.4	34.0
Storage Technology	2.2	20.2	4.2	22.4
Memorex	1.7	15.6	3.2	17.0
Other U.S.	2.3	21.1	2.4	12.8
Other Non-U.S.	<u>.7</u>	<u>6.4</u>	<u>2.6</u>	<u>13.8</u>
TOTAL	10.9	100.0	18.8	100.0







## OPTICAL DISK DRIVES

### Introduction

For the first time with this edition, the DISK/TREND report includes information on optical disk drives intended for data storage applications. As individual optical disk drive configurations are introduced, or firm plans are known to exist for their introduction, they will be added to the DISK/TREND Report. Coverage will be confined to optical disk drives intended for data storage, and products intended primarily to serve document and image storage areas will not be included.

The optical disk field is still characterized by many individual programs, with limited cooperation between participants in setting standards for media interchange or in establishing valid second sources for hardware and media. Except for the short list of disk drives actually announced in detail so far, the majority of products which will participate in this segment of the industry are still uncommitted, and the extent of the markets is conjectural. Accordingly, no forecasts have been included in this edition of the DISK/TREND Report, following our philosophy of avoiding specific forecasts until the general character of individual markets is clear.

Unless a better method of organization becomes apparent with time, DISK/TREND data and analysis will be arranged in subgroups consisting of write-once, read-only and erasable drives. It is recognized that some manufacturers intend to produce drives which will be able to use media designed for more than one of these uses, and a later reorganization of groups may be necessary depending on the manner in which the market dev-

elops. In the meantime, we intend to collect data on shipments in these groups and to use it in statistical information to be included in the 1985 DISK/TREND Report.

### Coverage

Examples of disk drives in this group include:

#### 12" -- Write-Once

Alcatel Thomson Gigadisc	GD 1001
Fujitsu	6441
Hitachi	OF301, OL301
NEC	N6329-21
Optical Storage International	LaserDrive 1200
Shugart	Optimem 1000
Toshiba	DF-0400

#### 12" -- Read-Only

Reference Technology	Series 2000
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#### 14" -- Write-once

Storage Technology	7640
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At this time, no specific drives or media have been announced with erasable recording capability, although numerous companies have confirmed development activities. It should also be noted that the above list includes only the write-once and read-only drives which have been announced as specific products. Many other firms have revealed the general character of the drives they intend to announce later without offering complete specifications or initial delivery dates. Although several firms have indicated an intention to introduce "CD-ROM" 120 millimeter read-only drives, detailed product specifications are still lacking, and they are not yet included in the above list.

### Market status

So far, optical disk drives for data storage applications remain mostly a promise -- but the industry has progressed to the point where limited shipments have actually been delivered to system manufacturers. Here is the situation with specific subgroups:

Write-once drives: With the exception of the 14" Storage Technology drive intended for end user applications with mainframe computers, all of the currently announced write-once drives use 12" disks and are aimed at the OEM market. However, some of the manufacturers may use these drives on a captive basis with their own general purpose or specialized systems. Outside of the document storage area (not covered by this report), it appears that most early applications for OEM drives will be found with specialized systems in fields such as medical, CAD and other imaging areas. Usage in specific data processing applications in which data is infrequently or never revised is also expected, but system development time will be lengthy, and the market development time may take just as long.

The really large market opportunity for write-once drives will probably depend on availability of small diameter drives. Some firms have indicated that they will announce drives with nominal 5.25" diameter disks as early as fourth quarter, 1984, using box sizes and interfaces compatible with existing magnetic disk drives. It appears likely that this field will be pioneered by young entrepreneurial companies, several of which are located in Colorado, the site of their founders' previous employment with either Storage Technology or the Control Data/Philips optical disk joint venture. One of these



firms, Information Storage, Inc., plans an introduction at Comdex in November, 1984, of a write-once 5.25" unit with 100 megabytes capacity, which is also intended to be usable as a read-only drive.

It is too early to have a complete understanding of the range of applications for which 5.25" write-once drives will be widely used, but the personal computer market and certain specialized systems are prime candidates. In the PC area, write-once optical disks won't compete with magnetic flexible or rigid disks, but should find a place in applications involving maintenance of comparatively large data bases -- in the 100 to 500 megabyte range -- with the frequent need to add new information. There are numerous potential examples, including financial information, engineering specifications, medical records, pricing information, and others waiting to be uncovered.

An obvious market opportunity for a write-once subsystem would be as a specialized file server dedicated to one of the above information areas. When 5.25" hardware and media are actually available to system manufacturers, we will see many attempts to develop such applications, but no one should expect big markets to occur overnight. Years will be required to settle on the right combination of recording system and system features for individual applications, after numerous experimental product introductions.

Storage Technology's 4 gigabyte write-once subsystem using 14" disks is in a class by itself, so far. Most cool heads in the business of offering plug compatible subsystems to attach to IBM mainframes usually wait for IBM to make the first move in establishing the form

and function of new peripherals. But STC has brashly determined to pioneer the sale of write-once optical disk drives to IBM's mainframe customers, with hardware now scheduled for first shipment in first quarter, 1985. It is expected that STC will find a market for this product. There are many mainframe users with bulging tape libraries in high-rent sites, who will welcome the volumetric efficiency of optical disk for at least a portion of their offline data storage requirements. And the often mentioned applications such as storage of geophysical exploration data, financial transaction records and infrequently updated insurance files will probably also be available to this kind of system. But development of these markets will consume much time -- to build customer confidence, to modify software and to change human habits. And STC can never forget that IBM is a company not known to react passively to competitive inroads.

Read-only drives: The read-only disk may create major new markets for data storage products -- or the proposed users may yawn softly and continue to use microfilm, paper and remote databases. It is always difficult to predict human reaction to entirely new products, and this one is not different in that regard.

Reference Technology is offering the first read-only drive, using a 12" video disk on which up to 1 gigabyte of digital information is stored on each side. 3M and other manufacturers of industry standard video disks will be able to offer volume replication services customized for regular publication of database updates. Reference Technology will sell the hardware on an OEM basis, and is targeting owners of legal, medical, scientific, economic and financial data-

bases -- who presumably will develop retrieval systems using the optical disk hardware and market them to users.

Also expected to soon appear on the market from companies such as Hitachi, Sony and Philips is the "CD-ROM", a digital read-only version of the 120 millimeter "CD" compact audio disk. The audio CD is now a major product in consumer markets, with large-scale production of hardware and media. The CD-ROM player will probably be packaged by most manufacturers in the same box size as a full size 5.25" flexible disk drive, using industry standard interfaces, and will have a formatted capacity of 552 megabytes. Some of the CD audio disk replicators will probably offer duplication services for digital CD-ROM disks.

Like the 5.25" write-once optical disk, the CD-ROM has an interesting potential in the microcomputer market, both as a file server for local area networks and as a specialized peripheral for individual users of personal computers. Market development, obviously, will depend on someone taking the initiative to develop the databases or other large datasets to be published in this medium, and to risk the large sums required to underwrite individual programs. In this situation hardware sales will depend on availability of disks with attractive content. It will require experimentation to determine whether end users will be willing to spend their money on disks full of games, financial information, an encyclopedia, or whatever.

Erasable media: The erasable optical disk will clearly be a commercial reality, but the prime question is when. Extensive

development activities have been underway in the United States, Japan and Europe for many years, and many researchers believe the time to introduce the first actual products is at hand. But the cost to be a pioneer in this area could be high to any company wishing to start a major program. System manufacturers with mainstream, high volume products usually do not like to experiment with unproven data storage technologies and, at minimum, will demand that vendors have in place the capability to produce large quantities of both drives and media. So, the manufacturers intending to start erasable optical disk businesses must be prepared to invest heavily in facilities and processes, hoping that all the serious bugs have been eliminated and praying that the market will not take too many years to develop. Although there may be announcements earlier, it is believed that the first volume shipments of major erasable disk drive systems will occur 3 - 5 years in the future.

From the end users' and system OEMs' point of view, it probably doesn't matter too much whether either of the rival technologies, magneto-optical or phase change, is first in the market. Presumably, both would be used in much the same way. The problems for customers will occur if both magneto-optical and phase change should be introduced and gain supporters, further compounding existing confusion over media interchange standards. Although magneto-optical has many more supporters and is backed with major development programs, phase change also has firm backing by its fewer proponents. But most of the smart money seems to be on magneto-optical.

When erasable optical disks are properly introduced -- with interchange standards and credible multiple sources for drives and media -- the existing disk drive industry will have to make room for the newcomer. Potentially, the advantages will be obvious: Higher areal densities, elimination of head/disk interference problems and disk removability where needed. It is likely that the first serious competition for magnetic disk drives will occur in the mid and high capacity ranges, with low end drives feeling the pressure later, as costs for optical components come down with volume.





## DISK DRIVE SPECIFICATIONS

### Coverage

This listing includes most disk drives intended for computer data storage which are now in new production or announced, arranged alphabetically by manufacturer. Most of the listed drives are still in production, but a number of IBM drives no longer in new production are listed for reference. 150

Specifications on drive models sold by computer system manufacturers but purchased on an OEM basis from others have been included in ~~only~~ a few cases, for identification purposes. ~~Also~~ not listed in most cases are captive drives which are similar to OEM models made by the same manufacturer.

### Generic type

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

### Technology type

IBM drive model numbers are also used as a general guide to type of heads and recording disks when appropriate, using a broad interpretation of IBM specifications, since later drives frequently use higher track and linear densities.



Capacities

Capacities are listed as "U" for unformatted or "F" for formatted. In general, unformatted capacities are shown for OEM drives, and formatted capacities for given for captive and PCM drives.

Interfaces

Specific interfaces available are indicated for most drives, using references to manufacturers' own unique interfaces or to de facto industry standards where applicable. However, this is a rapidly changing area for OEM drives, so please be alert to the need to check for manufacturers' latest information if you need precise data.

OEM prices

The 100 unit price is given for most OEM drives sold in the United States. Since these prices may be changed by manufacturers without notice, please use them with the appropriate caution.

*7/16/84  
@UAST*

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.

1984 DISK/TREND product groups

- |                           |   |
|---------------------------|---|
| REMOVABLE MAGNETIC MEDIA: | 1. Disk cartridge drives, less than 12 MB |
|                           | 2. Disk cartridge drives, more than 12 MB |
|                           | 3. Disk pack drives, less than 100 MB     |
|                           | 4. Disk pack drives, more than 100 MB     |
| FIXED MAGNETIC MEDIA:     | 5. Fixed disk drives, less than 30 MB     |
|                           | 6. Fixed disk drives, 30-100 MB           |
|                           | 7. Fixed disk drives, 100-300 MB          |
|                           | 8. Fixed disk drives, 300-500 MB          |
|                           | 9. Fixed disk drives, more than 500 MB    |
| OPTICAL MEDIA:            | 10. All optical disk drives               |

**1984 DISK/TREND REPORT**

MANUFACTURER	ADVANCED STORAGE TECHNOLOGY	ADVANCED STORAGE TECHNOLOGY	ADVANCED STORAGE TECHNOLOGY	ADVANCED STORAGE TECHNOLOGY	ADVANCED STORAGE TECHNOLOGY
DRIVE	AST 12202	AST 96202	AST 12203	AST 12332	AST 12333
DISK/TREND GROUP	6	6	7	7	7
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID
Recording medium	Plated	Plated	Plated	Plated	Plated
DRIVE: Technology type	Modified 3370	Modified 3370	Modified 3370	Modified 3370	Modified 3370
Heads	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
Interface	ESDI	ESDI	ESDI	ESDI, IPI-2	ESDI, IPI-2
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 76.7	U: 61.8	U: 127.8	U: 121.0	U: 202.0
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 20,880	U: 20,880	U: 20,880	U: 33,060	U: 33,060
Data surfaces per spindle	3	3	5	3	5
Heads per data surface	1	1	1	1	1
Tracks per surface	1225	987	1225	1225	1225
Track density (TPI)	1200	960	1200	1200	1200
Maximum linear density (BPI)	19405 BPI 12937 FCI	19405 BPI 12937 FCI	19405 BPI 12937 FCI	30502 BPI 20335 FCI	30502 BPI 20335 FCI
Rotational speed (RPM)	3600	3600	3600	3600	3600
PERFORMANCE					
Actuator type	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil
Average positioning time (msec)	30	30	30	20	20
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	38.3	38.3	38.3	28.3	28.3
Data transfer rate (KBytes/sec)	1250	1250	1250	1984	1984
FIRST CUSTOMER SHIPMENT	3Q85	11/1/84	3Q85	3Q85	3Q85
U.S. OEM PRICE FOR 100 UNITS	--	\$1,450	--	--	--
COMMENTS	1.625" High	1.625" High	1.95" High	1.625" High	1.95" High

MANUFACTURER	ADVANCED STORAGE TECHNOLOGY	ALCATEL THOMSON GIGADISC	ALPHA DATA	AMCODYNE	AMCODYNE
DRIVE	AST 96203	GD 1001	Atlas	7110 Arapahoe	8160 Comanche
DISK/TREND GROUP	7	10	6	2	7
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	Fixed	GM 1001/2	Fixed	8" Cartridge	Fixed
Nominal disk diameter	130 mm OD 40 mm ID	12"	14"	200 mm OD 63.5 mm ID	200 mm OD 63.5 mm ID
Recording medium	Plated	Gold/Glass	Plated	Oxide Coated	Oxide Coated
DRIVE: Technology type	Modified 3370	Write-Once Opt.	Special	3370 (Ferrite)	3370 (Ferrite)
Heads	Thin Film	Diode Laser	Ferrite	Ferrite	Ferrite
Interface	ESDI	SCSI	SMD	SMD, SCSI	SMD
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 103.0	--	U: 160.0	U: 26.9	U: 165.9
REMOVABLE	--	F: 1,000	--	U: 26.9	--
Capacity per track (Bytes)	U: 20,880	F: 25,600	U: 20,160	U: 20,928	U: 20,160
Data surfaces per spindle	5	1	5	4	10
Heads per data surface	1	1	10	1	1
Tracks per surface	987	40,000	1600	644	823
Track density (TPI)	960	14,500	540	550	960
Maximum linear density (BPI)	19405 BPI 12937 FCI	15,300	600	7324 FRPI 10986 BPI*	6500 FRPI 9750 BPI*
Rotational speed (RPM)	3600	1122	3600	3523	3657
PERFORMANCE					
Actuator type	Linear, Voice Coil	Linear, Voice Coil	Rotary, Voice Coil	Linear, Voice Coil	Linear, Voice Coil
Average positioning time (msec)	30	200	18	35	22
Average rotational delay (msec)	8.3	27	8.3	8.45	8.2
Average access time (msec)	38.3	227	26.3*	43.45	30.2
Data transfer rate (KBytes/sec)	1250	1000	1209	1229	1229
FIRST CUSTOMER SHIPMENT	11/1/84	4Q84	3Q83	1Q83	11/84
U.S. OEM PRICE FOR 100 UNITS	\$1,700	\$6933*	\$5,995	\$3,175	\$3,495
COMMENTS	1.95" High	*w/o controller	*Access is faster when no head movement is required	Embedded Servo *2,7 RLL Code	Embedded Servo *2,7 RLL Code

MANUFACTURER	AMCODYNE	AMPEX	AMPEX	AMPEX	AMPEX
DRIVE	8220 Comanche	DFR-932	DFR-964	DFR-996	DM-980
DISK/TREND GROUP	7	2	2	2	3
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	Fixed	CMD	CMD	CMD	SMD
Nominal disk diameter	200 mm OD	14"	14"	14"	14"
Recording medium	63.5 mm ID Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	3370 (Ferrite)	3330-11	3330-11	3330-11	3330-11
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	SMD	SMD	SMD	SMD	SMD
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 224.6	U: 16.289	U: 48.868	U: 81.446	--
REMOVABLE	--	U: 16.289	U: 16.289	U: 16.289	U: 82.8
Capacity per track (Bytes)	U: 20,160	U: 20,160	U: 20,160	U: 20,160	U: 20,160
Data surfaces per spindle	10	1 Fixed 1 Removable	3 Fixed 1 Removable	5 Fixed 1 Removable	5
Heads per data surface	1	2 Fixed 1 Removable	2 Fixed 1 Removable	2 Fixed 1 Removable	1
Tracks per surface	1114	823	823	823	823
Track density (TPI)	960	367 Fixed 384 Removable	367 Fixed 384 Removable	367 Fixed 384 Removable	384
Maximum linear density (BPI)	7324 FRPI 10986 BPI*	6274 Fixed 6038 Removable	6274 Fixed 6038 Removable	6274 Fixed 6038 Removable	6038
Rotational speed (RPM)	3657	3600	3600	3600	3600
PERFORMANCE					
Actuator type	Linear, Voice Coil	Fix: Rotary VC Rem: Linear VC	Fix: Rotary VC Rem: Linear VC	Fix: Rotary VC Rem: Linear VC	Linear, Voice Coil
Average positioning time (msec)	25	30	30	30	30
Average rotational delay (msec)	8.2	8.3	8.3	8.3	8.3
Average access time (msec)	33.2	38.3	38.3	38.3	38.3
Data transfer rate (KBytes/sec)	1229	1209	1209	1209	1209
FIRST CUSTOMER SHIPMENT	11/84	4Q79	4Q79	4Q79	1/76
U.S. OEM PRICE FOR 100 UNITS	--	\$4,525	\$5,145	\$5,700	\$5,885
COMMENTS	Embedded Servo *2,7 RLL Code	Mfg. by Toshiba	Mfg. by Toshiba	Mfg. by Toshiba	

## MANUFACTURER

## DRIVE

## DISK/TREND GROUP

## MARKET

## MEDIA: Generic type

Nominal disk diameter

Recording medium

## DRIVE: Technology type

Heads

Interface

## CAPACITY/RECORDING DENSITY

Total capacity (MBytes) FIXED

REMOVABLE

Capacity per track (Bytes)

Data surfaces per spindle

Heads per data surface

Tracks per surface

Track density (TPI)

Maximum linear density (BPI)

Rotational speed (RPM)

## PERFORMANCE

Actuator type

Average positioning time (msec)

Average rotational delay (msec)

Average access time (msec)

Data transfer rate (KBytes/sec)

## FIRST CUSTOMER SHIPMENT

## U.S. OEM PRICE FOR 100 UNITS

## COMMENTS

AMPEX	AMPEX	AMPEX	AMPEX	AMPEX
DM-9300	DM-9300A	PTD-930X Parallel Transfer Drive	PYXIS 7	PYXIS 13
4	4	4	5	5
OEM	OEM	OEM	OEM	OEM
3336-11	3336-11	3336-11	Fixed	Fixed
14"	14"	14"	130 mm OD 40 mm ID Oxide Coated	130 mm OD 40 mm ID Oxide Coated
Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
3336-11	3336-11	3330-11	Modified 3350	Modified 3350
Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
SMD	SMD	Special	ST506	ST506
---	--	--	U: 6.67	U: 13.33
U: 312.0	U: 315.0	U: 312.177	--	--
U: 20,160	U: 20,160	U: 20,160	U: 10,417	U: 10,417
19	19	19	2	4
1	1	1	1	1
815	823	815	320	320
370	384	384	360	360
6038	6038	6038	8720	8720
3600	3600	3600	3600	3600
Linear, Voice Coil 28	Linear, Voice Coil 28	Linear, Voice Coil 28	Rotary, Stepping Motor 90 (including settling)	Rotary, Stepping Motor 90 (including settling)
8.3	8.3	8.3	8.3	8.3
36.3	36.3	36.3	98.3	98.3
1209	1209	1209	625	625
5/76	3Q80	11/78	5/82	5/82
\$10,365	\$10,365	\$55,000	\$545	\$655
		Up to 9 track parallel data transfer	Manufactured under Rodime license	Manufactured under Rodime license

MANUFACTURER	AMPEX	AMPEX	AMPEX	AMPEX	AMPEX
DRIVE	PYXIS 20	PYXIS 27	165 Capricorn 165E Capricorn	330 Capricorn	A-330
DISK/TREND GROUP	5	5	7	8	8
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	130 mm OD	130 mm OD	14"	14"	14"
Recording medium	40 mm ID Oxide Coated	40 mm ID Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	Modified 3350	Modified 3350	Modified 3350	Modified 3350	Modified 3350
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	ST506	ST506	SMD	SMD	Modifed SMD
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 20.0	U: 26.67	U: 165.9	U: 330.3	--
REMOVABLE	--	--	--	--	U: 330.3
Capacity per track (Bytes)	U: 10,417	U: 10,417	U: 20,160	U: 20,160	U: 40,320
Data surfaces per spindle	6	8	5	8	4
Heads per data surface	1	1	2	2	2
Tracks per surface	320	320	1646	2048	2048
Track density (TPI)	360	360	960	960	960
Maximum linear density (BPI)	8720	8720	5950	6250	12500*
Rotational speed (RPM)	3600	3600	3600	3600	2766
PERFORMANCE					
Actuator type	Rotary, Stepping Motor	Rotary, Stepping Motor	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil
Average positioning time (msec)	90 (including settling)	90 (including settling)	30	30	21
Average rotational delay (msec)	8.3	8.3	8.3	8.3	10.8
Average access time (msec)	98.3	98.3	38.3	38.3	31.8
Data transfer rate (KBytes/sec)	625	625	1209	1209	1859
FIRST CUSTOMER SHIPMENT	5/82	5/82	3Q81	3Q81	9/84
U.S. OEM PRICE FOR 100 UNITS	\$795	\$920	\$5,155	\$7,050	\$5,895
COMMENTS	Manufactured under Rodime license	Manufactured under Rodime license	165E emulates DM-9160		*RLL Code

SPEC-9

MANUFACTURER

DRIVE

DISK/TREND GROUP

MARKET

MEDIA: Generic type

Nominal disk diameter

Recording medium

DRIVE: Technology type

Heads

Interface

CAPACITY/RECORDING DENSITY

Total capacity (MBytes) FIXED

REMOVABLE

Capacity per track (Bytes)

Data surfaces per spindle

Heads per data surface

Tracks per surface

Track density (TPI)

Maximum linear density (BPI)

Rotational speed (RPM)

PERFORMANCE

Actuator type

Average positioning time (msec)

Average rotational delay (msec)

Average access time (msec)

Data transfer rate (KBytes/sec)

FIRST CUSTOMER SHIPMENT

U.S. OEM PRICE FOR 100 UNITS

COMMENTS

	AMPEX	AMPEX	APPLIED INFORMATION MEMORIES	APPLIED INFORMATION MEMORIES	APPLIED INFORMATION MEMORIES
	A-660	A-825	DART 130	DART 250	LANCE 1000
	9	9	7	7	7
	OEM	OEM	OEM	OEM	OEM
	Fixed	Fixed	Fixed	Fixed	Fixed
	14"	14"	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID
	Oxide Coated	Oxide Coated	Sputtered	Sputtered	Sputtered
	Modified 3350	Modified 3350	Special	Special	Special
	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
	Modified SMD	Modified SMD	SMD,SCSI,IPI-2	SMD,SCSI,IPI-2	SMD,SCSI,IPI-2
	--	--	U: 129.27	U: 250.4	U:1001.6(Drive) U:250.4(Spindle)
	U: 660.6	U: 825.7	--	--	--
	U: 40,320	U: 40,320	U: 20,832	U: 30,240	U: 30,240
	8	10	7	9	7
	2	2	1	1	1
	2048	2048	916	920	920
	960	960	1000	1000	1000
	12500*	12500*	18534	27801 BPI 18534 FCI	27801 BPI 18534 FCI
	2766	2766	3600	3600	3600
	Linear, Voice Coil 21	Linear, Voice Coil 21	Linear, Voice Coil 18	Linear, Voice Coil 18	Linear, Voice Coil 18
	10.8	10.8	8.3	8.3	8.3
	31.8	31.8	26.3	26.3	26.3
	1859	1859	1210	1814	1814
	9/84	9/84	7/84	1Q85	4Q84
	\$7,195	\$8,825	\$2,695 (500)	\$3,235 (500)	\$12,500(500)
	*RLL Code	*RLL Code			(Price above per drive). Drive has four spindles.

1984 DISK/TREND REPORT

MANUFACTURER	APPLIED PERIPHERAL SYSTEMS	APPLIED PERIPHERAL SYSTEMS	APPLIED PERIPHERAL SYSTEMS	APPLIED PERIPHERAL SYSTEMS	APPLIED PERIPHERAL SYSTEMS
DRIVE	4830-2	4830-3	4835-2	4835-3	4865
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	14"	14"	14"	14"	14"
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	3380	3380	3380	3380	3380
Heads	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
Interface	SMD	SMD	Modified SMD	Modified SMD	Modified SMD
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 337.1	U: 404.5	U: 337.1	U: 404.5	U: 640.4
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 40,960	U: 40,960	U: 40,960	U: 40,960	U: 40,960
Data surfaces per spindle	5	6	5	6	9.5
Heads per data surface	2	2	2	2	2
Tracks per surface	1646	1646	1646	1646	1646
Track density (TPI)	694	694	694	694	694
Maximum linear density (BPI)	12877*	12877*	12877*	12877*	12877*
Rotational speed (RPM)	1785	1785	2964	2964	2964
PERFORMANCE					
Actuator type	Linear, Voice Coil 25	Linear, Voice Coil 25	Linear, Voice Coil 25	Linear, Voice Coil 25	Linear, Voice Coil 25
Average positioning time (msec)	16.8	16.8	10.1	10.1	10.1
Average rotational delay (msec)	41.8	41.8	35.1	35.1	35.1
Average access time (msec)	1200	1200	2000	2000	2000
Data transfer rate (KBytes/sec)	3/82	3/82	8/82	8/82	9/83
FIRST CUSTOMER SHIPMENT	\$6,500	\$6,500	\$6,500	\$6,500	\$8,200
U.S. OEM PRICE FOR 100 UNITS	*RLL Code	*RLL Code	*RLL Code	*RLL Code	*RLL Code
COMMENTS					

1984 DISK/TREND REPORT



MANUFACTURER

DRIVE

DISK/TREND GROUP

MARKET

MEDIA: Generic type

Nominal disk diameter

Recording medium

DRIVE: Technology type

Heads

Interface

CAPACITY/RECORDING DENSITY

Total capacity (MBytes) FIXED

REMOVABLE

Capacity per track (Bytes)

Data surfaces per spindle

Heads per data surface

Tracks per surface

Track density (TPI)

Maximum linear density (BPI)

Rotational speed (RPM)

PERFORMANCE

Actuator type

Average positioning time (msec)

Average rotational delay (msec)

Average access time (msec)

Data transfer rate (KBytes/sec)

FIRST CUSTOMER SHIPMENT

U.S. OEM PRICE FOR 100 UNITS

COMMENTS

ATASI	ATASI	ATASI	ATASI	BASF
3033	3046	3065	3075	6182
6	6	6	6	5
OEM	OEM	OEM	OEM	OEM
Fixed	Fixed	Fixed	Fixed	Fixed
130 mm OD 40 mm ID Oxide Coated	130 mm OD 40 mm ID Oxide Coated	130 mm OD 40 mm ID Oxide Coated	130 mm OD 40 mm ID Oxide Coated	130 mm OD 40 mm ID Oxide Coated
Modified 3350	Modified 3350	Modified 3350	Modified 3350	Modified 3350
Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
ST412	ST412	ST412	ST412	ST506
U: 33.07	U: 46.3	U: 65.6	U: 75.0	U: 6.38
--	--	--	--	--
U: 10,416	U: 10,416	U: 10,416	U: 10,416	U: 10,416
5	7	7	8	4
1	1	1	1	1
635	635	900	900	153
800	800	980	980	254
8780	8780	9490	9490	7690
3600	3600	3600	3600	3600
Linear, Voice Coil 30 (including settling)	Linear, Voice Coil 30 (including settling)	Linear, Voice Coil 24	Linear, Voice Coil 24	Band, Stepping Motor 76 (including settling)
8.3	8.3	8.3	8.3	8.3
38.3	38.3	32.3	32.3	84.3
625	625	625	625	625
10/82	11/82	4Q84	4Q84	1Q82
\$1,720	\$1,830	\$2,120	\$2,230	--

MANUFACTURER	BASF	BASF	BASF	BASF	BASF
DRIVE					
	6183	6185	6188	6190-52	6190-73
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	130 mm OD 40 mm ID	130 mm OD 40 mm ID
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Plated	Plated
DRIVE: Technology type	Modified 3350	Modified 3350	Modified 3350	Modified 3350	Modified 3350
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	ST506	ST506	ST506	ST506/ESDI	ST506/ESDI
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 9.57	U: 27.5	U: 15.0	U: 52	U: 73
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 10,416	U: 10,416	U: 10,416	U: 10,416	U: 10,416
Data surfaces per spindle	6	6	4	5	7
Heads per data surface	1	1	1	1	1
Tracks per surface	153	440	360	1000	1000
Track density (TPI)	254	508	406	1000	1000
Maximum linear density (BPI)	7690	8853	8900	10000	10000
Rotational speed (RPM)	3600	3600	3600	3600	3600
PERFORMANCE					
Actuator type	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Rotary, Voice coil	Rotary, Voice coil
Average positioning time (msec)	76 (including settling)	142 (including settling)	102 (including settling)	30	30
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	84.3	150.3	110.3	38.3	38.3
Data transfer rate (KBytes/sec)	625	625	625	625	625
FIRST CUSTOMER SHIPMENT	1Q82	1983	1984	2Q85	2Q85
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	--
COMMENTS			1.625" High		

**1984 DISK/TREND REPORT**

MANUFACTURER	BASF	BULL	BULL	BULL	BULL
DRIVE	6190-94	D120 D122 Cynthia	D140 D142 Cynthia	D520 Cynthia	D145 Cynthia
DISK/TREND GROUP	6	1	2	2	2
MARKET	OEM	Captive, OEM	Captive, OEM	OEM	OEM
MEDIA: Generic type	Fixed	Special Cartridge	Special Cartridge	5.25" Cartridge	Special Cartridge
Nominal disk diameter	130 mm OD	10.5" OD	10.5" OD	130 mm OD	10.5" OD
Recording medium	40 mm ID Plated	6.6" ID Oxide Coated	6.6" ID Oxide Coated	40 mm ID Oxide Coated	6.6" ID Oxide Coated
DRIVE: Technology type	Modified 3350	3330-11	3330-11	Modified 3350	3330-11
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	ST506/ESDI	Cynthia	Cynthia	ST506, DMA	SASI
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 94	--	F: 10.0	F: 10.485	F: 10.0
REMOVABLE	--	F: 10.0	F: 10.0	F: 10.485	F: 10.0
Capacity per track (Bytes)	U: 10,416	F: 12,800	F: 12,800	F: 8,192	F: 12,800
Data surfaces per spindle	9	2	4	4	4
Heads per data surface	1	1	1	1	1
Tracks per surface	1000	392	392	640	392
Track density (TPI)	1000	500	500	860	500
Maximum linear density (BPI)	10000	4750	4750	9200	4750
Rotational speed (RPM)	3600	3600	3600	3400	3600
PERFORMANCE					
Actuator type	Rotary, Voice coil	Linear, Voice Coil	Linear, Voice Coil	Rotary, Voice Coil	Linear, Voice Coil
Average positioning time (msec)	30	50	50	40	50
Average rotational delay (msec)	8.3	8.3	8.3	8.8	8.3
Average access time (msec)	38.3	58.3	58.3	48.8	58.3
Data transfer rate (KBytes/sec)	625	920	920	625	920
FIRST CUSTOMER SHIPMENT	2Q85	7/78	4Q79	2Q84	8/82
U.S. OEM PRICE FOR 100 UNITS	--	\$1,890	\$2,675	\$1,530	\$3,150
COMMENTS		Embedded Servo	Embedded Servo	Embedded Servo	Embedded Servo

MANUFACTURER	BULL	BULL	BULL	BULL	BULL
DRIVE	D505 Cynthia	D506 Cynthia	D510 Cynthia	D160/4 D162/4 Cynthia	D160/6 D162/6 Cynthia
DISK/TREND GROUP	5	5	5	6	6
MARKET	Captive, OEM	Captive, OEM	Captive, OEM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	10.5" OD 6.6" ID	10.5" OD 6.6" ID
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	Modified 3350	Modified 3350	Modified 3350	3350	3350
Heads	Ferrite	Ferrite	Ferrite	Thin Film	Thin Film
Interface	ST506	ST506	ST506	Cynthia	Cynthia
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 6.38	U: 6.38	U: 12.76	F: 60.21	F: 90.31
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 10,416	U: 10,416	U: 10,416	F: 12,800	F: 12,800
Data surfaces per spindle	4	2	4	4	6
Heads per data surface	1	1	1	1	1
Tracks per surface	153	306	306	1176	1176
Track density (TPI)	255	345	345	900	900
Maximum linear density (BPI)	7690	9074	9074	4850	4850
Rotational speed (RPM)	3600	3600	3600	3600	3600
PERFORMANCE					
Actuator type	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Linear, Voice Coil	Linear, Voice Coil
Average positioning time (msec)	85 (including settling)	85 (including settling)	85 (including settling)	40	40
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	93.3	93.3	93.3	48.3	48.3
Data transfer rate (KBytes/sec)	625	625	625	920	920
FIRST CUSTOMER SHIPMENT	1982	1983	1983	3Q81	3Q81
U.S. OEM PRICE FOR 100 UNITS	--	--	--	\$2,850	\$3,100
COMMENTS	Mfg. under Seagate license	Mfg. under Seagate license	Mfg. under Seagate license	Embedded Servo	Embedded Servo

MANUFACTURER

DRIVE

DISK/TREND GROUP

MARKET

MEDIA: Generic type  
 Nominal disk diameter  
 Recording medium

DRIVE: Technology type  
 Heads  
 Interface

CAPACITY/RECORDING DENSITY

Total capacity (MBytes) FIXED  
 REMOVABLE

Capacity per track (Bytes)

Data surfaces per spindle

Heads per data surface

Tracks per surface

Track density (TPI)

Maximum linear density (BPI)

Rotational speed (RPM)

PERFORMANCE

Actuator type

Average positioning time (msec)

Average rotational delay (msec)

Average access time (msec)

Data transfer rate (KBytes/sec)

FIRST CUSTOMER SHIPMENT

U.S. OEM PRICE FOR 100 UNITS

COMMENTS

BULL	BULL	BULL	BULL	BURROUGHS
D530	D550	D570	D160/8 D162/8 Cynthia	9484-5
6	6	6	7	3
OEM	OEM	OEM	OEM	End User
Fixed 130 mm OD 40 mm ID Plated	Fixed 130 mm OD 40 mm ID Plated	Fixed 130 mm OD 40 mm ID Plated	Fixed 10.5" OD 6.6" ID Oxide Coated	Trident 14" Oxide Coated
Modified 3350 Ferrite ST506	Modified 3350 Ferrite ST506	Modified 3350 Ferrite ST506	3350 Thin Film Cynthia	3330-11 Ferrite Burroughs
U: 30.8	U: 51.4	U: 72.0	F: 120.42	--
--	--	--	--	F: 65.2
U: 10,416	U: 10,416	U: 10,416	F: 12,800	F: 16,200
3	5	7	8	5
1	1	1	1	1
987	987	987	1176	815
960	960	960	900	370
9920	9920	9920	4850	6039
3600	3600	3600	3600	3672
Rotary, Voice Coil 30	Rotary, Voice Coil 30	Rotary, Voice Coil 30	Linear, Voice Coil 40	Linear, Voice Coil 25
8.3	8.3	8.3	8.3	8.3
38.3	38.3	38.3	48.3	33.3
625	625	625	920	1210
4Q83	4Q83	4Q83	3Q81	1977
\$1,480	\$1880	\$2200	\$3,350	--
Mfg. Under Vertex Peripherals License	Mfg. Under Vertex Peripherals License	Mfg. Under Vertex Peripherals License	Embedded Servo	

MANUFACTURER	BURROUGHS	BURROUGHS	BURROUGHS	BURROUGHS	CARDIFF TECHNOLOGY
DRIVE					
	9484-12	FD 214	9494-4	9494-5	D-240
DISK/TREND GROUP	4	6	7	9	2
MARKET	Captive	OEM, Captive	End User	Captive	OEM
MEDIA: Generic type	3336-11	Fixed	Fixed	Fixed	5.25" Cartridge
Nominal disk diameter	14"	14"	14"	14"	130 mm OD 40 mm ID Plated
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	
DRIVE: Technology type	3330-11	3340	3330-11	3350	Modified 3350
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	Burroughs	Intelligent Parallel 1/F	Burroughs	Burroughs	Modified ST506
CAPACITY/RECORDING DENSITY			(2 spindles)		
Total capacity (MBytes) FIXED	--	F: 79.822	F: 402.0	F: 542	U: 20.0
REMOVABLE	F: 252	--	--	--	U: 20.0
Capacity per track (Bytes)	F: 16,200	F: 14,848	F: 16,060	F: 16,200	U: 10,419
Data surfaces per spindle	19	8	8	15	4
Heads per data surface	1	2	1	2	1
Tracks per surface	815	672	1564	2250	960
Track density (TPI)	384	300	714	960	980
Maximum linear density (BPI)	6060	5500	6551	6425	10590
Rotational speed (RPM)	3600	3000	3672	3600	3467
PERFORMANCE					
Actuator type	Linear, Voice Coil	Rotary, Voice Coil	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil
Average positioning time (msec)	28.50	35	28	22.00	25
Average rotational delay (msec)	8.33	10	8	8.33	8.8
Average access time (msec)	36.83	45	36	30.33	33.8
Data transfer rate (KBytes/sec)	1209	888	1300	1209	625
FIRST CUSTOMER SHIPMENT	1Q83	12/79	4Q78	4Q83	2Q85
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	\$1,400
COMMENTS	B2900 B7900 B7800	Equivalent to B9493-76 and B9493-80	B1800-B7800 Embedded Servo	B4900 B7800, B7900 9494-10 is Dual Spindle Version	Embedded Servo

1984 DISK/TREND REPORT

## MANUFACTURER

## DRIVE

## DISK/TREND GROUP

## MARKET

## MEDIA: Generic type

Nominal disk diameter

Recording medium

## DRIVE: Technology type

Heads

Interface

## CAPACITY/RECORDING DENSITY

Total capacity (MBytes) FIXED

REMOVABLE

Capacity per track (Bytes)

Data surfaces per spindle

Heads per data surface

Tracks per surface

Track density (TPI)

Maximum linear density (BPI)

Rotational speed (RPM)

## PERFORMANCE

Actuator type

Average positioning time (msec)

Average rotational delay (msec)

Average access time (msec)

Data transfer rate (KBytes/sec)

## FIRST CUSTOMER SHIPMENT

## U.S. OEM PRICE FOR 100 UNITS

## COMMENTS

	CENTURY DATA SYSTEMS	CENTURY DATA SYSTEMS	CENTURY DATA SYSTEMS	CENTURY DATA SYSTEMS	CENTURY DATA SYSTEMS
	C2075	T82 Trident	T202 Trident	T300 T302 T306 Trident	M80 Marksman
	2	3	4	4	6
	OEM	OEM	OEM	OEM	OEM
	8" Cartridge	Trident	3330-11	3330-11	Fixed
	200 mm OD	14"	14"	14"	14"
	63.5 mm ID				
	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
	Modified 3350	3330-11	3330-11	3330-11	3350
	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
	SMD	SMD	SMD	T300: Trident T302/6: SMD	Marksman, SMD
	U: 51.89	--	--	--	U: 80.64
	U: 25.9	U: 82.9	U: 210.2	U: T300: 312.1	--
	U: 20,790	U: 20,160	U: 13,440	U: 20,160	U: 24,000
	6	5	19	19	3
	1	1	1	1	2
	624	823 384		T300: 815 T302/6: 823	1138
	555		T202: 823 T202: 384	T300: 370 T302/6: 384	480
	11761*	6060	4040	6060	7545
	3600	3600	3600	3600	2400
	Linear, Voice Coil 30	Linear, Voice Coil 30	Linear, Voice Coil 30	Linear, Voice Coil 30	Band, Torque Motor 50
	8.3	8.3	8.3	8.3	12.5
	38.3	38.3	38.3	38.3	62.5
	1300	1209	806	1209	960
	3/82	8/75	6/76	8/76	4Q81
	\$3,450	\$5,935	\$9,055	\$10,255	\$3,265
	* RLL Code Embedded Servo				

MANUFACTURER	CENTURY DATA SYSTEMS	CENTURY DATA SYSTEMS	CENTURY DATA SYSTEMS	CENTURY DATA SYSTEMS	COGITO SYSTEMS
DRIVE	M160 Marksman	AMS 315	AMS 513	AMS 571	CG912
DISK/TREND GROUP	7	8	9	9	5
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	14"	14"	14"	14"	130 mm OD 40 mm ID
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	Modified 3350	Modified 3350	Modified 3350	3370	Modified 3350
Heads	Ferrite	Ferrite	Ferrite	Thin Film	Ferrite
Interface	Marksman, SMD	SMD	SMD	Modifed SMD	ST506
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	--	U: 315.2	U: 513.7	U: 590.2	U: 12.76
REMOVABLE	U: 160.7	--	--	--	--
Capacity per track (Bytes)	U: 32,000	U: 20,160	U: 32,064	U: 33,012	U: 10,416
Data surfaces per spindle	3	9.5	9.5	9.5	4
Heads per data surface	2	2	2	2	1
Tracks per surface	1690	1646	1690	1882	306
Track density (TPI)	712	712	712	800	345
Maximum linear density (BPI)	10000	6363	10000	10295	8783
Rotational speed (RPM)	2400	3600	2400	3600	3600
PERFORMANCE					
Actuator type	Band, Torque Motor 50	Linear, Voice Coil 25	Linear, Voice Coil 25	Linear, Voice Coil 19	Band, Stepping Motor 85 (including settling)
Average positioning time (msec)	12.5	8.3	12.5	8.3	8.3
Average rotational delay (msec)	62.5	33.3	37.5	27.3	93.3
Data transfer rate (KBytes/sec)	1280	1209	1280	1980	625
FIRST CUSTOMER SHIPMENT	1Q82	11/82	1/83	8/83	6/83
U.S. OEM PRICE FOR 100 UNITS	\$4,050	\$6,780	\$7,200	\$9,000	\$695
COMMENTS					1.625" High

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SPEC-19

MANUFACTURER

DRIVE

DISK/TREND GROUP

MARKET

MEDIA: Generic type

Nominal disk diameter

Recording medium

DRIVE: Technology type

Heads

Interface

CAPACITY/RECORDING DENSITY

Total capacity (MBytes) FIXED

REMOVABLE

Capacity per track (Bytes)

Data surfaces per spindle

Heads per data surface

Tracks per surface

Track density (TPI)

Maximum linear density (BPI)

Rotational speed (RPM)

PERFORMANCE

Actuator type

Average positioning time (msec)

Average rotational delay (msec)

Average access time (msec)

Data transfer rate (KBytes/sec)

FIRST CUSTOMER SHIPMENT

U.S. OEM PRICE FOR 100 UNITS

COMMENTS

	COGITO SYSTEMS	COGITO SYSTEMS	COMPUTER MEMORIES	COMPUTER MEMORIES	COMPUTER MEMORIES
	PT 912	PT 925	CM-3212	CM-3426	CM-5206
	5	5	5	5	5
	OEM	OEM	OEM	OEM	OEM
	Fixed	Fixed	Fixed	Fixed	Fixed
	130 mm OD 40 mm ID Plated/Sputter	130 mm OD 40 mm ID Plated/Sputter	130 mm OD 40 mm ID Oxide Coated	130 mm OD 40 mm ID Oxide Coated	130 mm OD 40 mm ID Oxide Coated
	Modified 3350	Modified 3350	Modified 3350	Modified 3350	Modified 3350
	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
	ST506	ST506	ST506	ST506	ST506
	U: 12.76	U: 25.52	U: 12.76	U: 12.76	U: 6.38
	--	--	--	--	--
	U: 10,416	U: 10,416	U: 10,416	U: 10,416	U: 10,416
	2	4	2	2	2
	1	1	1	1	1
	612	612	612	612	306
	527	527	690	690	345
	11000	11000	8765	8765	9180
	3600	3600	3558	3558	3600
	Band, Stepping Motor 85 (including settling)	Band, Stepping Motor 85 (including settling)	Rotary, Stepping Motor 85 (including settling)	Rotary, Stepping Motor 85 (including settling)	Rotary, Stepping Motor 93 (including settling)
	8.3	8.3	8.3	8.3	8.3
	93.3	93.3	93.3	93.3	101.3
	625	625	625	625	625
	8/84	8/84	2Q84	2Q84	1Q82
	\$695	\$995	\$625	\$725	\$625
	1.625" High	1.625" High	1.625" High	1.625" High	

1984 DISK/TREND REPORT

MANUFACTURER	COMPUTER MEMORIES	COMPUTER MEMORIES	COMPUTER MEMORIES	COMPUTER MEMORIES	COMPUTER MEMORIES
DRIVE	CM-5412	CM-5619	CM-6213	CM-6426	CM-6640
DISK/TREND GROUP	5	5	5	5	6
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	Modified 3350	Modified 3350	Modified 3350	Modified 3350	Modified 3350
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	ST506	ST506	ST506	ST506	ST506
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 12.76	U: 19.14	U: 13.34	U: 26.68	U: 40
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 10,416	U: 10,416	U: 10,416	U: 10,416	U: 10,416
Data surfaces per spindle	4	6	2	4	6
Heads per data surface	1	1	1	1	1
Tracks per surface	306	306	640	640	640
Track density (TPI)	345	345	720	720	720
Maximum linear density (BPI)	9180	9180	9275	9275	9275
Rotational speed (RPM)	3600	3600	3573	3573	3573
PERFORMANCE					
Actuator type	Rotary, Stepping Motor 93 (including settling)	Rotary, Stepping Motor 93 (including settling)	Rotary, Torque Motor 40 (including settling)	Rotary, Torque Motor 40 (including settling)	Rotary, Torque Motor 40 (including settling)
Average positioning time (msec)	8.3	8.3	8.39	8.39	8.39
Average rotational delay (msec)	101.3	101.3	48.39	48.39	48.39
Data transfer rate (KBytes/sec)	625	625	625	625	625
FIRST CUSTOMER SHIPMENT	1Q82	1Q82	4Q82	4Q82	1Q83
U.S. OEM PRICE FOR 100 UNITS	\$675	\$725	\$1,005	\$1,115	\$1,225
COMMENTS					

1984 DISK/TREND REPORT

## MANUFACTURER

## DRIVE

## DISK/TREND GROUP

## MARKET

## MEDIA: Generic type

Nominal disk diameter

Recording medium

## DRIVE: Technology type

Heads

Interface

## CAPACITY/RECORDING DENSITY

Total capacity (MBytes) FIXED

REMOVABLE

Capacity per track (Bytes)

Data surfaces per spindle

Heads per data surface

Tracks per surface

Track density (TPI)

Maximum linear density (BPI)

Rotational speed (RPM)

## PERFORMANCE

Actuator type

Average positioning time (msec)

Average rotational delay (msec)

Average access time (msec)

Data transfer rate (KBytes/sec)

## FIRST CUSTOMER SHIPMENT

## U.S. OEM PRICE FOR 100 UNITS

## COMMENTS

	COMPUTER MEMORIES	COMPUTER MEMORIES	CONTROL DATA	CONTROL DATA	CONTROL DATA
	CM-7660	CM-7880	9427H Hawk	280-10 280-20	9448-32 Phoenix or CMD
	6	6	1	2	2
	OEM	OEM	OEM, Captive	PCM	OEM, Captive
	Fixed	Fixed	5440	Cartridge Module Drive 14"	Cartridge Module Drive 14"
	130 mm OD 40 mm ID Oxide Coated	130 mm OD 40 mm ID Oxide Coated	14" Oxide Coated	Oxide Coated	Oxide Coated
	3370 (Ferrite)	3370 (Ferrite)	2314	3330-11	3330-11
	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
	ST506	ST506	Various Options	IBM Series 1	SMD
	U: 60	U: 80	U: 6.25	F: 64.5	U: 16.289
	--	--	U: 6.25	F: 13.3	U: 16.289
	U: 10,416	U: 10,416	U: 7,812	F: 16,384	U: 20,160
	6	8	4	5 Fixed 1 Removable	1 Fixed 1 Removable
	1	1	1	1	1
	960	960	406	814	823
	1173	1173	200	384	384
	9275	9275	2200	6038	6038
	3573	3573	2400/1500	3600	3600
	Rotary, Torque Motor 30 (including settling)	Rotary, Torque Motor 30 (including settling)	Linear, Voice Coil 35	Linear, Voice Coil 30	Linear, Voice Coil 30
	8.3	8.3	12.5/20	8.3	8.3
	38.3	38.3	47.5/55	38.3	38.3
	625	625	312.5/195	1209	1209
	2Q84	2Q84	8/74	4/82	9/78
	\$1,660	\$1,900	\$4,230	--	\$5,315
					Separate Servo surface for fixed and removable disks

MANUFACTURER	CONTROL DATA	CONTROL DATA	CONTROL DATA	CONTROL DATA	CONTROL DATA
DRIVE	9448-64 Phoenix or CMD	9448-96 Phoenix or CMD	9454 Lark	9455 Lark	9457 Lark
DISK/TREND GROUP	2	2	2	2	2
MARKET	OEM, Captive	OEM, Captive	OEM, Captive	OEM, Captive	OEM, Captive
MEDIA: Generic type	Cartridge Module Drive 14"	Cartridge Module Drive 14"	Lark Module Drive 195 mm OD 100 mm ID Oxide Coated	Lark Module Drive 195 mm OD 100 mm ID Oxide Coated	Lark Module Drive 195 mm OD 100 mm ID Oxide Coated
Nominal disk diameter					
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	3330-11	3330-11	Modified 3350	Modified 3350	Modified 3350
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	SMD	SMD	LDI	LDI, SMD, ISI	LDI, SMD, ISI
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 48.869	U: 81.446	U: 8.35	U: 8.35	U: 25.0
REMOVABLE	U: 16.289	U: 16.289	U: 8.35	U: 8.35	U: 25.0
Capacity per track (Bytes)	U: 20,160	U: 20,160	U: 20,672	U: 20,672	U: 20,672
Data surfaces per spindle	3 Fixed 1 Removable	5 Fixed 1 Removable	4	4	4
Heads per data surface	1	1	1	1	1
Tracks per surface	823	823	202	202	606
Track density (TPI)	384	384	237	237	715
Maximum linear density (BPI)	6038	6038	6774 FRPI 10161 BPI 3510	6774 FRPI 10161 BPI 3510	6774 FRPI 10161 BPI 3510
Rotational speed (RPM)	3600	3600	3600	3600	3600
PERFORMANCE					
Actuator type	Linear, Voice Coil 30	Linear, Voice Coil 30	Linear, Voice Coil 50	Linear, Voice Coil 50	Linear, Voice Coil 35
Average positioning time (msec)	30	30	50	50	35
Average rotational delay (msec)	8.3	8.3	8.55	8.55	8.55
Average access time (msec)	38.3	38.3	58.55	58.55	43.55
Data transfer rate (KBytes/sec)	1209	1209	1209	1209	1209
FIRST CUSTOMER SHIPMENT	9/78	9/78	1Q82	1Q81	4Q82
U.S. OEM PRICE FOR 100 UNITS	\$6,005	\$6,695	--	\$2,600	\$3,440
COMMENTS	Separate Servo surface for fixed and removable disks	Separate Servo surface for fixed and removable disks	Embedded Servo	Embedded Servo	Embedded Servo

## 1984 DISK/TREND REPORT

MANUFACTURER	CONTROL DATA	CONTROL DATA	CONTROL DATA	CONTROL DATA	CONTROL DATA
DRIVE	270-10 270-20 271-10	9710 RSD	9762 SMD	270-30	9766 SMD
DISK/TREND GROUP	3	3	3	4	4
MARKET	PCM	OEM	OEM, Captive	PCM	OEM, Captive
MEDIA: Generic type	Storage Module Drive	Removable Storage Drive	Storage Module Drive	3336-11	3336-11
Nominal disk diameter	14"	230 mm OD 100 mm ID	14"	14"	14"
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	3330-11	Modified 3350	3330-11	3330-11	3330-11
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	IBM Series 1	SMD, ISI	SMD	IBM Series 1	SMD
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	--	--	--	--	--
REMOVABLE	U: 63.2	U: 82.9	U: 82.9	F: 240.1	U: 315.2
Capacity per track (Bytes)	U: 15,360	U: 20,160	U: 20,160	F: 15,360	U: 20,160
Data surfaces per spindle	5	5	5	19	19
Heads per data surface	1	1	1	1	1
Tracks per surface	823	823	823	823	823
Track density (TPI)	384	550	384	384	384
Maximum linear density (BPI)	6038	10000*	6038	6038	6038
Rotational speed (RPM)	3600	3600	3600	3600	3600
PERFORMANCE					
Actuator type	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil
Average positioning time (msec)	30	30	30	30	30
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	38.3	38.3	38.3	38.3	38.3
Data transfer rate (KBytes/sec)	1209	1209	1209	1209	1209
FIRST CUSTOMER SHIPMENT	1978	1Q83	3/75	1978	3/76
U.S. OEM PRICE FOR 100 UNITS	--	\$4,915	\$6,715	--	\$12,355
COMMENTS		*RLL Code			

MANUFACTURER	CONTROL DATA	CONTROL DATA	CONTROL DATA	CONTROL DATA	CONTROL DATA
DRIVE	230-10 240-10	230-15 240-15	9415-19 Wren	9415-32 Wren	94153 Wren
DISK/TREND GROUP	5	5	5	6	6
MARKET	PCM	PCM	Captive, OEM	Captive, OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	14"	14"	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	3350	3350	Modified 3350	Modified 3350	Modified 3350
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Thin Film
Interface	IBM Series 1	IBM Series 1	Finch, ST506	Finch, ST506	CDC Finch
CAPACITY/RECORDING DENSITY	1.48 MB Fixed Head Option F: 9.3	1.48 MB Fixed Head Option F: 13.9			
Total capacity (MBytes) FIXED			U: 21.0	U: 36.0	U: 80.10
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 15,360	F: 15,360	U: 10,080	U: 10,080	U: 10,080
Data surfaces per spindle	1	1.5	3	5	9
Heads per data surface	2	2	1	1	1
Tracks per surface	606	606	635	635	883
Track density (TPI)	296	296	800	800	960
Maximum linear density (BPI)	6220	6220	8730	8730	9230
Rotational speed (RPM)	3600	3600	3600	3600	3600
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Average positioning time (msec)	25	25	40	40	30
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	33.3	33.3	48.3	48.3	38.3
Data transfer rate (KBytes/sec)	1209	1209	605	605	605
FIRST CUSTOMER SHIPMENT	1Q79	2Q79	2Q83	2Q83	2Q84
U.S. OEM PRICE FOR 100 UNITS	--	--	\$1,410	\$1,660	\$2,255
COMMENTS					

MANUFACTURER	CONTROL DATA	CONTROL DATA	CONTROL DATA	CONTROL DATA	CONTROL DATA
DRIVE	94155 Wren	94156 Wren	231 241*	9715-160 FSD	9730-160 MMD
DISK/TREND GROUP	6	6	7	7	7
MARKET	OEM	OEM	PCM	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	14"	230 mm OD 100 mm ID	14"
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	Modified 3350	Modified 3350	3350	Modified 3350	Modified 3350
Heads	Thin Film	Thin Film	Ferrite	Ferrite	Ferrite
Interface	ST506	ESDI	IBM Series 1	SMD, ISI	SMD
CAPACITY/RECORDING DENSITY					0.96 or 1.93 MB Fixed Head Option
Total capacity (MBytes) FIXED	U: 85.96	U: 85.96	F: 126.4	U: 165.9	U: 165.9
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 10,416	U: 10,416	F: 15,360	U: 20,160	U: 20,160
Data surfaces per spindle	9	9	5	10	5
Heads per data surface	1	1	2	1	2
Tracks per surface	917	917	1646	823	1646
Track density (TPI)	960	960	680	550	680
Maximum linear density (BPI)	9540	9540	6220	10000*	6220
Rotational speed (RPM)	3600	3600	3600	3600	3600
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Average positioning time (msec)	30	30	30	30	30
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	38.3	38.3	38.3	38.3	38.3
Data transfer rate (KBytes/sec)	625	625	1209	1209	1209
FIRST CUSTOMER SHIPMENT	2Q84	2Q84	5/83	4Q82	2Q79
U.S. OEM PRICE FOR 100 UNITS	\$2,255	\$2,255	--	\$4,960	\$5,785
COMMENTS				*RLL Code	

MANUFACTURER

DRIVE

DISK/TREND GROUP

MARKET

MEDIA: Generic type

Nominal disk diameter

Recording medium

DRIVE: Technology type

Heads

Interface

CAPACITY/RECORDING DENSITY

Total capacity (MBytes) FIXED

REMOVABLE

Capacity per track (Bytes)

Data surfaces per spindle

Heads per data surface

Tracks per surface

Track density (TPI)

Maximum linear density (BPI)

Rotational speed (RPM)

PERFORMANCE

Actuator type

Average positioning time (msec)

Average rotational delay (msec)

Average access time (msec)

Data transfer rate (KBytes/sec)

FIRST CUSTOMER SHIPMENT

U.S. OEM PRICE FOR 100 UNITS

COMMENTS

CONTROL DATA	CONTROL DATA	CONTROL DATA	CONTROL DATA	CONTROL DATA
33501-A2 33501-B2 33501-C2	33801-A2 33801-B2 33801-C2 (3330 Format)	819-11	9715-340 FSD	33502-A2 33502-B2 33502-C2
8	8	8	8	9
PCM	PCM	Captive	OEM	PCM
Fixed	Fixed	Fixed	Fixed	Fixed
14"	14"	14"	230 mm OD 100 mm ID Oxide Coated	14"
Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
Modified 3350	Modified 3350	3330-11	3380	Modified 3350
Ferrite	Ferrite	Ferrite	Thin Film	Ferrite
IBM	IBM	CDC	SMD, ISI	IBM
1.72 MB Fixed Head Option	1.24 MB Fixed Head Option			1.72 MB Fixed Head Option
F: 317.5	F: 400.0	U: 325.8	U: 344.0	F: 635.0
--	--	--	--	--
F: 19,069	F: 13,030	U: 20,160	U: 20,160	F: 19,069
20	20	40	12	20
2	2	1	2	2
843	1686	411	1422	1686
660	660	192	960	660
6350	6350	6000	9492	6350
3600	3600	3600	3600	3600
Linear, Voice Coil 18	Linear, Voice Coil 25	Linear, Voice Coil 50	Linear, Voice Coil 20	Linear, Voice Coil 24
8.3	8.3	8.3	8.3	8.3
26.3	33.3	58.3	28.3	32.3
1198	1198	4840	1209	1198
1978	1978	1978	4Q83	1Q79
--	--	--	\$7,290	--
		4 track parallel data transfer		CDC Model 885

1984 DISK/TREND REPORT



MANUFACTURER

DRIVE

DISK/TREND GROUP

MARKET

MEDIA: Generic type

Nominal disk diameter

Recording medium

DRIVE: Technology type

Heads

Interface

CAPACITY/RECORDING DENSITY

Total capacity (MBytes) FIXED

REMOVABLE

Capacity per track (Bytes)

Data surfaces per spindle

Heads per data surface

Tracks per surface

Track density (TPI)

Maximum linear density (BPI)

Rotational speed (RPM)

PERFORMANCE

Actuator type

Average positioning time (msec)

Average rotational delay (msec)

Average access time (msec)

Data transfer rate (KBytes/sec)

FIRST CUSTOMER SHIPMENT

U.S. OEM PRICE FOR 100 UNITS

COMMENTS

CONTROL DATA	CONTROL DATA	CONTROL DATA	CONTROL DATA	CONTROL DATA
33800-A4 33800-AA4 33800-B4	819-21	885-42	9715-500 FSD	9771 XMD
9	9	9	9	9
PCM	Captive	Captive	OEM	OEM
Fixed	Fixed	Fixed	Fixed	Fixed
14"	14"	14"	230 mm OD 100 mm ID Oxide Coated	14"
Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
3380	3330-11	Modified 3350	3380	3380
Thin Film	Ferrite	Ferrite	Thin Film	Thin Film
IBM	CDC	CDC	Modified SMD, ISI	Modified SMD, ISI, SDI
F: 630	U: 651.6	U: 673.0	U: 516.0	U: 825.0
--	--	--	--	--
F: 47,476	U: 20,160	U: 20,160	U: 30,240	U: 50,400
8	40	20	12	8
2	1	2	2	2
1774	823	1686	1422	2046
800	384	660	960	960
16174*	6000	6350	15159*	15400*
3600	3600	3600	3600	2160
Linear, Voice Coil 16	Linear, Voice Coil 50	Linear, Voice Coil 25	Linear, Voice Coil 20	Linear, Voice Coil 16
8.3	8.3	8.3	8.3	13.89
24.3	58.3	33.3	28.3	29.89
3000	4840	4788	1825	1825
1/83	1978	1982	4Q83	3Q83
--	--	--	\$8,530	\$10,660
PCM 3380 4 spindles per drive *RLL Code	4 track parallel data transfer	Cyber 865 & 875 4 track parallel data transfer. Drive has two spindles.	*RLL Code	*RLL Code

	CONTROL DATA	CONTROL DATA	DATA GENERAL	DATA GENERAL	DATA GENERAL
MANUFACTURER					
DRIVE	9775 FMD	9797	6060	6061	6122
DISK/TREND GROUP	9	9	4	4	4
MARKET	OEM	OEM	Captive	Captive	Captive
MEDIA: Generic type	Fixed Module Drive 14"	Fixed 14"	3336-1 14"	3336-11 14"	3336-11 14"
Nominal disk diameter					
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	Modified 3350	3330-11	3330-11	3330-11	3330-11
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	SMD	Special	Data General	Data General	Data General
CAPACITY/RECORDING DENSITY	1.9 MB Fixed Head Option				
Total capacity (MBytes) FIXED	U: 675.0	U: 651.6	--	--	--
REMOVABLE	--	--	F: 95.957	F: 190.280	F: 277.491
Capacity per track (Bytes)	U: 20,160	U: 20,160	F: 12,288	F: 12,288	F: 17,920
Data surfaces per spindle	20	40	19	19	19
Heads per data surface	2	1	1	1	1
Tracks per surface	1686	822	411	815	815
Track density (TPI)	660	384	192	370	370
Maximum linear density (BPI)	6350	6000	4040	4040	6060
Rotational speed (RPM)	3600	3600	3600	3600	3600
PERFORMANCE					
Actuator type	Linear, Voice Coil 25	Linear, Voice Coil 50	Linear, Voice Coil 35	Linear, Voice Coil 35	Linear, Voice Coil 35
Average positioning time (msec)	8.3	8.3	8.3	8.3	8.3
Average rotational delay (msec)	33.3	58.3	43.3	43.3	43.3
Average access time (msec)	1209	4840	806	806	1209
Data transfer rate (KBytes/sec)					
FIRST CUSTOMER SHIPMENT	4/80	1977	1976	1976	1Q80
U.S. OEM PRICE FOR 100 UNITS	\$15,155	--	--	--	--
COMMENTS		4 track parallel data transfer			

MANUFACTURER	DATA GENERAL	DATA GENERAL	DATA GENERAL	DATA GENERAL	DATA GENERAL
DRIVE	6098 6099 6101 6102	6100 6103 6104 6105	6220 6225	6222 6227	6234
DISK/TREND GROUP	5	5	5	5	6
MARKET	Captive	Captive	Captive	Captive	Captive
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	14"	14"	200 mm OD 63.5 mm OD	200 mm OD 63.5 mm OD	14"
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	3340	3340	3350	3350	3350
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	Data General	Data General	Data General	Data General	Data General
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	F: 12.58	F: 25.16	F: 5.0	F: 15.0	F: 50.7
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 16,384	F: 16,384	F: 10,240	F: 10,240	F: 22,016
Data surfaces per spindle	2	4	2	6	6
Heads per data surface	2	2	1	1	2
Tracks per surface	384	384	245	245	384
Track density (TPI)	166	166	200	200	166
Maximum linear density (BPI)	5760	5760	6500	6500	7678
Rotational speed (RPM)	2964	2964	3155	3155	2385
PERFORMANCE					
Actuator type	Band, Stepping Motor 60 (including settling)	Band, Stepping Motor 60 (including settling)	Band, Stepping Motor 66 (including settling)	Band, Stepping Motor 66 (including settling)	Band, Stepping Motor 60 (including settling)
Average positioning time (msec)	10.1	10.1	9.5	9.5	12.5
Average rotational delay (msec)	70.1	70.1	75.5	75.5	72.5
Average access time (msec)	910.6	910.6	625	625	971
DATA TRANSFER RATE (KBytes/sec)	3Q79	4Q79	9/82	9/82	3/83
FIRST CUSTOMER SHIPMENT	--	--	--	--	--
U.S. OEM PRICE FOR 100 UNITS					
COMMENTS					

MANUFACTURER	DATA GENERAL	DATA GENERAL	DIGITAL EQUIPMENT CORPORATION	DIGITAL EQUIPMENT CORPORATION	DIGITAL EQUIPMENT CORPORATION
DRIVE	6236 6237	6239 6290 6240	RL01	RL02	RC25
DISK/TREND GROUP	8	9	1	1	2
MARKET	Captive	Captive	Captive	Captive	Captive
MEDIA: Generic type	Fixed	Fixed	5440	5440	Special Cartridge 8"
Nominal disk diameter	14"	14"	14"	14"	
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	Modified 3350	Modified 3350	3330-1	3330-1	Modified 3350
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	Data General	Data General	Unibus, LSI-11	Unibus, LSI-11	Unibus,Q-Bus
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	F: 354.1	F: 592.2	--	--	F: 26
REMOVABLE	--	--	F: 5.24	F: 10.48	F: 26
Capacity per track (Bytes)	F: 28,672	F: 38,400	F: 10,240	F: 10,240	F: 15,872
Data surfaces per spindle	8	8	2	2	4
Heads per data surface	2	2	1	1	1
Tracks per surface	1572	1960	256	512	821
Track density (TPI)	714	800	125	250	1000
Maximum linear density (BPI)	10438*	13909*	3725	3725	12350
Rotational speed (RPM)	3000	2944	2400	2400	2850
PERFORMANCE					
Actuator type	Linear, Voice Coil 20	Linear, Voice Coil 21	Linear, Voice Coil 55	Linear, Voice Coil 55	Rotary, Voice Coil 35
Average positioning time (msec)	10	10.1	12.5	12.5	10.5
Average rotational delay (msec)	30	31.1	67.5	67.5	45.5
Average access time (msec)	1680	2200	512.5	512.5	1250
Data transfer rate (KBytes/sec)	9/83	4Q84	4/78	1979	4Q83
FIRST CUSTOMER SHIPMENT	--	--	--	--	--
U.S. OEM PRICE FOR 100 UNITS					
COMMENTS	*RLL Code 6237-3 Spindles	*RLL Code 6239-1 Spindles 6290-2 Spindles 6240-3 Spindles	Embedded Servo	Embedded Servo	Embedded Servo

1984 DISK/TREND REPORT

MANUFACTURER

DRIVE

DISK/TREND GROUP

MARKET

MEDIA: Generic type

Nominal disk diameter

Recording medium

DRIVE: Technology type

Heads

Interface

CAPACITY/RECORDING DENSITY

Total capacity (MBytes) FIXED

REMOVABLE

Capacity per track (Bytes)

Data surfaces per spindle

Heads per data surface

Tracks per surface

Track density (TPI)

Maximum linear density (BPI)

Rotational speed (RPM)

PERFORMANCE

Actuator type

Average positioning time (msec)

Average rotational delay (msec)

Average access time (msec)

Data transfer rate (KBytes/sec)

FIRST CUSTOMER SHIPMENT

U.S. OEM PRICE FOR 100 UNITS

COMMENTS

DIGITAL EQUIPMENT CORPORATION	DIGITAL EQUIPMENT CORPORATION	DIGITAL EQUIPMENT CORPORATION	DIGITAL EQUIPMENT CORPORATION	DIGITAL EQUIPMENT CORPORATION
RK06	RK07	RM02	RM03	RA60
2	2	3	3	4
Captive	Captive	Captive	Captive	Captive
Special Cartridge 14"	Special Cartridge 14"	SMD 14"	SMD 14"	Special Disk Pack 14"
Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
3330-1	3330-11	3330-11	3330-11	Modified 3330
Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Unibus	Unibus	Unibus, Massbus	Unibus, Massbus	Unibus
--	--	--	--	--
F: 13.89	F: 27.54	F: 67.42	F: 67.42	F: 205.0
F: 11,264	F: 11,264	F: 16,384	F: 16,384	F: 21,504
3	3	5	5	6
1	1	1	1	1
411	815	823	823	1600
192.3	384.6	384	384	779
4040	4040	6038	6038	7251 FRPI 9668 BPI
2400	2400	2400	3600	3600
Linear, Voice Coil 38	Linear, Voice Coil 36.5	Linear, Voice Coil 30	Linear, Voice Coil 30	Linear, Voice Coil 41.7
12.5	12.5	12.5	8.3	8.3
50.5	49	42.5	38.3	50.0
538	538	806	1209	1980
12/76	4/78	4/78	4Q77	3Q83
--	--	--	--	--
		Manufactured by CDC	Manufactured by CDC	Embedded Servo

MANUFACTURER	DIGITAL EQUIPMENT CORPORATION	DIGITAL EQUIPMENT CORPORATION	DIGITAL EQUIPMENT CORPORATION	DIGITAL EQUIPMENT CORPORATION	DIGITAL EQUIPMENT CORPORATION
DRIVE	RM05	RP06	RA80	RM80	RA81
DISK/TREND GROUP	4	4	7	7	8
MARKET	Captive	Captive	Captive	Captive	Captive
MEDIA: Generic type	3330-11	3330-11	Fixed	Fixed	Fixed
Nominal disk diameter	14"	14"	14"	14"	14"
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	3330-11	3330-11	Modified 3350	Modified 3350	Modified 3350
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	Massbus	Unibus, Massbus	Unibus	Massbus	Unibus
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	--	--	F: 121.0	F: 124.0	F: 456.0
REMOVABLE	F: 256.0	F: 176.0	--	--	--
Capacity per track (Bytes)	F: 16,384	F: 11,264	F: 15,872	F: 16,384	F: 26,112
Data surfaces per spindle	19	19	7	7	7
Heads per data surface	1	1	2	2	2
Tracks per surface	823	815	1092	1122	2496
Track density (TPI)	384	384	478	478	960
Maximum linear density (BPI)	6038	4040	6339	6339	8550 FRPI 11400 BPI
Rotational speed (RPM)	3600	3600	3600	3600	3600
PERFORMANCE					
Actuator type	Linear, Voice Coil	Linear, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Average positioning time (msec)	30	30	25	25	28
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	38.3	38.3	33.3	33.3	36.3
Data transfer rate (KBytes/sec)	1209	806	1200	1200	2200
FIRST CUSTOMER SHIPMENT	3Q80	4Q76	1/82	1981	9/82
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	--
COMMENTS	Manufactured by CDC	Manufactured by Memorex			Embedded Servo

## 1984 DISK/TREND REPORT

MANUFACTURER

DRIVE

DISK/TREND GROUP

MARKET

MEDIA: Generic type  
Nominal disk diameter  
Recording medium

DRIVE: Technology type  
Heads  
Interface

CAPACITY/RECORDING DENSITY

Total capacity (MBytes) FIXED  
REMOVABLE

Capacity per track (Bytes)  
Data surfaces per spindle  
Heads per data surface  
Tracks per surface  
Track density (TPI)  
Maximum linear density (BPI)  
Rotational speed (RPM)

PERFORMANCE

Actuator type  
Average positioning time (msec)  
Average rotational delay (msec)  
Average access time (msec)  
Data transfer rate (KBytes/sec)

FIRST CUSTOMER SHIPMENT

U.S. OEM PRICE FOR 100 UNITS

COMMENTS

DIGITAL EQUIPMENT CORPORATION	DIGITAL EQUIPMENT CORPORATION	DISC TECH ONE	DISC TECH ONE	DISC TECH ONE
RP20	RP07	5007	5014	5019
8	9	5	5	5
Captive	Captive	OEM	OEM	OEM
Fixed	Fixed	Fixed	Fixed	Fixed
14"	14"	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID
Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
Modified 3350	Modified 3350	Modified 3350	Modified 3350	Modified 3350
Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Massbus	Massbus	ST506	ST506	ST506
F: 483.4	F: 516.0	U: 6.38	U: 12.75	U: 19.13
--	--	--	--	--
F: 14,400	F: 25,600	U: 10,416	U: 10,416	U: 10,416
15	16	2	4	6
2	2	1	1	1
2238	1260	306	306	306
957	537	383	383	383
6425	11139*	8944	8944	8944
3600	3600	3600	3600	3600
Linear, Voice Coil 25	Linear, Voice Coil 23	Rotary, Band, Stepping Motor 90 (including settling)	Rotary, Band, Stepping Motor 90 (including settling)	Rotary, Band, Stepping Motor 90 (including settling)
8.3	8.3	8.3	8.3	8.3
33.3	31.3	98.3	98.3	98.3
1198	2160	625	625	625
4Q80	7/81	3Q84	3Q84	3Q84
--	--	--	\$385(2500)	\$420(2500)
2 spindles per drive Manufactured by Storage Technology	*Effective BPI Manufactured by ISS/Univac	Previously Disctron Product	Previously Disctron Product	Previously Disctron Product

MANUFACTURER	DISC TECH ONE	DISC TECH ONE	DISC TECH ONE	DISC TECH ONE	DISC TECH ONE
DRIVE	5026	8432	8533	3306	4160
DISK/TREND GROUP	5	5	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	210 mm OD 100 mm ID	210 mm OD 100 mm ID	14"	14"
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	Modified 3350	3350	Modified 3350	3350	Modified 3350
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	ST506	ANSI X3T9/1226	ANSI X3T9/1226	SMD, Priam	SMD
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 25.5	U: 20.07	U: 60	U: 83.95	U: 165.9
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 10,416	U: 17,920	U: 17,920	U: 20,160	U: 20,160
Data surfaces per spindle	8	4	4	6	5
Heads per data surface	1	1	1	2	2
Tracks per surface	306	280	838	704	1646
Track density (TPI)	383	219	693	286	706
Maximum linear density (BPI)	8944	8649	8555	6122	6270
Rotational speed (RPM)	3600	3125	3125	2964	3600
PERFORMANCE					
Actuator type	Rotary, Band, Stepping Motor 90 (including settling)	Rotary, Stepping Motor 65	Rotary, Voice Coil 29	Rotary, Voice Coil 38	Rotary, Voice Coil 38
Average positioning time (msec)	8.3	9.6	9.6	10.12	8.3
Average rotational delay (msec)	98.3	74.6	38.6	48.12	46.3
Data transfer rate (KBytes/sec)	625	933.3	933.3	1000	1209
FIRST CUSTOMER SHIPMENT	3Q84	4/81	1/82	7/77	1Q83
U.S. OEM PRICE FOR 100 UNITS	\$575(2500)	\$800	\$2,500	\$3,500	\$4,000
COMMENTS	Previously Disctron Product	Previously 3M Product	Previously 3M Product		

1984 DISK/TREND REPORT



MANUFACTURER	DISC TECH ONE	DISC TECH ONE	DISCTRON	DISCTRON	DMA SYSTEMS
DRIVE	4230	4300	DP-100	DP-400	5R Micro-Magnum
DISK/TREND GROUP	7	8	1	6	1
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	8" Cartridge	Fixed	5.25" Cartridge
Nominal disk diameter	14"	14"	200 mm OD 63.5 mm ID	200 mm OD 63.5 mm ID	130 mm OD 40 mm ID
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	Modified 3350	Modified 3350	Modified 3350	Modified 3350	Modified 3350
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	Priam Stan.	SMD	Modified SA 1000	Modified SA 1000	Modified SA1000
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 232.3	U: 301.0	--	U: 46.4	--
REMOVABLE	--	--	U: 11.6	--	U: 6.75
Capacity per track (Bytes)	U: 20,160	U: 25,872	U: 13,440	U: 13,440	U: 10,560
Data surfaces per spindle	7	7	2	4	2
Heads per data surface	2	2	1	1	1
Tracks per surface	1664	1664	426	864	320
Track density (TPI)	706	706	478	640	454
Maximum linear density (BPI)	6270	8072	6968	8325	8617
Rotational speed (RPM)	2964	2964	3600	3600	3443
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil
Average positioning time (msec)	38	38	60	60	40
Average rotational delay (msec)	10.1	10.1	8.3	8.3	8.7
Average access time (msec)	48.1	48.1	68.3	68.3	48.7
Data transfer rate (KBytes/sec)	1209	1278	875	875	625
FIRST CUSTOMER SHIPMENT	2/84	1Q83	4/81	4/82	9/82
U.S. OEM PRICE FOR 100 UNITS	\$5,000	\$5,000	\$1,580	\$1,770	\$1,775
COMMENTS			Embedded Servo	Embedded Servo	Embedded Servo

MANUFACTURER	DMA SYSTEMS	DMA SYSTEMS	DMA SYSTEMS	DMA SYSTEMS	FUJITSU, LTD.
DRIVE	11/11 Micro-Magnum	11R Micro-Magnum	360	5/5 Micro-Magnum	F451
DISK/TREND GROUP	2	2	2	2	2
MARKET	OEM	OEM	OEM	OEM	Captive
MEDIA: Generic type	"Micro-Magnum"	"Micro-Magnum"	"Micro-Magnum"	5.25" Cartridge	Special 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	14"
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	Modified 3350	Modified 3350	Modified 3350	Modified 3350	3330-11
Heads	Ferrite	Ferrite	Ferrite	Ferrite Modified SA 1000	Ferrite
Interface	ST506	ST506	ST506		Fujitsu
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 13.6	--	--	U: 6.75	--
REMOVABLE	U: 13.6	U: 13.6	U: 12.75	U: 6.75	F: 19.86
Capacity per track (Bytes)	U: 10,640	U: 10,640	U: 10,416	U: 10,560	F: 16,384
Data surfaces per spindle	4	4	2	4	3
Heads per data surface	1	1	1	1	1
Tracks per surface	640	640	612	320	404
Track density (TPI)	908	908	612	454	370
Maximum linear density (BPI)	9254	9254	10894	8617	6135
Rotational speed (RPM)	3247	3247	3473	3443	2400
PERFORMANCE					
Actuator type	Linear, Voice Coil	Linear, Voice Coil	Rack & Pinion, Stepping Motor	Linear, Voice Coil	Linear, Voice Coil
Average positioning time (msec)	50 (including settling)	50 (including settling)	98 (including settling)	40	30
Average rotational delay (msec)	9.24	9.24	8.6	8.7	12.5
Average access time (msec)	59.24	59.24	106.6	48.7	42.5
Data transfer rate (KBytes/sec)	625	625	625	625	819
FIRST CUSTOMER SHIPMENT	6/84	6/84	5/84	5/82	3Q77
U.S. OEM PRICE FOR 100 UNITS	\$2,050	\$1,800	\$945	\$2000	--
COMMENTS	Embedded Servo	Embedded Servo	1.625" High Embedded Servo	Embedded Servo	

## 1984 DISK/TREND REPORT

MANUFACTURER

DRIVE

DISK/TREND GROUP

MARKET

MEDIA: Generic type  
Nominal disk diameter  
Recording medium

DRIVE: Technology type  
Heads  
Interface

CAPACITY/RECORDING DENSITY

Total capacity (MBytes) FIXED  
REMOVABLE

Capacity per track (Bytes)  
Data surfaces per spindle  
Heads per data surface

Tracks per surface  
Track density (TPI)  
Maximum linear density (BPI)  
Rotational speed (RPM)

PERFORMANCE

Actuator type  
Average positioning time (msec)  
Average rotational delay (msec)  
Average access time (msec)  
Data transfer rate (KBytes/sec)

FIRST CUSTOMER SHIPMENT

U.S. OEM PRICE FOR 100 UNITS

COMMENTS

FUJITSU, LTD.	FUJITSU, LTD.	FUJITSU, LTD.	FUJITSU, LTD.	FUJITSU, LTD.
F452	F6417	M2201	M2211	F479
2	2	2	2	4
Captive	Captive	OEM	OEM	Captive
Special Cartridge 14"	Special Cartridge 14"	Special Cartridge 14"	Special Cartridge 14"	3336-11 14"
Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
3330-11	3330-11	3330-11	3330-11	3330-11
Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Fujitsu	Fujitsu	SMD	SMD	Fujitsu
--	--	--	--	--
F: 39.7	F: 67.6	U: 50.56	U: 84.27	F: 200.0
F: 16,384	F: 16,736	U: 20,480	U: 20,480	F: 13,030
3	5	3	5	19
1	1	1	1	1
808	808	823	823	815
370	370	370	370	370
6135	5636	6135	6135	4040
2400	2400	2400	2400	3600
Linear, Voice Coil 30	Linear, Voice Coil 30	Linear, Voice Coil 30	Linear, Voice Coil 30	Linear, Voice Coil 25
30	30	30	30	25
12.5	12.5	12.5	12.5	8.4
42.5	42.5	42.5	42.5	33.4
819	717	819	819	806
3Q77	4Q79	4Q77	4Q79	3Q75
--	--	--	--	--

MANUFACTURER	FUJITSU, LTD	FUJITSU, LTD.	FUJITSU, LTD.	FUJITSU, LTD.	FUJITSU, LTD
DRIVE	M2230AS/B	M2230AT M2230BT	M2231A/B	M2232A/B	M2233AS/B
DISK/TREND GROUP	5	5	5	5	5
MARKET	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	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	Modified 3350	Modified 3350	Modified 3350	Modified 3350	Modified 3350
Heads	Ferrite AS=ST506 B=SA4000	Ferrite ST506/SA4000	Ferrite A = ST506 B = SA4000	Ferrite A = ST506 B = SA4000	Ferrite AS=ST506 B=SA4000
INTERFACE					
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 6.66	U: 6.66	U: 6.66	U: 10.0	U: 13.3
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 10,416	U: 10,416	U: 10,416	U: 10,416	U: 10,416
Data surfaces per spindle	2	2	4	6	4
Heads per data surface	1	1	1	1	1
Tracks per surface	320	320	160	160	320
Track density (TPI)	300	300	254	254	300
Maximum linear density (BPI)	10,200	10200	8020	8020	10,200
Rotational speed (RPM)	3600	3600	3600	3600	3600
PERFORMANCE					
Actuator type	Rotary, Stepping Motor 83 (including settling)	Rotary,Band, Stepping Motor 95 (including settling)	Rotary, Stepping Motor 95 (including settling)	Rotary, Stepping Motor 95 (including settling)	Rotary, Stepping Motor 83 (including settling)
Average positioning time (msec)	8.3	8.3	8.3	8.3	8.3
Average rotational delay (msec)	91.3	103.3	103.3	103.3	91.3
Average access time (msec)	625	625	625	625	625
Data transfer rate (KBytes/sec)	4/83	5/84	7/82	7/82	4/83
FIRST CUSTOMER SHIPMENT	\$750	\$745	--	\$1,050	\$775
U.S. OEM PRICE FOR 100 UNITS		1.625" High			
COMMENTS					

MANUFACTURER

DRIVE

DISK/TREND GROUP

MARKET

MEDIA: Generic type

Nominal disk diameter

Recording medium

DRIVE: Technology type

Heads

Interface

CAPACITY/RECORDING DENSITY

Total capacity (MBytes) FIXED

REMOVABLE

Capacity per track (Bytes)

Data surfaces per spindle

Heads per data surface

Tracks per surface

Track density (TPI)

Maximum linear density (BPI)

Rotational speed (RPM)

PERFORMANCE

Actuator type

Average positioning time (msec)

Average rotational delay (msec)

Average access time (msec)

Data transfer rate (KBytes/sec)

FIRST CUSTOMER SHIPMENT

U.S. OEM PRICE FOR 100 UNITS

COMMENTS

FUJITSU, LTD.	FUJITSU, LTD	FUJITSU, LTD	FUJITSU, LTD.	FUJITSU, LTD.
M2233AT M2233BT	M2234AS/B	M2235AS	M2301B/K	M2301BE/KE
5	5	5	5	5
Captive,OEM	OEM	OEM	OEM	OEM
Fixed	Fixed	Fixed	Fixed	Fixed
130 mm OD 40 mm ID Oxide Coated	130 mm OD 40 mm ID Oxide Coated	130 mm OD 40 mm ID Oxide Coated	200 mm OD 100 mm ID Oxide Coated	200 mm OD 100 mm ID Oxide Coated
Modified 3350	Modified 3350	Modified 3350	3340	Modified 3350
Ferrite ST506/SA4000	Ferrite AS=ST506 B=SA4000	Ferrite AS=ST506 B=SA4000	Ferrite B=SA4000, K= Bidirectional	Ferrite BE=SA4000, KE= Bidirectional
U: 13.33	U: 20.0	U: 20.0	U: 11.712	U: 11.87
--	--	--	--	--
U: 10,416	U: 10,416	U: 10,416	U: 12,000	U: 24,320
4	6	6	4	2
1	1	1	1	1
320	320	320	244	244
300	300	300	195	195
10200	10,200	10,200	6100	12360
3600	3600	3600	2964	2964
Rotary,Band, Stepping Motor 95 (including settling)	Rotary, Stepping Motor 83 (including settling)	Rotary, Stepping Motor 83 (including settling)	Band, Stepping Motor 70 (including settling)	Band, Stepping Motor 70 (including settling)
8.3	8.3	8.3	10.1	10.1
103.3	91.3	91.3	80.1	80.1
625	625	625	593	1200
5/84	4/83	10/83	7/80	9/82
\$800	\$900	\$995	\$1,610 (B)	\$1,610 (BE)
1.625" High				

MANUFACTURER	FUJITSU, LTD.	FUJITSU, LTD.	FUJITSU, LTD.	FUJITSU, LTD.	FUJITSU, LTD.
DRIVE	M2302B/K	M2302BE/KE	M2241AS M2241B	M2242AS M2242B	M2243AS M2243B
DISK/TREND GROUP	5	5	6	6	6
MARKET	OEM	OEM	Captive,OEM	Captive,OEM	Captive,OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	200 mm OD 100 mm ID	200 mm OD 100 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	3340	Modified 3350	Modified 3350	Modified 3350	Modified 3350
Heads	Ferrite B=SA4000, K=	Ferrite BE=SA4000, KE=	Ferrite	Ferrite	Ferrite
Interface	Bidirectional	Bidirectional	ST506/SA4000	ST506/SA4000	ST506/SA4000
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 23.424	U: 23.74	U: 31.4	U: 54.9	U: 86.3
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 12,000	U: 24,320	U: 10,416	U: 10,416	U: 10,416
Data surfaces per spindle	8	4	4	7	11
Heads per data surface	1	1	1	1	1
Tracks per surface	244	244	754	754	754
Track density (TPI)	195	195	760	760	760
Maximum linear density (BPI)	6100	12360	10200	10200	10200
Rotational speed (RPM)	2964	2964	3600	3600	3600
PERFORMANCE					
Actuator type	Band, Stepping Motor	Band, Stepping Motor	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Average positioning time (msec)	70 (including settling)	70 (including settling)	35	35	35
Average rotational delay (msec)	10.1	10.1	8.3	8.3	8.3
Average access time (msec)	80.1	80.1	43.3	43.3	43.3
Data transfer rate (KBytes/sec)	593	1200	625	625	625
FIRST CUSTOMER SHIPMENT	7/80	9/82	5/84	5/84	5/84
U.S. OEM PRICE FOR 100 UNITS	\$2,090 (B)	\$1,850 (BE)	\$1600	\$1800	\$2000
COMMENTS					

## MANUFACTURER

## DRIVE

## DISK/TREND GROUP

## MARKET

## MEDIA: Generic type

Nominal disk diameter

Recording medium

## DRIVE: Technology type

Heads

Interface

## CAPACITY/RECORDING DENSITY

Total capacity (MBytes) FIXED

REMOVABLE

Capacity per track (Bytes)

Data surfaces per spindle

Heads per data surface

Tracks per surface

Track density (TPI)

Maximum linear density (BPI)

Rotational speed (RPM)

## PERFORMANCE

Actuator type

Average positioning time (msec)

Average rotational delay (msec)

Average access time (msec)

Data transfer rate (KBytes/sec)

## FIRST CUSTOMER SHIPMENT

## U.S. OEM PRICE FOR 100 UNITS

## COMMENTS

	FUJITSU, LTD	FUJITSU, LTD.	FUJITSU, LTD	FUJITSU, LTD	FUJITSU, LTD
	M2280	M2303BE/KE	M2311K/S	M2312K/S	M2321K/S
	6	6	6	6	6
	OEM	OEM	OEM	OEM	OEM
	Fixed	Fixed	Fixed	Fixed	Fixed
	14"	200 mm OD 100 mm ID	200 mm OD 100 mm ID	200 mm OD 100 mm ID	210 mm OD 100 mm ID
	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
	Modified 3350	Modified 3350	Modified 3350	Modified 3350	Modified 3350
	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
	SMD	B=SA4000, K= Bidirectional	SMD, SCSI	SMD, SCSI	SMD, SCSI
	U: 84.3	U: 47.47	U: 48.25	U: 48.25	U: 84.2
	--	--	--	--	--
	U: 20,480	U: 24,320	U: 20,480	U: 20,480	U: 20,480
	3	8	4	4	5
	2	1	1	1	1
	1646	244	589	589	823
	680	195	720	720	683
	6580	12360	9550	9550	9867
	2964	2964	3600	3600	3600
	Rotary, Voice Coil 27	Band, Stepping Motor 70 (including settling)	Rotary, Voice Coil 20	Rotary, Voice Coil 20	Rotary, Voice Coil 20
	10.12	10.1	8.3	8.3	8.3
	37.12	80.1	28.3	28.3	28.3
	1012	1200	1229	1229	1229
	4Q79	9/82	4/81	4/81	11/83
	\$3,817	\$2,250 (BE)	\$3,195	\$2,995	\$3,750

MANUFACTURER	FUJITSU, LTD.	FUJITSU, LTD	FUJITSU, LTD.	FUJITSU, LTD	FUJITSU, LTD
DRIVE					
	F436	F437	F6411	M2284	M2322K/S
DISK/TREND GROUP	7	7	7	7	7
MARKET	Captive	Captive	Captive	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	14"	14"	14"	14"	210 mm OD 100 mm ID
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	Modified 3350	Modified 3350	Modified 3350	Modified 3350	Modified 3350
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	Fujitsu	Fujitsu	Fujitsu	SMD	SMD, SCSI
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	F: 100.0	F: 158	F: 135.0	U: 168.6	U: 168.5
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 16,384	F: 16,384	F: 16,736	U: 20,480	U: 20,480
Data surfaces per spindle	5	6	5	5	10
Heads per data surface	2	2	2	2	1
Tracks per surface	1630	1630	1630	1646	823
Track density (TPI)	668	680	668	680	683
Maximum linear density (BPI)	6580	6580	5694	6580	9867
Rotational speed (RPM)	2400	2400	2964	2964	3600
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Average positioning time (msec)	27	27	27	27	20
Average rotational delay (msec)	12.5	12.5	10.1	10.12	8.3
Average access time (msec)	39.5	39.5	37.1	37.12	28.3
Data transfer rate (KBytes/sec)	819	819	885	1012	1229
FIRST CUSTOMER SHIPMENT	4/79	10/81	4/79	4Q79	11/83
U.S. OEM PRICE FOR 100 UNITS	--	--	--	\$4,775	\$4000
COMMENTS					

## 1984 DISK/TREND REPORT



## MANUFACTURER

## DRIVE

## DISK/TREND GROUP

## MARKET

## MEDIA: Generic type

Nominal disk diameter

Recording medium

## DRIVE: Technology type

Heads

Interface

## CAPACITY/RECORDING DENSITY

Total capacity (MBytes) FIXED

REMOVABLE

Capacity per track (Bytes)

Data surfaces per spindle

Heads per data surface

Tracks per surface

Track density (TPI)

Maximum linear density (BPI)

Rotational speed (RPM)

## PERFORMANCE

Actuator type

Average positioning time (msec)

Average rotational delay (msec)

Average access time (msec)

Data transfer rate (KBytes/sec)

## FIRST CUSTOMER SHIPMENT

## U.S. OEM PRICE FOR 100 UNITS

## COMMENTS

	FUJITSU, LTD.	FUJITSU, LTD	FUJITSU, LTD.	FUJITSU, LTD.	FUJITSU, LTD
	M2331K/KS	F438	F493	F6421	M2294K/N
	7	8	8	8	8
	OEM	Captive	Captive	Captive	OEM
	Fixed	Fixed	Fixed	Fixed	Fixed
	210 mm OD 100 mm ID Oxide Coated	14"  Oxide Coated	14"  Oxide Coated	10.5" OD 4" ID Oxide Coated	14"  Oxide Coated
	Modified 3350	Modified 3350	3350	Modified 3350	Modified 3350
	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
	MOD, SMD, SCSI	Fujitsu	Fujitsu	Fujitsu	SMD
	U: 168.5	F: 300	1.144 MB Fixed Head Option F: 317.5	1.607 or 1.144 MB Fixed Head Option F: 446/317.5	U: 335.5
	--	--	--	--	--
	U: 40,960	F: 24,576	F: 19,069	F: 26,793/ 19,069	U: 20,480
	5	6	15	10	8
	1	2	2	2	2
	823	2048	1110	1680	2048
	683	793	480	880	858
	19734*	9870	6362	12790	6500
	3600	2400	3600	3961	2964
	Rotary, Voice Coil 20	Rotary, Voice Coil 27	Linear, Voice Coil 20	Rotary, Voice Coil 18	Rotary, Voice Coil 27
	8.3	12.5	8.3	7.5	10.12
	28.3	39.5	28.3	25.5	37.12
	2458	1229	1198	1859	1012
	11/84	6/83	4Q79	3Q81	5/83
	--	--	--	--	\$5,800
	*RLL CODE		Drive has two spindles	Drive has four spindles	

MANUFACTURER	FUJITSU, LTD.	FUJITSU, LTD	FUJITSU, LTD.	FUJITSU, LTD.	FUJITSU, LTD.
DRIVE	M2333K/KS	M2350A	M2351A	F496	F6425
DISK/TREND GROUP	8	8	8	9	9
MARKET	OEM	OEM	OEM	Captive	Captive
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	210 mm OD	10.5" OD	10.5" OD	14"	10.5" OD
Recording medium	100 mm ID Oxide Coated	4" ID Oxide Coated	4" ID Oxide Coated	Oxide Coated	4" ID Sputtered/Oxide
DRIVE: Technology type	Modified 3350	Modified 3350	Modified 3350	Modified 3350	Special
Heads	Ferrite	Ferrite	Ferrite	Ferrite	T. Film/Ferrite
Interface	MOD, SMD, SCSI	Modified SMD	Modified SMD	Fujitsu	Fujitsu
CAPACITY/RECORDING DENSITY			1.69 MB Fixed Head Option	1.144 MB Fixed Head Option	1.4 MB Fixed Head Option
Total capacity (MBytes) FIXED	U: 337.0	U: 473.6	U: 474.214	F: 635.0	F: 630.0
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 40,960	U: 28,160	U: 28,160	F: 19,069	F: 47,476
Data surfaces per spindle	10	10	10	20	8
Heads per data surface	1	2	2	2	2
Tracks per surface	823	1684	1684	1660	1770
Track density (TPI)	683	880	880	668	*
Maximum linear density (BPI)	19734*	12790	12790	6426	*
Rotational speed (RPM)	3600	3961	3961	3600	3600
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Linear, Voice Coil	Rotary, Voice Coil
Average positioning time (msec)	20	18	18	20	15
Average rotational delay (msec)	8.3	7.5	7.5	8.3	8.3
Average access time (msec)	28.3	25.5	25.5	28.3	23.3
Data transfer rate (KBytes/sec)	2458	1.86/7.44/9.3	1859	1198	3000
FIRST CUSTOMER SHIPMENT	11/84	2/84	3/82	2Q80	3Q83
U.S. OEM PRICE FOR 100 UNITS	\$5,350	\$28,000 QTY 25	\$8,800	--	--
COMMENTS	*RLL CODE	Parallel data transfer, 4 or 5 channels		Drive has two spindles	Drive has four spindles

## 1984 DISK/TREND REPORT

MANUFACTURER	FUJITSU, LTD	FUJITSU, LTD.	HEWLETT-PACKARD	HEWLETT-PACKARD	HEWLETT-PACKARD
DRIVE	M2298K/N	FACOM 6441	7906	7920	7925
DISK/TREND GROUP	9	10	2	3	4
MARKET	OEM	OEM	Captive	Captive	Captive
MEDIA: Generic type	Fixed		2315	Special SMD	Special Pack
Nominal disk diameter	14"	12"	14"	14"	14"
Recording medium	Oxide Coated		Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	Modified 3350	Write-Once Opt.	3330-1	3330-11	--
Heads	Ferrite	Laser Diode	Ferrite	Ferrite	Ferrite
Interface	Modified SMD	IBM, SCSI	HPiB	HPiB	HPiB
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 671	--	F: 9.38	--	--
REMOVABLE	--	F:1,470(1 side)	F: 9.38	F: 50.07	F: 120.18
Capacity per track (Bytes)	U: 40,960	F: 32,700	F: 12,288	F: 12,288	U: 16,384
Data surfaces per spindle	8	1	3	5	9
Heads per data surface	2	1	1	1	1
Tracks per surface	2048	45,000	812 Fixed 406 Removable	815	815
Track density (TPI)	858	16,000	384 Fixed 192 Removable	384	384
Maximum linear density (BPI)	8,667 FCI 13,000 BPI		4860	4680	6250
Rotational speed (RPM)	2722	900	3600	3600	2700
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil
Average positioning time (msec)	27	350	25	25	25
Average rotational delay (msec)	11	33.3	8.3	8.3	11.1
Average access time (msec)	38	383.33	33.3	33.3	36.1
Data transfer rate (KBytes/sec)	1859	783	937.5	937.5	937.5
FIRST CUSTOMER SHIPMENT	10/84	1985	3/78	3/77	6/78
U.S. OEM PRICE FOR 100 UNITS	\$7.045	--	--	--	--
COMMENTS					

## 1984 DISK/TREND REPORT

MANUFACTURER	HEWLETT-PACKARD	HEWLETT-PACKARD	HEWLETT-PACKARD	HEWLETT-PACKARD	HEWLETT-PACKARD
DRIVE	7935H	7908	7911	7912	7914
DISK/TREND GROUP	4	5	5	6	7
MARKET	Captive	Captive	Captive	Captive	Captive
MEDIA: Generic type	Special Disk Pack	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	14"	200 mm OD	14"	14"	14"
Recording medium	Oxide Coated	63.5 mm ID Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	Modified 3330	3350	3350	3350	3350
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	HPIB	HPIB	HPIB	HPIB	HPIB
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	--	F: 16.5	F: 28.1	F: 65.6	F: 132.1
REMOVABLE	F: 404.4	--	--	--	--
Capacity per track (Bytes)	F: 23,552	F: 8,960	F: 16,384	F: 16,384	F: 16,384
Data surfaces per spindle	13	5	1.5	3.5	3.5
Heads per data surface	2	1	2	2	2
Tracks per surface	1321	370	1144	1144	2288
Track density (TPI)	625	300	478	478	910
Maximum linear density (BPI)	8320*	6000	6161	6161	6161
Rotational speed (RPM)	2700	3600	3600	3600	3600
PERFORMANCE					
Actuator type	Linear, Voice Coil	Linear, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Average positioning time (msec)	24.0	41.6	26.7	26.7	26.7
Average rotational delay (msec)	11.1	8.3	8.3	8.3	8.3
Average access time (msec)	35.1	49.9	35.0	35.0	35.0
Data transfer rate (KBytes/sec)	1000	537.6	983	983	983
FIRST CUSTOMER SHIPMENT	4/83	9/81	10/81	10/81	2/83
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	--
COMMENTS	*Uses RLL Code	Drive manufactured by International Memories			

SPEC-47

MANUFACTURER	HEWLETT-PACKARD	HITACHI, LTD.	HITACHI, LTD.	HITACHI, LTD.	HITACHI, LTD.
DRIVE	7933H	DK502-1	DK502-2	DK502-3	DK503-1
DISK/TREND GROUP	8	5	5	5	5
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	130 mm OD 40 mm ID
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	Modified 3330	Modified 3350	Modified 3350	Modified 3350	Modified 3350
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	HPIB	ST 506	ST 506	ST 506	ST 506
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	F: 404.4	U: 13.3	U: 20.0	U: 26.6	U: 6.7
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 23,552	U: 10,416	U: 10,416	U: 10,416	U: 10,416
Data surfaces per spindle	13	4	6	8	2
Heads per data surface	2	1	1	1	1
Tracks per surface	1321	320	320	320	320
Track density (TPI)	625	360	360	360	360
Maximum linear density (BPI)	8320*	9260	9260	9260	9260
Rotational speed (RPM)	2700	3600	3600	3600	3600
PERFORMANCE					
Actuator type	Linear, Voice Coil	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor
Average positioning time (msec)	24.0	85 (including settling)	85 (including settling)	85 (including settling)	85 (including settling)
Average rotational delay (msec)	11.1	8.3	8.3	8.3	8.3
Average access time (msec)	35.1	93.3	93.3	93.3	93.3
Data transfer rate (KBytes/sec)	1000	625	625	625	625
FIRST CUSTOMER SHIPMENT	12/81	10/83	10/83	10/83	10/83
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	--
COMMENTS	*Uses RLL Code	Mfg. by Tokico	Mfg. by Tokico	Mfg. by Tokico	1.625" High Mfg. by Tokico

1984 DISK/TREND REPORT

MANUFACTURER	HITACHI, LTD.	HITACHI, LTD.	HITACHI, LTD.	HITACHI, LTD.	HITACHI, LTD.
DRIVE					
	DK503-2	DK811-2	DK 811-4	DK 811-8	DK511-3
DISK/TREND GROUP	5	5	6	6	6
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	130 mm OD 40 mm ID	210 mm OD 100 mm ID	210 mm OD 100 mm ID	210 mm OD 100 mm ID	130 mm OD 40 mm ID
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	Modified 3350	Modified 3350	3350	3350	Modified 3350
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	ST 506	Modified SMD	Modified SMD	Modified SMD	ST 506, SCSI
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 13.3	U: 24.0 F: 20.0	U: 48.0 F: 40.0	U: 89.1 F: 71.1	U: 36.4
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 10,416	F: 12,800	F: 12,800	F: 12,800	U: 10,416
Data surfaces per spindle	4	3	6	11	5
Heads per data surface	1	1	1	1	1
Tracks per surface	320	521	521	526	699
Track density (TPI)	360	480	480	480	784
Maximum linear density (BPI)	9260	7495	7495	7495	9340
Rotational speed (RPM)	3600	3521	3521	3521	3600
PERFORMANCE					
Actuator type	Band, Stepping Motor	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Average positioning time (msec)	85 (including settling)	25	25	25	30
Average rotational delay (msec)	8.3	8.5	8.5	8.5	8.3
Average access time (msec)	93.3	33.5	33.5	33.5	38.3
Data transfer rate (KBytes/sec)	625	904	904	904	625
FIRST CUSTOMER SHIPMENT	10/83	10/80	10/80	3/82	1Q84
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	--
COMMENTS	1.625" High Mfg. by Tokico				

## 1984 DISK/TREND REPORT

MANUFACTURER	HITACHI, LTD.	HITACHI, LTD.	HITACHI, LTD.	HITACHI, LTD.	HITACHI, LTD.
DRIVE					
	DK511-5	DK511-8	DK812S-5	DK812S-8	DK512-17
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	130 mm OD	210 mm OD	210 mm OD	130 mm OD
Recording medium	40 mm ID Oxide Coated	40 mm ID Oxide Coated	100 mm ID Oxide Coated	100 mm ID Oxide Coated	40 mm ID Oxide Coated
DRIVE: Technology type	Modified 3350	Modified 3350	Modified 3350	Modified 3350	Modified 3350
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	ST 506, SCSI	ST 506, SCSI	SMD	SMD	ESDI, SMD, SCSI
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 51.0	U: 85.7	U: 51	U: 85	U: 171.0
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 10,416	U: 10,416	U: 20,672	U: 20,672	U: 20,832
Data surfaces per spindle	7	10	3	5	10
Heads per data surface	1	1	1	1	1
Tracks per surface	699	823	823	823	823
Track density (TPI)	784	925	750	750	925
Maximum linear density (BPI)	9340	9250	6433 FCI 9650 BPI	6433 FCI 9650 BPI	18500
Rotational speed (RPM)	3600	3600	3510	3510	3600
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Average positioning time (msec)	30	30	25	25	30
Average rotational delay (msec)	8.3	8.3	8.5	8.5	8.3
Average access time (msec)	38.3	38.3	33.5	33.5	38.3
Data transfer rate (KBytes/sec)	625	625	1209	1209	1209
FIRST CUSTOMER SHIPMENT	1Q84	--	7/83	7/83	1Q85
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	--
COMMENTS					

MANUFACTURER	HITACHI, LTD.	HITACHI, LTD.	HITACHI, LTD.	HITACHI, LTD.	HITACHI, LTD.
DRIVE	DK812S-12	DK812S-17	DKU-80	DK815-5	DKU-97I
DISK/TREND GROUP	7	7	8	9	9
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	210 mm OD	210 mm OD	8" Nominal	224 mm OD	14"
Recording medium	100 mm ID Oxide Coated	100 mm ID Oxide Coated	Oxide Coated	100 mm ID Hi Dens-Oxide	Oxide Coated
DRIVE: Technology type	Modified 3350	Modified 3350		Modified 3350	Modified 3350
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	SMD	SMD	IBM, SMD	Mod. SMD IPI-3	IBM
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 119	U: 170.1	U: 427.7	U: 525.0	F: 635.0
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 20,672	U: 20,672	U: 26,880	U: 30,240	F: 19,069
Data surfaces per spindle	7	10	13	14	20
Heads per data surface	1	1	2	1	2
Tracks per surface	823	823	1224	1241	1666
Track density (TPI)	750	750		885	720
Maximum linear density (BPI)	6433 FCI	6433 FCI		14736*	6425
Rotational speed (RPM)	9650 BPI 3510	9650 BPI 3510	3000	3600	3600
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Dual Rotary, Voice Coil
Average positioning time (msec)	25	25	18	18	20/18
Average rotational delay (msec)	8.5	8.5	10.0	8.3	8.3
Average access time (msec)	33.5	33.5	28.0	26.3	28.3/26.3
Data transfer rate (KBytes/sec)	1209	1209	1344	1800	1198
FIRST CUSTOMER SHIPMENT	6/83	6/83	11/83	12/84	1/81
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	--
COMMENTS				*2,7 RLL	Drive has two spindles



MANUFACTURER

DRIVE

DISK/TREND GROUP

MARKET

MEDIA: Generic type

Nominal disk diameter

Recording medium

DRIVE: Technology type

Heads

Interface

CAPACITY/RECORDING DENSITY

Total capacity (MBytes) FIXED

REMOVABLE

Capacity per track (Bytes)

Data surfaces per spindle

Heads per data surface

Tracks per surface

Track density (TPI)

Maximum linear density (BPI)

Rotational speed (RPM)

PERFORMANCE

Actuator type

Average positioning time (msec)

Average rotational delay (msec)

Average access time (msec)

Data transfer rate (KBytes/sec)

FIRST CUSTOMER SHIPMENT

U.S. OEM PRICE FOR 100 UNITS

COMMENTS

HITACHI, LTD.	HITACHI, LTD.	HITACHI, LTD.	HITACHI, LTD.	IBIS
DKU-97S	DKU-98I H-8598	H-8576-12 H-8576-22	OF301 OL301	1400
9	9	9	10	9
OEM	Captive, OEM	Captive	OEM	OEM
Fixed	Fixed	Fixed	OC301	Fixed
14"	14"	14"	12"	14"
Oxide Coated	Oxide Coated	Oxide Coated	TeSe/Glass	Plated
Modified 3350	3380	Modified 3350	Write-Once Opt.	Special
Ferrite	Ferrite	Ferrite	Laser Diode	Ferrite
SMD	IBM	IBM	GP-IB	Custom
U: 697.059	F: 1260	F: 635.0	--	U: 1,409.0
--	--	--	F:1,310(1 side)	--
U: 20,672	F: 47,476	F: 19,069	F: 31,744	U: 49,728
20	20	20	1	16
2	2	2	1	2
1682	1328 (Physical)	1666	41,300	1776
720	600	720	16,000	769
6425	15240**	6425	19,500	15294
3600	3600	3600	600	3600
Dual Rotary, Voice Coil	Dual Rotary, Voice Coil	Dual Rotary, Voice Coil	Linear, Voice Coil	Linear, Voice Coil
20	16	20	200	16
8.3	8.3	8.3	50	8.3
28.3	24.3	28.3	250	24.3
1240	3000	1198	440	Up To 12,000
9/83	4Q82	4Q80	2Q84	4Q83
--	--	--	--	--
	**RLL Code  Drive has two spindles	Drive has two spindles	OL301 is Library Unit with up to 32 disks	Drive has one spindle, with two actuators. Up to 4 track parallel data transfer.

MANUFACTURER	IBM	IBM	IBM	IBM	IBM
DRIVE					
	1131 2310	2311-1	2311-11	2311-12	2314-1
DISK/TREND GROUP	--	--	--	--	--
MARKET	Captive	Captive	Captive	Captive	Captive
MEDIA: Generic type	2315	1316	1316	1316	2316
Nominal disk diameter	14"	14"	14"	14"	14"
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	2310	2311	2311	2311	2314
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	IBM	IBM	IBM	IBM	IBM
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	--	--	--	--	--
REMOVABLE	F: 1,024	F: 7.45	F: 5.4	F: 2.7	F: 29.176
Capacity per track (Bytes)	F: 2,560	F: 3,625	F: 2,700	F: 2,700	F: 7,294
Data surfaces per spindle	2	10	10	10	20
Heads per data surface	1	1	1	1	1
Tracks per surface	200	203	203	103	203
Track density (TPI)	100	100	100	100	100
Maximum linear density (BPI)	1100	1100	1100	1100	2200
Rotational speed (RPM)	1500	2400	2400	2400	2400
PERFORMANCE					
Actuator type	Linear, Step- ping Voice Coil	Linear, Hydraulic	Linear, Hydraulic	Linear, Hydraulic	Linear, Hydraulic
Average positioning time (msec)	520	75	75	60	75
Average rotational delay (msec)	20	12.5	12.5	12.5	12.5
Average access time (msec)	540	87.5	87.5	72.5	87.5
Data transfer rate (KBytes/sec)	97.5	156	156	156	312.5
FIRST CUSTOMER SHIPMENT	11/65	6/65	11/70	11/70	4/65
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	--
COMMENTS	1130	System/360	System/360	System/360	System/360 System/370

MANUFACTURER	IBM	IBM	IBM	IBM	IBM
DRIVE	2314-A 2314-B 2312 2319	3330-1	3330-11	3340-A2 3340-B1 3340-B2	5444-1
DISK/TREND GROUP	--	--	--	--	--
MARKET	Captive	Captive	Captive	Captive	Captive
MEDIA: Generic type	2316	3336-1	3336-11	3348	5440
Nominal disk diameter	14"	14"	14"	14"	14"
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	2314	3330-1	3330-1	3340	5444
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	IBM	IBM	IBM	IBM	IBM
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	--	--	--	--	F: 1.22
REMOVABLE	F: 29.176	F: 100.018	F: 200.036	F: 34.9/69.8	F: 1.22
Capacity per track (Bytes)	F: 7,294	F: 13,030	F: 13,030	F: 16,736	F: 6,144
Data surfaces per spindle	20	19	19	3/6	4
Heads per data surface	1	1	1	2	1
Tracks per surface	203	411	815	696	100
Track density (TPI)	100	192	370	300	100
Maximum linear density (BPI)	2200	4040	4040	5636	2200
Rotational speed (RPM)	2400	3600	3600	2964	1500
PERFORMANCE					
Actuator type	Linear, Hydraulic	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil	Lead Screw, Friction Drive
Average positioning time (msec)	60	30	30	25	153
Average rotational delay (msec)	12.5	8.3	8.3	10.1	20
Average access time (msec)	72.5	38.3	38.3	35.1	173
Data transfer rate (KBytes/sec)	312.5	806	806	885	199
FIRST CUSTOMER SHIPMENT	see below	8/71	1973	11/73	9/70
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	--
COMMENTS	A-8/69 B, 2319-12/70 System/360 System/370	System/370 303X Series 43XX	System/370 303X Series 43XX	Original Winchester Disk Drive	System/3

12.5

11.7

MANUFACTURER	IBM	IBM	IBM	IBM	IBM
DRIVE	5444-2/3	5445	4952-30D 4954-30D 4956-30D 4965-30D	4963-23A 4963-23B	4963-29A 4963-29B
DISK/TREND GROUP	--	--	5	5	5
MARKET	Captive	Captive	Captive	Captive	Captive
MEDIA: Generic type	5440	2316	Fixed	Fixed	Fixed
Nominal disk diameter	14"	14"	210 mm OD 100 mm ID	210 mm OD 100 mm ID	210 mm OD 100 mm ID
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	5444	2314	Modified 3350	Piccolo	Piccolo
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	IBM	IBM	IBM	IBM	IBM
CAPACITY/RECORDING DENSITY				0.131 MB Fixed Heads	
Total capacity (MBytes) FIXED	F: 2.45	--	F: 30.84	F: 23.461888	F: 29.327360
REMOVABLE	F: 2.45	F: 20.48	--	--	--
Capacity per track (Bytes)	F: 6,144	F: 5,120	F: 17,408	F: 16,384	F: 16,384
Data surfaces per spindle	4	20	4	5	5
Heads per data surface	1	1	1	1	1
Tracks per surface	200	203	443	359	359
Track density (TPI)	100	100	523	450	450
Maximum linear density (BPI)	2200	2200	6875 FRPI 10312 BPI	8530	8530
Rotational speed (RPM)	1500	2400	3151	3125	3125
PERFORMANCE					
Actuator type	Lead Screw, Friction Drive	Linear, Hydraulic	Linear, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Average positioning time (msec)	269	60	38	27	27
Average rotational delay (msec)	20	12.5	9.5	9.6	9.6
Average access time (msec)	289	72.5	47.5	36.6	36.6
Data transfer rate (KBytes/sec)	199	312.5	1250	1031	1031
FIRST CUSTOMER SHIPMENT	1970	6/72	9/83	2/79	2/79
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	--
COMMENTS	System/3	System/3	Series/1 Embedded Servo 64 KB Cache	Series/1	Series/1

## 1984 DISK/TREND REPORT

MANUFACTURER	IBM	IBM	IBM	IBM	IBM
DRIVE	5247-011	5525-020 5525-030	8101-A11	8130-A21 8130-A31 A41, A51 A61, A71	8130-A22 8140-A32 A42, A52 A62, A72
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	210 mm OD	210 mm OD	210 mm OD	210 mm OD	210 mm OD
Recording medium	100 mm ID Oxide Coated	100 mm ID Oxide Coated	100 mm ID Oxide Coated	100 mm ID Oxide Coated	100 mm ID Oxide Coated
DRIVE: Technology type	3350	Piccolo	Piccolo	Piccolo	Piccolo
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	IBM	IBM	IBM	IBM	IBM
CAPACITY/RECORDING DENSITY					.131072 MB Fixed Heads
Total capacity (MBytes) FIXED	F: 15.4	F: 29.327360	F: 29.327360	F: 29.327360	F: 23.461888
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 17,408	F: 16,384	F: 16,384	F: 16,384	F: 16,384
Data surfaces per spindle	2	5	5	5	5
Heads per data surface	1	1	1	1	1
Tracks per surface	443	359	359	359	359
Track density (TPI)	523	450	450	450	450
Maximum linear density (BPI)	6875 FRPI 10312 BPI	8530	8530	8530	8530
Rotational speed (RPM)	3151	3125	3125	3125	3125
PERFORMANCE					
Actuator type	Linear, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Average positioning time (msec)	38	27	27	27	27
Average rotational delay (msec)	9.51	9.6	9.6	9.6	9.6
Average access time (msec)	49.51	36.6	36.6	36.6	36.6
Data transfer rate (KBytes/sec)	1250	1031	1031	1031	1031
FIRST CUSTOMER SHIPMENT	9/82	2/80	3Q79	3Q79	3Q79
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	--
COMMENTS	Embedded Servo Shared storage for Datamaster	5520 Admin. System	8100 System	8100 System	8100 System

14.1

8.8

MANUFACTURER

DRIVE

DISK/TREND GROUP

MARKET

MEDIA: Generic type

Nominal disk diameter

Recording medium

DRIVE: Technology type

Heads

Interface

CAPACITY/RECORDING DENSITY

Total capacity (MBytes) FIXED

REMOVABLE

Capacity per track (Bytes)

Data surfaces per spindle

Heads per data surface

Tracks per surface

Track density (TPI)

Maximum linear density (BPI)

Rotational speed (RPM)

PERFORMANCE

Actuator type

Average positioning time (msec)

Average rotational delay (msec)

Average access time (msec)

Data transfer rate (KBytes/sec)

FIRST CUSTOMER SHIPMENT

U.S. OEM PRICE FOR 100 UNITS

COMMENTS

IBM	IBM	IBM	IBM	IBM
3310-A1 3310-A2 3310-B1 5.5 3310-B2 10.1	4963-58A 4963-58B	4963-64A 4963-64B - 11.1	5247-012	5340-XX4
6	6	6	6	6
Captive	Captive	Captive	Captive	Captive
Fixed	Fixed	Fixed	Fixed	Fixed
210 mm OD 100 mm ID Oxide Coated	210 mm OD 100 mm ID Oxide Coated	210 mm OD 100 mm ID Oxide Coated	210 mm OD 100 mm ID Oxide Coated	210 mm OD 100 mm ID Oxide Coated
Piccolo	Piccolo	Piccolo	3350	Piccolo
Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
IBM	IBM	IBM	IBM	IBM
	0.131 MB Fixed Heads			
F: 64.520192	F: 58.654720	F: 64.520192	F: 30.84	F: 63.905792
--	--	--	--	--
F: 16,384	F: 16,384	F: 16,384	F: 17,408	F: 16,384
11	11	11	4	11
1	1	1	1	1
359	359	359	443	359
450	450	450	523	450
8530	8530	8530	6875 FRPI 10312 BPI 3151	8530
3125	3125	3125		3125
Rotary, Voice Coil 27	Rotary, Voice Coil 27	Rotary, Voice Coil 27	Linear, Voice Coil 38	Rotary, Voice Coil 27
9.6	9.6	9.6	9.51	9.6
36.6	36.6	36.6	47.51	36.6
1031	1031	1031	1250	1031
3/79	2/79	2/79	9/82	1/79
--	--	--	--	--
4331	Series/1	Series/1	Embedded Servo Shared storage for Datamaster	System/34

1984 DISK/TREND REPORT

2.00  
SPINDLE  
+ 76

MANUFACTURER

DRIVE

DISK/TREND GROUP

MARKET

MEDIA: Generic type

Nominal disk diameter

Recording medium

DRIVE: Technology type

Heads

Interface

CAPACITY/RECORDING DENSITY

Total capacity (MBytes) FIXED

REMOVABLE

Capacity per track (Bytes)

Data surfaces per spindle

Heads per data surface

Tracks per surface

Track density (TPI)

Maximum linear density (BPI)

Rotational speed (RPM)

PERFORMANCE

Actuator type

Average positioning time (msec)

Average rotational delay (msec)

Average access time (msec)

Data transfer rate (KBytes/sec)

FIRST CUSTOMER SHIPMENT

U.S. OEM PRICE FOR 100 UNITS

COMMENTS

IBM	IBM	IBM	IBM	IBM
5340-XX5	5360-AX1	5360-AX2	5362-X	5381- All Models
6	6	6	6	6
Captive	Captive	Captive	Captive	Captive
Fixed	Fixed	Fixed	Fixed	Fixed
210 mm OD 100 mm ID Oxide Coated	210 mm OD 100 mm ID Oxide Coated	210 mm OD 100 mm ID Oxide Coated	210 mm OD 100 mm ID Oxide Coated	210 mm OD 100 mm ID Oxide Coated
Piccolo	Modified 3350	Modified 3350	Modified 3350	Piccolo
Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
IBM	IBM	IBM	IBM	IBM
(2 spindles)		(2 Spindles)		
F: 128.425984	F: 30.84	F: 61.69	F: 61.6	F: 64.520192
--	--	--	--	--
F: 16,384	F: 17,408	F: 17,408	F: 17,920	F: 16,384
11	4	4	4	11
1	1	1	1	1
359	443	443	886	359
450	523	523	1000	450
8530	6875 FRPI 10312 BPI 3151	6875 FRPI 10312 BPI 3151	6875 FRPI 10312 BPI 3151	8530
3125	3151	3151	3151	3125
Rotary, Voice Coil 27	Linear, Voice Coil 38	Linear, Voice Coil 38	Linear, Voice Coil 38	Rotary, Voice Coil 27
9.6	9.5	9.5	9.51	9.6
36.6	47.5	47.5	47.51	36.6
1031	1250	1250	1250	1031
1/79	7/83	7/83	1Q84	8/79
--	--	--	--	--
System/34	System/36 Embedded Servo	System/36 Embedded Servo	System/36 Embedded Servo	System/38 5381 Processor available with up to six disk spindles

MANUFACTURER	IBM	IBM	IBM	IBM	IBM
DRIVE	5525-040 5525-050	676	680	8101-A13	8130-A23 8130-B23 8140-A33 A43, A53 A63, A73
DISK/TREND GROUP	6	6	6	6	6
MARKET	Captive	OEM	OEM	Captive	Captive
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	210 mm OD	210 mm OD	210 mm OD	210 mm OD	210 mm OD
Recording medium	100 mm ID Oxide Coated	100 mm ID Oxide Coated	100 mm ID Oxide Coated	100 mm ID Oxide Coated	100 mm ID Oxide Coated
DRIVE: Technology type	Piccolo	Modified 3350	Piccolo	Piccolo	Piccolo
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	IBM	IBM	IBM	IBM	IBM
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	F: 64.520192	F: 31.8 U: 38.6	F: 64.5	F: 64.520192	F: 64.520192
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 16,384	F: 17,920 U: 21,700	F: 16,384	F: 16,384	F: 16,384
Data surfaces per spindle	11	4	11	11	11
Heads per data surface	1	1	1	1	1
Tracks per surface	359	445	358	359	359
Track density (TPI)	450	523	450	450	450
Maximum linear density (BPI)	8530	6875 FRPI 10312 BPI	8530	8530	8530
Rotational speed (RPM)	3125	3151	3125	3125	3125
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Linear, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Average positioning time (msec)	27	38	27	27	27
Average rotational delay (msec)	9.6	9.51	9.6	9.6	9.6
Average access time (msec)	36.6	47.51	36.6	36.6	36.6
Data transfer rate (KBytes/sec)	1031	1250	1031	1031	1031
FIRST CUSTOMER SHIPMENT	11/80	12/82	1/82	3Q79	3Q79
U.S. OEM PRICE FOR 100 UNITS	--	\$2,750	\$4,375	--	--
COMMENTS	5520 Admin. System -050 Model is Dual Spindle	Embedded Servo	Embedded Servo	8100 System	8100 System



## SPEC-59

MANUFACTURER	IBM	IBM	IBM	IBM	IBM
DRIVE	8130-A24 8130-B24 8140-A34 A44, A54 A64, A74	8140-B51 B61 B71	8140-B52 B62 B72	3344-B2 3344-B2F	4967-2CA 4967-2CB
DISK/TREND GROUP	6	6	6	7	7
MARKET	Captive	Captive	Captive	Captive	Captive
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	210 mm OD 100 mm ID	210 mm OD 100 mm ID	210 mm OD 100 mm ID	14"	14"
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	Piccolo	Piccolo	Piccolo	3350	Modified 3350
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	IBM	IBM	IBM	IBM	IBM
CAPACITY/RECORDING DENSITY	.131072 MB Fixed Heads	.131072 MB Fixed Heads	.131072 MB Fixed Heads (2 spindles)	1.004 MB Fixed Head Option	
Total capacity (MBytes) FIXED	F: 58.654720	F: 58.654720	F: 123.174912	F: 279.558	F: 200.202
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 16,384	F: 16,384	F: 16,384	F: 16,736	F: 25,088
Data surfaces per spindle	11	11	11	15	7
Heads per data surface	1	1	1	2	2
Tracks per surface	359	359	359	1114	1140
Track density (TPI)	450	450	450	478	485
Maximum linear density (BPI)	8530	8530	8530	5636	9751
Rotational speed (RPM)	3125	3125	3125	2964	2964
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Linear, Voice Coil	Linear, Voice Coil
Average positioning time (msec)	27	27	27	25	25
Average rotational delay (msec)	9.6	9.6	9.6	10.1	10.1
Average access time (msec)	36.6	36.6	36.6	35.1	35.1
Data transfer rate (KBytes/sec)	1031	1031	1031	885	1500
FIRST CUSTOMER SHIPMENT	3Q79	4Q80	4Q80	2Q76	7/83
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	--
COMMENTS	8100 System	8100 System	8100 System	System/370 System/3 303X Series 4341 Drive has two spindles	Series/1 384 KB Cache

MANUFACTURER	IBM	IBM	IBM	IBM	IBM
DRIVE	5360-BX3	3350-A2 3350-B2 3350-C2	3370-A1 3370-A11 3370-B1 3370-B11	3370-A02 3370-A12 3370-B02 3370-B12	3375-A1 3375-B1 3375-D1
DISK/TREND GROUP	7	8	9	9	9
MARKET	Captive	Captive	Captive	Captive	Captive
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	14"	14"	14"	14"	14"
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	Modified 3350	3350	3370	3370	3370
Heads	Ferrite	Ferrite	Thin Film	Thin Film	Thin Film
Interface	IBM	IBM	IBM	IBM	IBM
CAPACITY/RECORDING DENSITY		1.144 MB Fixed Head Option	1.144 MB Fixed Head Option		
Total capacity (MBytes) FIXED	F: 200.202	F: 317.5	F: 571.392	F: 729.858	F: 819.7
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 25,088	F: 19,069	F: 31,744	F: 31,744	F: 35,616
Data surfaces per spindle	7	15	12	12	12
Heads per data surface	2	2	2	2	2
Tracks per surface	1140	1110	1500	1916	1918
Track density (TPI)	485	478	635	800	800
Maximum linear density (BPI)	9751	6425	8128 FRPI 12134 BPI	8128 FRPI 12134 BPI	8128 FRPI 12134 BPI
Rotational speed (RPM)	2964	3600	2964	2964	2964
PERFORMANCE					
Actuator type	Linear, Voice Coil	Linear, Voice Coil	Dual, Linear, Voice Coil	Dual, Linear, Voice Coil	Dual, Linear, Voice Coil
Average positioning time (msec)	25	25	20	19	19
Average rotational delay (msec)	10.1	8.4	10.1	10.1	10.1
Average access time (msec)	35.1	33.4	30.1	29.1	29.1
Data transfer rate (KBytes/sec)	1500	1198	1859	1859	1859
FIRST CUSTOMER SHIPMENT	7/83	1Q76	10/79	2Q84	3Q81
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	--
COMMENTS	System/36 5360-BX4 uses 2 spindles, with total 400.4 MB	System/370 303X Series 43XX Drive has two spindles	43X1 Series System/38	4341 4361 4381 System/38	4331 4341 303X Series

## 1984 DISK/TREND REPORT

MANUFACTURER

DRIVE

DISK/TREND GROUP

MARKET

MEDIA: Generic type

Nominal disk diameter

Recording medium

DRIVE: Technology type

Heads

Interface

CAPACITY/RECORDING DENSITY

Total capacity (MBytes) FIXED

REMOVABLE

Capacity per track (Bytes)

Data surfaces per spindle

Heads per data surface

Tracks per surface

Track density (TPI)

Maximum linear density (BPI)

Rotational speed (RPM)

PERFORMANCE

Actuator type

Average positioning time (msec)

Average rotational delay (msec)

Average access time (msec)

Data transfer rate (KBytes/sec)

FIRST CUSTOMER SHIPMENT

U.S. OEM PRICE FOR 100 UNITS

COMMENTS

	IBM	INTERNATIONAL MEMORIES, INC.	INTERNATIONAL MEMORIES, INC.	INTERNATIONAL MEMORIES, INC.	INTERNATIONAL MEMORIES, INC.
	3380-A4 3380-AA4 3380-B4	2306H	2312H	5006H	5012H
	9	5	5	5	5
	Captive, OEM	OEM	OEM	OEM	OEM
	Fixed	Fixed	Fixed	Fixed	Fixed
	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
	Oxide Coated	Plated	Plated	Plated	Plated
	3380	Modified 3350	Modified 3350	Modified 3350	Modified 3350
	Thin Film	Ferrite	Ferrite	Ferrite	Ferrite
	IBM	ST506	ST506	ST506	ST506
	F: 1,260.4878	U: 6.38	U: 12.75	U: 6.38	U: 12.76
	--	--	--	--	--
	F: 47,476	U: 10,417	U: 10,417	U: 10,416	U: 10,416
	15	2	4	2	4
	2	1	1	1	1
	1770	306	306	306	306
	800	303	303	303	303
	10160 FRPI 15240 BPI	9706	9706	9706	9706
	3620	3600	3600	3600	3600
	Dual, Linear, Voice Coil	Band, Stepping Motor 85 (including settling)	Band, Stepping Motor 85 (including settling)	Band, Stepping Motor 68 (including settling)	Band, Stepping Motor 68 (including settling)
	16	8.3	8.3	8.3	8.3
	8.3	8.3	8.3	8.3	8.3
	24.3	93.3	93.3	76.3	76.3
	3000	625	625	625	625
	4Q81	6/84	6/84	6/82	6/82
	--	\$450	\$550	\$500	\$600
	303X Series 370/158, 158-3 370/168, 168-3	1.625" High	1.625" High		
	Drive has two spindles				

MANUFACTURER	INTERNATIONAL MEMORIES, INC.	INTERNATIONAL MEMORIES, INC.	INTERNATIONAL MEMORIES, INC.	INTERNATIONAL MEMORIES, INC.	INTERNATIONAL MEMORIES, INC.
DRIVE	5018H	5612H	5624H	5636H	5650H
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	130 mm OD	130 mm OD	130 mm OD	130 mm OD
Recording medium	40 mm ID Plated	40 mm ID Plated	40 mm ID Plated	40 mm ID Plated	40 mm ID Plated
DRIVE: Technology type	Modified 3350	Modified 3350	Modified 3350	Modified 3350	Modified 3350
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	ST506	ST506	ST506	ST506	ST506
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 19.14	U: 12.76	U: 25.52	U: 38.28	U: 51.0
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 10,416	U: 10,417	U: 10,417	U: 10,417	U: 10,417
Data surfaces per spindle	6	2	4	6	8
Heads per data surface	1	1	1	1	1
Tracks per surface	306	612	612	612	612
Track density (TPI)	303	606	606	606	606
Maximum linear density (BPI)	9706	9824	9824	9824	9824
Rotational speed (RPM)	3600	3557	3557	3557	3557
PERFORMANCE					
Actuator type	Band, Stepping Motor 68 (including settling)	Band, Stepping Motor 49 (including settling)	Band, Stepping Motor 49 (including settling)	Band, Stepping Motor 49 (including settling)	Band, Stepping Motor 49 (including settling)
Average positioning time (msec)	8.3	8.4	8.4	8.4	8.4
Average rotational delay (msec)	76.3	57.4	57.4	57.4	57.4
Average access time (msec)	625	625	625	625	625
Data transfer rate (KBytes/sec)	6/82	1/85	1/85	1/85	1/85
FIRST CUSTOMER SHIPMENT					
U.S. OEM PRICE FOR 100 UNITS	\$700	\$625	\$850	\$975	\$1100
COMMENTS					

MANUFACTURER	ISOT	ISOT	ISOT	ISOT	ISOT
DRIVE	ES 5061	CM 5400-00 CM 5400-01	CM 5400-02 CM 5400-03	CM 5410	CM 5412
DISK/TREND GROUP	--	1	1	1	3
MARKET	OEM	OEM	OEM	Captive OEM	OEM
MEDIA: Generic type	2316	5440	5440	5440	SMD
Nominal disk diameter	14"	14"	14"	14"	14"
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	2314	2314	2314	2314	3330-11
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface		Various Options	Various Options	Various Options	SMD
CAPACITY/RECORDING DENSITY				--	--
Total capacity (MBytes) FIXED	--	U: 3.125	--	U: 5.75	
REMOVABLE	F: 29	U: 3.125	U: 3.125	U: 5.75	U: 80
Capacity per track (Bytes)	F: 7,294	U: 7,812	U: 7,812	U: 7,812	U: 20,160
Data surfaces per spindle	20	4	4	4	5
Heads per data surface	1	1	1	1	1
Tracks per surface	203	204	204	406	823
Track density (TPI)	100	100	100	200	400
Maximum linear density (BPI)	2200	2200	2200	2200	6060
Rotational speed (RPM)	2400	2400/1500	2400/1500	2400/1500	2400/3600
PERFORMANCE					
Actuator type	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil
Average positioning time (msec)	50	50	50	50	45
Average rotational delay (msec)	12.5	12.5/20	12.5/20	12.5	12.5/8.3
Average access time (msec)	62.5	62.5/70	62.5/70	62.5	57.5/53.3
Data transfer rate (KBytes/sec)	312	312/195	312/195	312/195	806/1209
FIRST CUSTOMER SHIPMENT	1976	1979	1979	1982	1983
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	--
COMMENTS					

MANUFACTURER	ISOT	ISOT	JOSEPHINE COUNTY TECHNOLOGY	JOSEPHINE COUNTY TECHNOLOGY	JOSEPHINE COUNTY TECHNOLOGY
DRIVE	ES 5066 ES 5067.01 ES 5067.02	ES 5067	JCT-100	JCT-105	JCT-110
DISK/TREND GROUP	4	4	5	5	5
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	3336-1	3336-11	Fixed	Fixed	Fixed
Nominal disk diameter	14"	14"	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	3330-1	3330-11	Modified 3350	Modified 3350	Modified 3350
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface			ST506	ST506	ST506
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	--	--	U: 5.2	U: 6.8	U: 12.56
REMOVABLE	F: 100	F: 200	--	--	--
Capacity per track (Bytes)	F: 13,030	F: 13,030	U: 11,504	U: 11,504	U: 11,504
Data surfaces per spindle	19	19	2	2	4
Heads per data surface	1	1	1	1	1
Tracks per surface	411	815	226	306	306
Track density (TPI)	192	370	200	270	270
Maximum linear density (BPI)	4040	4040	7690	7690	7690
Rotational speed (RPM)	3600	3600	3600	3600	3600
PERFORMANCE					
Actuator type	Linear, Voice Coil	Linear, Voice Coil	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor
Average positioning time (msec)	30	30	110 (including settling)	150 (including settling)	150 (including settling)
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	38.3	38.3	118.3	158.3	158.3
Data transfer rate (KBytes/sec)	806	806	625	625	625
FIRST CUSTOMER SHIPMENT	1980	1981	6/84	9/84	2/85
U.S. OEM PRICE FOR 100 UNITS	--	--	\$336	\$408	\$470
COMMENTS			1.625" High	1.625" High	1.625" High

## 1984 DISK/TREND REPORT

MANUFACTURER	KENNEDY	KENNEDY	KENNEDY	KENNEDY	KENNEDY
DRIVE	6172	5380	6173	7340	7380
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	210 mm OD	14"	210 mm OD	200 mm OD	200 mm OD
Recording medium	100 mm ID Oxide Coated	Oxide Coated	100 mm ID Oxide Coated	63.5 mm ID Oxide Coated	63.5 mm ID Oxide Coated
DRIVE: Technology type	3350	3350	3350	3350	3350
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	SMD, DISK BUS, ANSI X3T9/1226	SMD	SMD, DISK BUS, ANSI X3T9/1226	SMD, PICO, ANSI X3T9/1226	SMD, PICO, ANSI X3T9/1226
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 24.5	U: 82.9	U: 40.9	U: 41.4	U: 82.9
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 13,444	U: 20,160	U: 13,444	U: 20,160	U: 20,160
Data surfaces per spindle	3	5	5	5	5
Heads per data surface	1	2	1	1	1
Tracks per surface	600	823	600	411	823
Track density (TPI)	500	430	500	560	1120
Maximum linear density (BPI)	6542	6330	6542	9006	9006
Rotational speed (RPM)	3600	3000	3600	3600	3600
PERFORMANCE					
Actuator type	Linear, Voice Coil	Rotary, Voice Coil	Linear, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Average positioning time (msec)	40	30	40	30	30
Average rotational delay (msec)	8.3	10	8.3	8.3	8.3
Average access time (msec)	48.3	40	48.3	38.3	38.3
Data transfer rate (KBytes/sec)	800	1000	800	1209	1209
FIRST CUSTOMER SHIPMENT	4Q79	3Q81	4Q81	2Q82	1Q83
U.S. OEM PRICE FOR 100 UNITS	\$1,595	\$3,700	\$2,195	\$2,560	\$3,195
COMMENTS					

MANUFACTURER	KENNEDY	KENNEDY	LAPINE TECHNOLOGY	LAPINE TECHNOLOGY	MATSUSHITA COMMUNICATION INDUSTRIAL
DRIVE	53160	73160	3521	3522	JU-603
DISK/TREND GROUP	7	7	5	5	5
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	14"	200 mm OD 63.5 mm ID	96 mm OD 40 mm ID	96 mm OD 40 mm ID	130 mm OD 40 mm ID
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	3350	Modified 3350	Modified 3350	Modified 3350	Modified 3350
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	SMD	SMD, ANSI, KENNEDY	ST506	ST506	ST506
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 165.5	U: 165.9	U: 6.38	U: 12.75	U: 10.0
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 20,160	U: 20,160	U: 10,416	U: 10,416	U: 10,416
Data surfaces per spindle	5	10	2	4	6
Heads per data surface	2	1	1	1	1
Tracks per surface	1646	823	306	306	160
Track density (TPI)	680	800	600	600	256
Maximum linear density (BPI)	6330	9980	11200	11200	7900
Rotational speed (RPM)	3000	3600	3600	3600	3600
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Band, Stepping Motor	Rotary, Band, Stepping Motor	Band, Stepping Motor
Average positioning time (msec)	30	20	80 (including settling)	80 (including settling)	95 (including settling)
Average rotational delay (msec)	10	8.3	8.3	8.3	8.3
Average access time (msec)	40	28.3	88.3	88.3	103.3
Data transfer rate (KBytes/sec)	1000	1209	625	625	625
FIRST CUSTOMER SHIPMENT	4Q82	3Q84	1Q85	1Q85	1Q83
U.S. OEM PRICE FOR 100 UNITS	\$4,625	\$3795	--	--	--
COMMENTS			1.625" x 4.0" x 5.75"	1.625" x 4.0" x 5.75"	

1984 DISK/TREND REPORT



MANUFACTURER

DRIVE

DISK/TREND GROUP

MARKET

MEDIA: Generic type

Nominal disk diameter

Recording medium

DRIVE: Technology type

Heads

Interface

CAPACITY/RECORDING DENSITY

Total capacity (MBytes) FIXED

REMOVABLE

Capacity per track (Bytes)

Data surfaces per spindle

Heads per data surface

Tracks per surface

Track density (TPI)

Maximum linear density (BPI)

Rotational speed (RPM)

PERFORMANCE

Actuator type

Average positioning time (msec)

Average rotational delay (msec)

Average access time (msec)

Data transfer rate (KBytes/sec)

FIRST CUSTOMER SHIPMENT

U.S. OEM PRICE FOR 100 UNITS

COMMENTS

	MATSUSHITA COMMUNICATION INDUSTRIAL	MATSUSHITA COMMUNICATION INDUSTRIAL	MATSUSHITA COMMUNICATION INDUSTRIAL	MATSUSHITA COMMUNICATION INDUSTRIAL	MATSUSHITA COMMUNICATION INDUSTRIAL
	JU-614	JU-615	JU-616	JU-662	JU-664
	5	5	5	5	5
	OEM	OEM	OEM	OEM	OEM
	Fixed	Fixed	Fixed	Fixed	Fixed
	130 mm OD 40 mm ID Oxide Coated	130 mm OD 40 mm ID Oxide Coated	130 mm OD 40 mm ID Oxide Coated	130 mm OD 40 mm ID Oxide Coated	130 mm OD 40 mm ID Oxide Coated
	Modified 3350	Modified 3350	Modified 3350	Modified 3350	Modified 3350
	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
	ST506	ST506	ST506	ST506	ST506
	U: 13.3	U: 20.0	U: 26.6	U: 6.7	U: 13.3
	--	--	--	--	--
	U: 10,416	U: 10,416	U: 10,416	U: 10,416	U: 10,416
	4	6	8	2	4
	1	1	1	1	1
	320	320	320	320	320
	360	360	360	360	360
	9100	9100	9100	9036	9036
	3600	3600	3600	3600	3600
	Band, Stepping Motor 85 (including settling)	Band, Stepping Motor 85 (including settling)	Band, Stepping Motor 85 (including settling)	Band, Stepping Motor 87 (including settling)	Band, Stepping Motor 87 (including settling)
	8.3	8.3	8.3	8.3	8.3
	93.3	93.3	93.3	95.3	95.3
	--	--	--	625	625
	1Q84	1Q84	1Q84	3Q84	3Q84
	--	--	--	--	--
				1.625" High	1.625" High

MANUFACTURER	MAXTOR	MAXTOR	MAXTOR	MAXTOR	MAXTOR
DRIVE					
	EXT-4075	XT-1065	XT-2085	XT-1105	XT-1140
DISK/TREND GROUP	6	6	6	7	7
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID
Recording medium	Plated	Plated	Plated	Plated	Plated
DRIVE: Technology type	3370 (Ferrite)	3370 (Ferrite)	3370 (Ferrite)	3370 (Ferrite)	3370 (Ferrite)
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	ESDI	ST506	ST506	ST506	ST506
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 76.49	U: 66.99	U: 89.24	U: 105.27	U: 143.55
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 20,832	U: 10,416	U: 10,416	U: 10,416	U: 10,416
Data surfaces per spindle	3	7	7	11	15
Heads per data surface	1	1	1	1	1
Tracks per surface	1224	918	1224	918	918
Track density (TPI)	980	980	980	980	980
Maximum linear density (BPI)	22310 BPI 14873 FCI	9875	11155	9875	9875
Rotational speed (RPM)	3600	3600	3600	3600	3600
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Average positioning time (msec)	30	30	30	30	30
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	38.3	38.3	38.3	38.3	38.3
Data transfer rate (KBytes/sec)	1250	625	625	625	625
FIRST CUSTOMER SHIPMENT	4Q84	2Q83	3Q84	2Q83	2Q83
U.S. OEM PRICE FOR 100 UNITS	\$2,000	\$1,890	\$2,080	\$2,660	\$3,430
COMMENTS					

## 1984 DISK/TREND REPORT

MANUFACTURER	MAXTOR	MAXTOR	MAXTOR	MAXTOR	MAXTOR
DRIVE					
	XT-2140	XT-2190	EXT-4175	EXT-4280	EXT-4380
DISK/TREND GROUP	7	7	7	7	8
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	130 mm OD	130 mm OD	130 mm OD	130 mm OD	130 mm OD
Recording medium	40 mm ID Plated	40 mm ID Plated	40 mm ID Plated	40 mm ID Plated	40 mm ID Plated
DRIVE: Technology type	3370 (Ferrite)	3370 (Ferrite)	3370 (Ferrite)	3370 (Ferrite)	3370 (Ferrite)
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	ST506	ST506	ESDI	ESDI	ESDI
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 140.24	U: 191.24	U: 178.48	U: 280.48	U: 382.48
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 10,416	U: 10,416	U: 20,832	U: 20,832	U: 20,832
Data surfaces per spindle	11	15	7	11	15
Heads per data surface	1	1	1	1	1
Tracks per surface	1224	1224	1224	1224	1224
Track density (TPI)	980	980	980	980	980
Maximum linear density (BPI)	11155	11155	22310 BPI 14873 FCI	22310 BPI 14873 FCI	22310 BPI 14873 FCI
Rotational speed (RPM)	3600	3600	3600	3600	3600
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Average positioning time (msec)	30	30	30	30	30
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	38.3	38.3	38.3	38.3	38.3
Data transfer rate (KBytes/sec)	625	625	1250	1250	1250
FIRST CUSTOMER SHIPMENT	3Q84	3Q84	4Q84	4Q84	4Q84
U.S. OEM PRICE FOR 100 UNITS	\$2,930	\$3,775	\$3,550	\$4,960	\$6,165
COMMENTS					

MANUFACTURER

DRIVE

DISK/TREND GROUP

MARKET

MEDIA: Generic type

Nominal disk diameter

Recording medium

DRIVE: Technology type

Heads

Interface

CAPACITY/RECORDING DENSITY

Total capacity (MBytes) FIXED

REMOVABLE

Capacity per track (Bytes)

Data surfaces per spindle

Heads per data surface

Tracks per surface

Track density (TPI)

Maximum linear density (BPI)

Rotational speed (RPM)

PERFORMANCE

Actuator type

Average positioning time (msec)

Average rotational delay (msec)

Average access time (msec)

Data transfer rate (KBytes/sec)

FIRST CUSTOMER SHIPMENT

U.S. OEM PRICE FOR 100 UNITS

COMMENTS

	MEGAVULT	MEGAVULT	MEGAVULT	MEGAVULT	MEGAVULT
	MV83	MV83H	MV116	MV132	MV166H
	6	6	7	7	7
	OEM	OEM	OEM	OEM	OEM
	Fixed	Fixed	Fixed	Fixed	Fixed
	200 mm OD 63.5 mm ID Oxide Coated	200 mm OD 63.5 mm ID Oxide Coated	200 mm OD 63.5 mm ID Oxide Coated	200 mm OD 63.5 mm ID Oxide Coated	200 mm OD 63.5 mm ID Oxide Coated
	Modified 3350	Modified 3350	Modified 3350	Modified 3350	Modified 3350
	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
	SMD, SCSI	SMD, SCSI	SMD, SCSI	SMD, SCSI	SMD, SCSI
	U: 83.0	U: 83.0	U: 116.0	U: 132.0	U: 166.0
	--	--	--	--	--
	U: 20,160	U: 20,160	U: 20,160	U: 20,160	U: 20,160
	5	8	7	5	8
	1	1	1	1	1
	823	515	823	1316	1024
	600	960	600	960	960
	8850 FRPI 11500 BPI 3600	8850 FRPI 11500 BPI 3600	8850 FRPI 11500 BPI 3600	8850 FRPI 11500 BPI 3600	8850 FRPI 11500 BPI 3600
	Rotary, Voice Coil 38	Rotary, Voice Coil 27	Rotary, Voice Coil 38	Rotary, Voice Coil 38	Rotary, Voice Coil 30
	8.3	8.3	8.3	8.3	8.3
	46.3	35.3	46.3	46.3	38.3
	1209	1209	1209	1209	1209
	4/82	1984	4/82	7/82	1984
	\$3,190	--	\$3,450	\$3,320	--

1984 DISK/TREND REPORT

MANUFACTURER

DRIVE

DISK/TREND GROUP

MARKET

MEDIA: Generic type

Nominal disk diameter

Recording medium

DRIVE: Technology type

Heads

Interface

CAPACITY/RECORDING DENSITY

Total capacity (MBytes) FIXED

REMOVABLE

Capacity per track (Bytes)

Data surfaces per spindle

Heads per data surface

Tracks per surface

Track density (TPI)

Maximum linear density (BPI)

Rotational speed (RPM)

PERFORMANCE

Actuator type

Average positioning time (msec)

Average rotational delay (msec)

Average access time (msec)

Data transfer rate (KBytes/sec)

FIRST CUSTOMER SHIPMENT

U.S. OEM PRICE FOR 100 UNITS

COMMENTS

	MEGAVULT	MEGAVULT	MEGAVULT	MEGAVULT	MEMOREX
	MV186	MV212	MVP132 PRAM	MVP212 PRAM	410
	7	7	7	7	1
	OEM	OEM	OEM	OEM	OEM
	Fixed	Fixed	Fixed	Fixed	5.25" Cartridge
	200 mm OD 63.5 mm ID Oxide Coated	200 mm OD 63.5 mm ID Oxide Coated	200 mm OD 63.5 mm ID Oxide Coated	200 mm OD 63.5 mm ID Oxide Coated	130 mm OD 40 mm ID Oxide Coated
	Modified 3350	Modified 3350	Modified 3350	Modified 3350	Modified 3350
	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
	SMD, SCSI	SMD, SCSI	SMD, ANSI, SCSI	SMD, ANSI, SCSI	ST 506
	U: 186.0	U: 212.0	U: 132.0	U: 212.0	U: 6.75
	--	--	--	--	U: 6.75
	U: 20,160	U: 20,160	U: 20,160	U: 20,160	U: 10,560
	7	8	8	8	4
	1	1	1	1	1
	1316	1316	823	1316	320
	960	960	600	960	454
	8850 FRPI 11500 BPI 3600	8850 FRPI 11500 BPI 3600	8850 FRPI 11500 BPI 3600	8850 FRPI 11500 BPI 3600	8617 3443
	Rotary, Voice Coil 38	Rotary, Voice Coil 38	Rotary, Voice Coil 38	Rotary, Voice Coil 38	Linear, Voice Coil 40
	8.3	8.3	8.3	8.3	8.7
	46.3	46.3	46.3	46.3	48.7
	1209	1209	4825 (4 tracks)	4825 (4 tracks)	625
	8/83	8/83	7/82	11/83	1982
	\$3,630	\$4,020	\$7,500	\$8,500	\$1,660
			4 Track parallel data transfer	4 Track parallel data transfer	Embedded Servo Licensed From DMA Systems

MANUFACTURER	MEMOREX	MEMOREX	MEMOREX	MEMOREX	MEMOREX
DRIVE					
	450	102	321	322	323
DISK/TREND GROUP	2	5	5	5	5
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	5.25" Cartridge	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	130 mm OD 40 mm ID	200 mm OD 100 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	Modified 3350	3340	Modified 3350	Modified 3350	Modified 3350
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	ST 506	SA4000	ST506	ST506	ST506
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	--	U: 23.4	U: 6.66	U: 13.33	U: 20.0
REMOVABLE	U: 12.75	--	--	--	--
Capacity per track (Bytes)	U: 10,416	U: 12,000	U: 10,416	U: 10,416	U: 10,416
Data surfaces per spindle	2	8	2	4	6
Heads per data surface	1	1	1	1	1
Tracks per surface	612	244	320	320	320
Track density (TPI)	612	195	298	298	298
Maximum linear density (BPI)	10894	6100	10,200	10,200	10,200
Rotational speed (RPM)	3473	2964	3600	3600	3600
PERFORMANCE					
Actuator type	Rack & Pinion, Stepping Motor 98 (including settling)	Band, Stepping Motor 70 (including settling)	Rotary, Stepping Motor 95 (including settling)	Rotary, Stepping Motor 95 (including settling)	Rotary, Stepping Motor 95 (including settling)
Average positioning time (msec)	8.6	10.1	8.3	8.3	8.3
Average rotational delay (msec)	106.6	80.1	103.3	103.3	103.3
Average access time (msec)	625	593	625	625	625
Data transfer rate (KBytes/sec)					
FIRST CUSTOMER SHIPMENT	1Q85	1Q81	1Q83	1Q83	2Q83
U.S. OEM PRICE FOR 100 UNITS	\$960	\$1,700	\$645	\$775	\$905
COMMENTS	1.625" High Embedded Servo  Licensed from DMA Systems	Manufactured by Fujitsu	Mfg. by Nippon Peripherals	Mfg. by Nippon Peripherals	Mfg. by Nippon Peripherals

SPEC-73

MANUFACTURER

DRIVE

DISK/TREND GROUP

MARKET

MEDIA: Generic type

Nominal disk diameter

Recording medium

DRIVE: Technology type

Heads

Interface

CAPACITY/RECORDING DENSITY

Total capacity (MBytes) FIXED

REMOVABLE

Capacity per track (Bytes)

Data surfaces per spindle

Heads per data surface

Tracks per surface

Track density (TPI)

Maximum linear density (BPI)

Rotational speed (RPM)

PERFORMANCE

Actuator type

Average positioning time (msec)

Average rotational delay (msec)

Average access time (msec)

Data transfer rate (KBytes/sec)

FIRST CUSTOMER SHIPMENT

U.S. OEM PRICE FOR 100 UNITS

COMMENTS

MEMOREX	MEMOREX	MEMOREX	MEMOREX	MEMOREX
324	214	233	512	513
5	6	6	6	6
OEM	OEM	OEM	OEM	OEM
Fixed	Fixed	Fixed	Fixed	Fixed
130 mm OD 40 mm ID Oxide Coated	200 mm OD 100 mm ID Oxide Coated	210 mm OD 100 mm ID Oxide Coated	130 mm OD 40 mm ID Oxide Coated	130 mm OD 40 mm ID Oxide Coated
Modified 3350	Modified 3350	Modified 3350	Modified 3350	Modified 3350
Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
ST506	SMD	SMD	ST506	ST506
U: 26.66	U: 85.439	U: 83.0	U: 30.03	U: 50.05
--	--	--	--	--
U: 10,416	U: 20,480	U: 20,160	U: 10,416	U: 10,416
8	7	5	3	5
1	1	1	1	1
320	589	823	961	961
298	720	900	970	970
10,200	9550	6000 FCI 9000 BPI	9912	9912
3600	3600	3600	3600	3600
Rotary, Stepping Motor 95 (including settling)	Rotary, Voice Coil 20	Rotary, Voice Coil 30	Linear, Voice Coil 21	Linear, Voice Coil 21
8.3	8.3	8.3	8.3	8.3
103.3	28.3	38.3	29.3	29.3
625	1229	1209	625	625
4Q83	7/82	3Q84	3Q84	3Q84
\$1,035	\$3,675	\$2,590	\$1,680	\$2,005
Mfg. by Nippon Peripherals	Manufactured by Fujitsu	Manufactured by Toshiba		

1984 DISK/TREND REPORT

MANUFACTURER	MEMOREX	MEMOREX	MEMOREX	MEMOREX	MEMOREX
DRIVE	514	234	236	3650-A2 3650-B2 3650-C2	3652-A2 3652-B2 3652-C2
DISK/TREND GROUP	6	7	7	9	9
MARKET	OEM	OEM	OEM	PCM	PCM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	130 mm OD	210 mm OD	210 mm OD	14"	14"
Recording medium	40 mm ID Oxide Coated	100 mm ID Oxide Coated	100 mm ID Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	Modified 3350	Modifed 3350	Modifed 3350	3350	3350
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	ST506	SMD	SMD	IBM	IBM
CAPACITY/RECORDING DENSITY				1.144 MB Fixed Head Option	1.144 MB Fixed Head Option
Total capacity (MBytes) FIXED	U: 70.07	U: 116.1	U: 165.9	F: 317.5	F: 635.0
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 10,416	U: 20,160	U: 20,160	F: 19,069	F: 19,069
Data surfaces per spindle	7	7	10	15	15
Heads per data surface	1	1	1	2	2
Tracks per surface	961	823	823	1110	2220
Track density (TPI)	970	900	900	480	960
Maximum linear density (BPI)	9912	6000 FCI 9000 BPI	6000 FCI 9000 BPI	6425	6425
Rotational speed (RPM)	3600	3600	3600	3600	3600
PERFORMANCE					
Actuator type	Linear, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Linear, Voice Coil	Linear, Voice Coil
Average positioning time (msec)	21	30	30	25	25
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	29.3	38.3	38.3	33.3	33.3
Data transfer rate (KBytes/sec)	625	1209	1209	1198	1198
FIRST CUSTOMER SHIPMENT	3Q84	3Q84	3Q84	4Q77	3Q79
U.S. OEM PRICE FOR 100 UNITS	\$2,390	\$2,850	\$3,240	--	--
COMMENTS		Manufactured by Toshiba	Manufactured by Toshiba	PCM 3350	PCM 3350 Double Density



MANUFACTURER

DRIVE

DISK/TREND GROUP

MARKET

MEDIA: Generic type

Nominal disk diameter

Recording medium

DRIVE: Technology type

Heads

Interface

CAPACITY/RECORDING DENSITY

Total capacity (MBytes) FIXED  
REMOVABLE

Capacity per track (Bytes)

Data surfaces per spindle

Heads per data surface

Tracks per surface

Track density (TPI)

Maximum linear density (BPI)

Rotational speed (RPM)

PERFORMANCE

Actuator type

Average positioning time (msec)

Average rotational delay (msec)

Average access time (msec)

Data transfer rate (KBytes/sec)

FIRST CUSTOMER SHIPMENT

U.S. OEM PRICE FOR 100 UNITS

COMMENTS

MEMOREX	MEMOREX	MEMOREX	MEMOREX	MICROCOMPUTER MEMORIES
3680	3690	3695	680	M-106
9	9	9	9	5
PCM	PCM	PCM	OEM	OEM
Fixed	Fixed	Fixed	Fixed	Fixed
14"	14"	14"	14"	96 mm OD 40 mm ID Oxide/Plated
Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide/Plated
3380	3370 (Ferrite)	3370 (Ferrite)	3380	Modified 3350
Thin Film	Ferrite	Ferrite	Thin Film	Ferrite
IBM	IBM	IBM	IPI-3 (String)	ST506
F: 1260	F: 571.3	F: 819.7	U: 1320	U: 6.38
--	--	--	--	--
F: 47,476	F: 31,744	F: 35,616	U: 49,720	U: 10,416
15	12	12	15	2
2	2	2	2	1
1,768	1,500	1,918	1,772	306
806	635	810	806	588
15,240*	12,128*	12,128*	15,240*	10,943
3600	2964	2964	3600	3600
Dual Linear, Voice Coil 16	Dual Linear, Voice Coil 20	Dual, Linear, Voice Coil 19	Dual Linear, Voice Coil 16	Rack & Pinion, Stepping Motor 85 (including settling)
8.3	10.1	10.12	8.3	8.3
24.3	30.1	29.12	24.3	93.3
3000	1859	1859	3000	625
8/83	9/82	4Q83	2Q85	3/84
--	--	--	--	--
Drive Has One Spindle *RLL Code	PCM 3370 *RLL Code Mfg. By Nippon Peripherals	PCM 3375 *RLL Code Mfg. by Nippon Peripherals	Drive Has One Spindle *RLL Code	1.625" x 4.0" x 5.75". Also available in 5.25" Half High and Full Size Form Factor

MANUFACTURER	MICROCOMPUTER MEMORIES	MICROCOMPUTER MEMORIES	MICRODATA	MICRODATA	MICROPOLIS
DRIVE	M-112	M-125	4721 Reflex II	4722 Reflex II	1202
DISK/TREND GROUP	5	5	7	7	5
MARKET	OEM	OEM	Captive, OEM	Captive, OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	96 mm OD	96 mm OD	14"	14"	200 mm OD
Recording medium	40 mm ID Oxide/Plated	40 mm ID Oxide/Plated	Oxide Coated	Oxide Coated	63.5 mm ID Oxide Coated
DRIVE: Technology type	Modified 3350	Modified 3350	3350	3350	3350
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	ST506	ST506	SMD	SMD	Micropolis, ANSI
CAPACITY/RECORDING DENSITY			1.2 MB Fixed Head Option	1.2 MB Fixed Head Option	
Total capacity (MBytes) FIXED	U: 12.75	U: 25.5	U: 113.1	U: 158.3	U: 27.4
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 10,416	U: 10,416	U: 20,160	U: 20,160	U: 15,364
Data surfaces per spindle	4	8	5	7	3
Heads per data surface	1	1	2	2	1
Tracks per surface	306	306	1122	1122	595
Track density (TPI)	588	588	478	478	478
Maximum linear density (BPI)	10943	10943	6427	6427	5749 FRPI 8623 BPI
Rotational speed (RPM)	3600	3600	3530	3530	3600
PERFORMANCE					
Actuator type	Rack & Pinion, Stepping Motor	Rack & Pinion, Stepping Motor	Linear, Voice Coil	Linear, Voice Coil	Rotary, Voice Coil
Average positioning time (msec)	85 (including settling)	85 (including settling)	30	30	42
Average rotational delay (msec)	8.3	8.3	8.5	8.5	8.3
Average access time (msec)	93.3	93.3	38.5	38.5	50.3
Data transfer rate (KBytes/sec)	625	625	1175	1175	922
FIRST CUSTOMER SHIPMENT	3/84	1Q85	1979	1979	11/79
U.S. OEM PRICE FOR 100 UNITS			--	--	\$2,075
COMMENTS	1.625" x 4.0" x 5.75". Also available in 5.25" Half High and Full Size Form Factor				

## 1984 DISK/TREND REPORT

MANUFACTURER	MICROPOLIS	MICROPOLIS	MICROPOLIS	MICROPOLIS	MICROPOLIS
DRIVE					
	1221-MII	1222-MII	1302	1203	1223-MII
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	200 mm OD	200 mm OD	130 mm OD	200 mm OD	200 mm OD
Recording medium	63.5 mm ID Oxide Coated	63.5 mm ID Oxide Coated	40 mm ID Oxide Coated	63.5 mm ID Oxide Coated	63.5 mm ID Oxide Coated
DRIVE: Technology type	3350	3350	Modified 3350	3350	3350
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	Micropolis Intelligent	Micropolis Intelligent	ST506	Micropolis, ANSI	Micropolis Intelligent
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 8.911	U: 26.73	U: 25.9	U: 45.7	U: 44.56
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 15,360	U: 15,360	U: 10,416	U: 15,364	U: 15,360
Data surfaces per spindle	1	3	3	5	5
Heads per data surface	1	1	1	1	1
Tracks per surface	580	580	830	595	580
Track density (TPI)	478	478	960	478	478
Maximum linear density (BPI)	5749 FRPI	5749 FRPI	9077	5749 FRPI	5749 FRPI
Rotational speed (RPM)	8623 BPI 3600	8623 BPI 3600	3600	8623 BPI 3600	8623 BPI 3600
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Average positioning time (msec)	42	42	30	42	42
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	50.3	50.3	38.3	50.3	50.3
Data transfer rate (KBytes/sec)	922	922	625	922	922
FIRST CUSTOMER SHIPMENT	11/79	11/79	2Q83	11/79	11/79
U.S. OEM PRICE FOR 100 UNITS	\$2,048	\$2,481	\$1,415	\$2,490	\$2,896
COMMENTS					

MANUFACTURER	MICROPOLIS	MICROPOLIS	MICROPOLIS	MICROPOLIS	MICROPOLIS
DRIVE					
	1303	1304	1323	1324	1325
DISK/TREND GROUP	6	6	6	6	6
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	Modified 3350	Modified 3350	3370 (Ferrite)	3370 (Ferrite)	3370 (Ferrite)
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	ST506	ST506	ST506	ST506	ST506
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 43.2	U: 51.9	U: 42.7	U: 64.0	U: 85.3
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 10,416	U: 10,416	U: 10,416	U: 10,416	U: 10,416
Data surfaces per spindle	5	6	4	6	8
Heads per data surface	1	1	1	1	1
Tracks per surface	830	830	1024	1024	1024
Track density (TPI)	960	960	1000	1000	1000
Maximum linear density (BPI)	9077	9077	9824	9824	9824
Rotational speed (RPM)	3600	3600	3600	3600	3600
PERFORMANCE					
Actuator type	Rotary, Voice Coil 30	Rotary, Voice Coil 30	Rotary, Voice Coil 28	Rotary, Voice Coil 28	Rotary, Voice Coil 28
Average positioning time (msec)	30	30	28	28	28
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	38.3	38.3	36.3	36.3	36.3
Data transfer rate (KBytes/sec)	625	625	625	625	625
FIRST CUSTOMER SHIPMENT	2Q83	2Q83	2Q84	2Q84	2Q84
U.S. OEM PRICE FOR 100 UNITS	\$1,565	\$1,675	\$1,600	\$1,800	\$1,980
COMMENTS					

## 1984 DISK/TREND REPORT

MANUFACTURER

DRIVE

DISK/TREND GROUP

MARKET

MEDIA: Generic type

Nominal disk diameter

Recording medium

DRIVE: Technology type

Heads

Interface

CAPACITY/RECORDING DENSITY

Total capacity (MBytes) FIXED

REMOVABLE

Capacity per track (Bytes)

Data surfaces per spindle

Heads per data surface

Tracks per surface

Track density (TPI)

Maximum linear density (BPI)

Rotational speed (RPM)

PERFORMANCE

Actuator type

Average positioning time (msec)

Average rotational delay (msec)

Average access time (msec)

Data transfer rate (KBytes/sec)

FIRST CUSTOMER SHIPMENT

U.S. OEM PRICE FOR 100 UNITS

COMMENTS

	MICROPOLIS	MICROPOLIS	MICROPOLIS	MICROPOLIS	MICROPOLIS
	1353	1403 SMD	1452	1354	1355
	6	6	6	7	7
	OEM	OEM	OEM	OEM	OEM
	Fixed	Fixed	Fixed	Fixed	Fixed
	130 mm OD 40 mm ID Plated	200 mm OD 63.5 mm ID Oxide Coated	200 mm OD 63.5 mm ID Oxide Coated	130 mm OD 40 mm ID Plated	130 mm OD 40 mm ID Plated
	3370 (Ferrite)	Modified 3350	3370 (Ferrite)	3370 (Ferrite)	3370 (Ferrite)
	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
	ESDI	SMD	SMD	ESDI	ESDI
	U: 85.3	U: 82.96	U: 82.96	U: 128.0	U: 170.6
	--	--	--	--	--
	U: 17,920	U: 20,160	U: 20,160	U: 17,920	U: 17,920
	4	5	2.5	6	8
	1	1	1/2	1	1
	1024	823	1646	1024	1024
	1000	960	1160	1000	1000
	19648	9287	12899	19648	19648
	3600	3600	3600	3600	3600
	Rotary, Voice Coil 25	Rotary, Voice Coil 20	Rotary, Voice Coil 20	Rotary, Voice Coil 25	Rotary, Voice Coil 25
	8.3	8.3	8.3	8.3	8.3
	33.3	28.3	28.3	33.3	33.3
	1250	1209	1209	1250	1250
	2Q85	3Q83	4Q84	2Q85	2Q85
	\$2,000	\$2,517	\$2,443(500)	\$2,250	\$2,475

MANUFACTURER

DRIVE

DISK/TREND GROUP

MARKET

MEDIA: Generic type

Nominal disk diameter

Recording medium

DRIVE: Technology type

Heads

Interface

CAPACITY/RECORDING DENSITY

Total capacity (MBytes) FIXED

REMOVABLE

Capacity per track (Bytes)

Data surfaces per spindle

Heads per data surface

Tracks per surface

Track density (TPI)

Maximum linear density (BPI)

Rotational speed (RPM)

PERFORMANCE

Actuator type

Average positioning time (msec)

Average rotational delay (msec)

Average access time (msec)

Data transfer rate (KBytes/sec)

FIRST CUSTOMER SHIPMENT

U.S. OEM PRICE FOR 100 UNITS

COMMENTS

MICROPOLIS	MICROPOLIS	MICROPOLIS	MICROSCIENCE INTERNATIONAL	MICROSCIENCE INTERNATIONAL
1406 SMD	1453	1456	HH-312	HH-612
7	7	8	5	5
OEM	OEM	OEM	OEM	OEM
Fixed	Fixed	Fixed	Fixed	Fixed
200 mm OD 63.5 mm ID Oxide Coated	200 mm OD 63.5 mm ID Oxide Coated	200 mm OD 63.5 mm ID Oxide Coated	95 mm OD 25 mm ID Plated	130 mm OD 40 mm ID Plated
Modified 3350	3370 (Ferrite)	3370 (Ferrite)	Modified 3350	Modified 3350
Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
SMD	SMD	SMD	ST506	ST506
U: 165.9	U: 165.92	U: 331.8	U: 12.76	U: 12.76
--	--	--	--	--
U: 20,160	U: 20,160	U: 20,160	U: 10,416	U: 10,416
10	5	10	4	2
1	2	2	1	2
823	1646	1646	306	612
960	1160	1160	648	648
9287	12899	12899	11000	9680
3600	3600	3600	3550	3550
Rotary, Voice Coil 20	Rotary, Voice Coil 20	Rotary, Voice Coil 20	Band, Stepping Motor 70 (including settling)	Band, Stepping Motor 70 (including settling)
8.3	8.3	8.3	8.45	8.45
28.3	28.3	28.3	78.45	78.45
1209	1209	1209	625	625
3Q83	4Q84	4Q84	6/84	9/83
\$3,203	\$3,095(500)	\$3,700(500)	\$850	\$540
			1.625" High Embedded Servo	1.625" High Embedded Servo

1984 DISK/TREND REPORT

MANUFACTURER	MICROSCIENCE INTERNATIONAL	MINISCRIBE	MINISCRIBE	MINISCRIBE	MINISCRIBE
DRIVE					
	HH-725	2012	3012	3212	3412
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	130 mm OD	130 mm OD	130 mm OD	130 mm OD
Recording medium	40 mm ID Plated	40 mm ID Oxide Coated	40 mm ID Plated	40 mm ID High Dens.Oxide	40 mm ID Plated
DRIVE: Technology type	Modified 3350	Modified 3350	Modified 3350	Modified 3350	Modified 3350
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	ST506	ST506	ST506	ST506	ST506
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 25.52	U: 12.8	U: 12.8	U: 12.8	U: 12.8
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 10,416	U: 10,416	U: 10,416	U: 10,416	U: 10,416
Data surfaces per spindle	4	4	2	2	2
Heads per data surface	2	1	1	1	2
Tracks per surface	612	306	612	612	612
Track density (TPI)	648	402	588	588	588
Maximum linear density (BPI)	9680	8280	1000	10030	10426
Rotational speed (RPM)	3550	3600	3600	3600	3600
PERFORMANCE					
Actuator type	Band, Stepping Motor	Rack & Pinion, Stepping Motor	Rack & Pinion, Stepping Motor	Rack & Pinion, Stepping Motor	Rack & Pinion, Stepping Motor
Average positioning time (msec)	80 (including settling)	85 (including settling)	155 (including settling)	85 (including settling)	60 (including settling)
Average rotational delay (msec)	8.45	8.3	8.3	8.3	8.3
Average access time (msec)	88.45	93.3	163.3	93.3	68.3
Data transfer rate (KBytes/sec)	625	625	625	625	625
FIRST CUSTOMER SHIPMENT	6/84	7/82	2Q83	1Q84	5/84
U.S. OEM PRICE FOR 100 UNITS	\$850	\$640	\$602	\$602	\$636
COMMENTS	1.625" High Embedded Servo		1.625" High	1.625" High	1.625" High

MANUFACTURER

DRIVE

DISK/TREND GROUP

MARKET

MEDIA: Generic type

Nominal disk diameter

Recording medium

DRIVE: Technology type

Heads

Interface

CAPACITY/RECORDING DENSITY

Total capacity (MBytes) FIXED

REMOVABLE

Capacity per track (Bytes)

Data surfaces per spindle

Heads per data surface

Tracks per surface

Track density (TPI)

Maximum linear density (BPI)

Rotational speed (RPM)

PERFORMANCE

Actuator type

Average positioning time (msec)

Average rotational delay (msec)

Average access time (msec)

Data transfer rate (KBytes/sec)

FIRST CUSTOMER SHIPMENT

U.S. OEM PRICE FOR 100 UNITS

COMMENTS

MINISCRIBE	MINISCRIBE	MITSUBISHI ELECTRIC CORPORATION	MITSUBISHI ELECTRIC CORPORATION	MITSUBISHI ELECTRIC CORPORATION
3425	4020	M2860-1	MR521	MR522
5	5	5	5	5
OEM	OEM	OEM	OEM	OEM
Fixed	Fixed	Fixed	Fixed	Fixed
130 mm OD 40 mm ID High Dens.Oxide	130 mm OD 40 mm ID Oxide Coated	200 mm OD 63.5 mm ID Oxide Coated	130 mm OD 40 mm ID Plated	130 mm OD 40 mm ID Plated
Modified 3350	Modified 3350	3330-11	Modified 3350	Modified 3350
Ferrite	Ferrite	Ferrite Trident, SMD, SA1000	Ferrite	Ferrite
ST506	ST506		ST506	ST506
U: 25.5	U: 20.0	U: 21.73	U: 12.75	U: 25.5
--	--	--	--	--
U: 10,416	U: 10,416	U: 13,440	U: 10,416	U: 10,416
4	4	3	2	4
1	1	1	1	1
612	480	549	612	612
588	588	480	690	690
10030	8575	7300	9201	9201
3600	3600	3600	3536	3536
Rack & Pinion, Stepping Motor 85 (including settling)	Rack & Pinion, Stepping Motor 133 (including settling)	Linear, Voice Coil 35	Band, Stepping Motor 85 (including settling)	Band, Stepping Motor 85 (including settling)
8.3	8.3	8.3	8.48	8.48
93.3	141.3	43.3	93.48	93.48
625	625	806	625	625
8/84	8/82	1981	4/84	6/84
\$695	\$665	\$2,100	\$750	\$940
1.625" High			1.625" High	1.625" High



## MANUFACTURER

## DRIVE

## DISK/TREND GROUP

## MARKET

## MEDIA: Generic type

Nominal disk diameter

Recording medium

## DRIVE: Technology type

Heads

Interface

## CAPACITY/RECORDING DENSITY

Total capacity (MBytes) FIXED

REMOVABLE

Capacity per track (Bytes)

Data surfaces per spindle

Heads per data surface

Tracks per surface

Track density (TPI)

Maximum linear density (BPI)

Rotational speed (RPM)

## PERFORMANCE

Actuator type

Average positioning time (msec)

Average rotational delay (msec)

Average access time (msec)

Data transfer rate (KBytes/sec)

## FIRST CUSTOMER SHIPMENT

## U.S. OEM PRICE FOR 100 UNITS

## COMMENTS

	MITSUBISHI ELECTRIC CORPORATION	MITSUBISHI ELECTRIC CORPORATION	MITSUBISHI ELECTRIC CORPORATION	MITSUBISHI ELECTRIC CORPORATION	NEC
	MR532	M2860-2	M2860-3	M4870	N7745
	5	6	6	7	4
	OEM	OEM	Worldwide	OEM	Captive
	Fixed	Fixed	Fixed	Fixed	3336-11
	130 mm OD 40 mm ID Plated	200 mm OD 63.5 mm ID Oxide Coated	200 mm OD 63.5 mm ID Oxide Coated	210 mm OD 100 mm ID Oxide Coated	14" Oxide Coated
	Modified 3350	3330-11	Modified 3350	Modified 3350	3330-11
	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
	ST506	Trident, SMD, SA1000	SMD, Trident	SMD	NEC
	U: 25.5	U: 50.71	U: 85.37	U: 251.4	--
	--	--	--	--	F:200
	U: 10,416	U: 13,440	U: 20,160	U: 20,480	F: 13,030
	4	7	7	12	19
	2	1	1	1	1
	612	549	621	1023	815
	690	480	546	1000	370
	9201	7300	10900	10000	4040
	3536	3600	3600	3544	3600
	Band, Stepping Motor 65	Linear, Voice Coil 35	Linear, Voice Coil 30	Rotary, Voice Coil 20 (including settling)	Linear, Voice Coil 30
	8.48	8.3	8.3	8.47	8.3
	73.48	43.3	38.3	28.47	38.3
	625	806	1209	1209	806
	4/85	1981	9/82	4/84	11/75
	--	\$2,400	\$3,000	\$6,000	--
	1.625" High Embedded Servo				

MANUFACTURER	NEC	NEC	NEC	NEC	NEC
DRIVE	D2220	D2226 N7724	D5114	D5124	D5224
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	210 mm OD	210 mm OD	130 mm OD	130 mm OD	130 mm OD
Recording medium	100 mm ID Oxide Coated	100 mm ID Oxide Coated	40 mm ID Oxide Coated	40 mm ID Oxide Coated	40 mm ID Oxide Coated
DRIVE: Technology type	Modified 3350	Modified 3350	Modified 3350	Modified 3350	Modified 3350
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	SMD	SMD	ST506	ST506	ST506
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 25.5	U: 28.3	U: 6.45	U: 12.91	U: 12.91
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 20,480	U: 20,480	U: 10,416	U: 10,416	U: 10,416
Data surfaces per spindle	3	2	2	4	4
Heads per data surface	1	1	1	1	1
Tracks per surface	415	692	310	310	310
Track density (TPI)	480	720	350	350	350
Maximum linear density (BPI)	8800	9040	9000	9000	9000
Rotational speed (RPM)	3510	3510	3600	3600	3600
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Band, Stepping Motor	Band, Stepping Motor	Rotary, Stepping Motor
Average positioning time (msec)	25	25	85 (including settling)	85 (including settling)	85 (including settling)
Average rotational delay (msec)	8.55	8.55	8.3	8.3	8.3
Average access time (msec)	33.55	33.55	93.3	93.3	93.3
Data transfer rate (KBytes/sec)	1198	1198	625	625	625
FIRST CUSTOMER SHIPMENT	3/81	5/82	3/84	3/84	4/83
U.S. OEM PRICE FOR 100 UNITS	\$2,375	--	--	\$650	\$725
COMMENTS	--		1.625" High	1.625" High	

1984 DISK/TREND REPORT

MANUFACTURER

DRIVE

DISK/TREND GROUP

MARKET

MEDIA: Generic type

Nominal disk diameter

Recording medium

DRIVE: Technology type

Heads

Interface

CAPACITY/RECORDING DENSITY

Total capacity (MBytes) FIXED

REMOVABLE

Capacity per track (Bytes)

Data surfaces per spindle

Heads per data surface

Tracks per surface

Track density (TPI)

Maximum linear density (BPI)

Rotational speed (RPM)

PERFORMANCE

Actuator type

Average positioning time (msec)

Average rotational delay (msec)

Average access time (msec)

Data transfer rate (KBytes/sec)

FIRST CUSTOMER SHIPMENT

U.S. OEM PRICE FOR 100 UNITS

COMMENTS

MANUFACTURER	NEC	NEC	NEC	NEC	NEC
DRIVE	D5244	D-1220 N7722	D-1245 N7723	D2230	D2236 N7725
DISK/TREND GROUP	5	6	6	6	6
MARKET	OEM	Captive, OEM	Captive, OEM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	130 mm OD 40 mm ID	14"	14"	210 mm OD 100 mm ID	210 mm OD 100 mm ID
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	Modified 3350	3350	3350	Modified 3350	Modified 3350
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	ST506	SMD	SMD	SMD	SMD
CAPACITY/RECORDING DENSITY		0.48/0.96 MB Fixed Head Option	0.48/0.96 MB Fixed Head Option		
Total capacity (MBytes) FIXED	U: 25.83	U: 41.5	U: 84.8	U: 42.5	U: 42.5
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 10,416	U: 19,968	U: 19,968	U: 20,480	U: 20,480
Data surfaces per spindle	8	2	4	5	3
Heads per data surface	1	2	2	1	1
Tracks per surface	310	1040	1040	415	692
Track density (TPI)	350	480	480	480	720
Maximum linear density (BPI)	9000	6370	6370	8800	9040
Rotational speed (RPM)	3600	3600	3600	3510	3510
PERFORMANCE					
Actuator type	Rotary, Stepping Motor 85 (including settling)	Rotary, Voice Coil 40	Rotary, Voice Coil 29	Rotary, Voice Coil 25	Rotary, Voice Coil 25
Average positioning time (msec)	8.3	8.3	8.3	8.55	8.55
Average rotational delay (msec)	93.3	48.3	37.3	33.55	33.55
Average access time (msec)	625	1198	1198	1198	1198
FIRST CUSTOMER SHIPMENT	5/83	9/78	9/80	3/81	5/82
U.S. OEM PRICE FOR 100 UNITS	\$875	--	--	\$2,475	--
COMMENTS				--	

MANUFACTURER	NEC	NEC	NEC	NEC	NEC
DRIVE	D2246 N7726	N2247	D1280	D2247E	D2257 N7729
DISK/TREND GROUP	6	6	7	7	7
MARKET	OEM, Captive	OEM	Captive	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	210 mm OD	210 mm OD	14"	210 mm OD	210 mm OD
Recording medium	100 mm ID Oxide Coated	100 mm ID Oxide Coated	Oxide Coated	100 mm ID Oxide Coated	100 mm ID Oxide Coated
DRIVE: Technology type	Modified 3350	Modified 3350	Modified 3350	Modified 3350	Modified 3350
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	SMD	SMD	SMD	SMD	SMD
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 85.0	U: 82.9	U: 180.6	U: 104.8	U: 167.7
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 20,480	U: 20,160	U: 19,968 F: 19,069	U: 20,480	U: 20,480
Data surfaces per spindle	6	5	6	5	8
Heads per data surface	1	1	2	1	1
Tracks per surface	692	823	1508	1024	1024
Track density (TPI)	720	960	680	960	720
Maximum linear density (BPI)	9040	8670	6400	9420	9420
Rotational speed (RPM)	3510	3600	3600	3510	3510
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Average positioning time (msec)	25	18.5	25	20	20
Average rotational delay (msec)	8.55	8.3	8.3	8.55	8.55
Average access time (msec)	33.55	26.8	33.3	28.55	28.55
Data transfer rate (KBytes/sec)	1198	1209	1198	1198	1198
FIRST CUSTOMER SHIPMENT	5/82	5/83	3/82	5/83	5/83
U.S. OEM PRICE FOR 100 UNITS	\$2,600	\$2,600	--	\$3200	\$3,675
COMMENTS					N7729 has two spindles per drive

1984 DISK/TREND REPORT

MANUFACTURER

DRIVE

DISK/TREND GROUP

MARKET

MEDIA: Generic type

Nominal disk diameter

Recording medium

DRIVE: Technology type

Heads

Interface

CAPACITY/RECORDING DENSITY

Total capacity (MBytes) FIXED

REMOVABLE

Capacity per track (Bytes)

Data surfaces per spindle

Heads per data surface

Tracks per surface

Track density (TPI)

Maximum linear density (BPI)

Rotational speed (RPM)

PERFORMANCE

Actuator type

Average positioning time (msec)

Average rotational delay (msec)

Average access time (msec)

Data transfer rate (KBytes/sec)

FIRST CUSTOMER SHIPMENT

U.S. OEM PRICE FOR 100 UNITS

COMMENTS

NEC	NEC	NEC	NEC	NEC
D-1510	JS4380N	N7751	D1550	D2351
8	8	8	9	9
OEM	Captive	Captive	OEM	OEM
Fixed	Fixed	Fixed	Fixed	Fixed
14"	210 mm OD 100 mm ID	14"	14"	230 mm OD 100 mm ID
Oxide Coated	Plated	Oxide Coated	Oxide Coated	Plated
3350	Modified 3350	3350	Modified 3350	Modified 3350
Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
SMD	Special	NEC	SMD	Modified SMD
1.19 MB Fixed Head Option	U: 402 Per Spindle	1.144 MB Fixed Head Option	1.19 MB Fixed Head Option	
U: 331.5	U: 3,200 Total	F: 317.5	U: 663.0	U: 520
--	--	--	--	--
U: 19,968	U: 25,520	F: 19,069	U: 19,968	U: 36,288
15	13	15	15	9.5
2	2	2	2	2/1
1122	1226	1122	2242	1520
480	1080	480	960	1000
6400	13840	6400	6400	18600
3600	3000	3600	3600	3070
Linear, Voice Coil	Rotary, Voice Coil	Linear, Voice Coil	Linear, Voice Coil	Rotary, Voice Coil
20	18	20	20	15
8.3	10	8.3	8.3	9.8
28.3	28	28.3	28.3	24.8
1200	1344	1198	1200	1860
5/78	3/82	12/77	1982	2Q84
--	--	--	--	\$8300
	8 spindles per drive			

MANUFACTURER	NEC	NEC	NEC	NEC	NEW WORLD COMPUTER COMPANY, INC.
DRIVE	N7755	N7756	N7761	N6329-21	5/5 Micro-Disc V
DISK/TREND GROUP	9	9	9	10	1
MARKET	Captive	Captive	Captive	Captive	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	3M Multilayer	Micro-Disc Cartridge
Nominal disk diameter	14"	230 mm OD 100 mm ID	14"	12"	130 mm OD 40 mm ID
Recording medium	Oxide Coated	Plated	Oxide Coated	Refractory	Plated
DRIVE: Technology type	Modified 3350	Modified 3350	3380	Write-Once Opt.	Special
Heads	Ferrite	Ferrite	Thin Film	Laser Diode	Ferrite
Interface	NEC	NEC	NEC	Mod. SASI	ST506
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	F: 635.0	F: 486.2	F: 630.0	--	F: 5.3
REMOVABLE	--	--	--	F:1,300	F: 5.3
Capacity per track (Bytes)	F: 19,069	F: 32,288	F: 49,950	F: 32,768	F: 8,192
Data surfaces per spindle	15	9.5	7	1	4
Heads per data surface	2	2/1	2	1	12
Tracks per surface	2244	1520	1800	40,000	312
Track density (TPI)	960	1000	820	15,200	325
Maximum linear density (BPI)	6400	18600	10133 FRPI 152600 BPI	23,000	9576
Rotational speed (RPM)	3600	3070	3600	900	3600
PERFORMANCE					
Actuator type	Linear, Voice Coil	Rotary, Voice Coil	Linear, Voice Coil	Linear, Voice Coil	Stepping Motor
Average positioning time (msec)	20	15	16	450	19.0 (including settling)
Average rotational delay (msec)	8.3	9.8	8.3	33.3	8.3
Average access time (msec)	28.3	24.8	24.3	483.3	27.3
Data transfer rate (KBytes/sec)	1198	1860	3000	810	625
FIRST CUSTOMER SHIPMENT	1979	3Q84	1983	1Q84	1Q84
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	-
COMMENTS		Drive has two spindles	4 spindles per drive		

MANUFACTURER

DRIVE

DISK/TREND GROUP

MARKET

MEDIA: Generic type  
 Nominal disk diameter  
 Recording medium

DRIVE: Technology type  
 Heads  
 Interface

CAPACITY/RECORDING DENSITY

Total capacity (MBytes) FIXED  
 REMOVABLE

Capacity per track (Bytes)  
 Data surfaces per spindle  
 Heads per data surface

Tracks per surface  
 Track density (TPI)  
 Maximum linear density (BPI)  
 Rotational speed (RPM)

PERFORMANCE

Actuator type  
 Average positioning time (msec)  
 Average rotational delay (msec)  
 Average access time (msec)  
 Data transfer rate (KBytes/sec)

FIRST CUSTOMER SHIPMENT

U.S. OEM PRICE FOR 100 UNITS

COMMENTS

NEWBURY DATA	NEWBURY DATA	NEWBURY DATA	NEWBURY DATA	NEWBURY DATA
505	D9427H	D9448-32	D9448-64	D9448-96
1	1	2	2	2
OEM	OEM	OEM	OEM	OEM
5.25" Cartridge	5440	CMD	CMD	CMD
130 mm OD 40 mm ID Oxide Coated	14" Oxide Coated	14" Oxide Coated	14" Oxide Coated	14" Oxide Coated
Modified 3350	2314	3330-11	3330-11	3330-11
Ferrite Modified SA 1000	Ferrite Various Options	Ferrite SMD	Ferrite SMD	Ferrite SMD
U: 6.75	U: 6.25	U: 16.289	U: 48.869	U: 81.446
U: 6.75	U: 6.25	U: 16.289	U: 16.289	U: 16.289
U: 10,890	U: 7,812	U: 20,160	U: 20,160	U: 20,160
4	4	1 Fixed 1 Removable	3 Fixed 1 Removable	5 Fixed 1 Removable
1	1	1	1	1
320	406	823	823	823
454	200	384	384	384
8737	2200	6038	6038	6038
3443	2400	3600	3600	3600
Linear, Voice Coil 40	Linear, Voice Coil 35	Linear, Voice Coil 30	Linear, Voice Coil 30	Linear, Voice Coil 30
8.7	12.5	8.3	8.3	8.3
48.7	47.5	38.3	38.3	38.3
625	312.5	1209	1209	1209
3083	1080	2081	2081	2081
--	--	--	--	--
Embedded servo Licensed from DMA Systems				

MANUFACTURER

DRIVE

DISK/TREND GROUP

MARKET

MEDIA: Generic type

Nominal disk diameter

Recording medium

DRIVE: Technology type

Heads

Interface

CAPACITY/RECORDING DENSITY

Total capacity (MBytes) FIXED

REMOVABLE

Capacity per track (Bytes)

Data surfaces per spindle

Heads per data surface

Tracks per surface

Track density (TPI)

Maximum linear density (BPI)

Rotational speed (RPM)

PERFORMANCE

Actuator type

Average positioning time (msec)

Average rotational delay (msec)

Average access time (msec)

Data transfer rate (KBytes/sec)

FIRST CUSTOMER SHIPMENT

U.S. OEM PRICE FOR 100 UNITS

COMMENTS

	NEWBURY DATA	NEWBURY DATA	NEWBURY DATA	NEWBURY DATA	NIPPON ELECTRIC INDUSTRY
	1065	9412	1105	1140	RD-2127
	6	6	7	7	5
	OEM	OEM	OEM	OEM	OEM
	Fixed	Fixed	Fixed	Fixed	Fixed
	130 mm OD 40 mm ID Plated	195 mm OD 100 mm ID Oxide Coated	130 mm OD 40 mm ID Plated	130 mm OD 40 mm ID Plated	130 mm OD 40 mm ID Oxide Coated
	3370 (Ferrite)	Modified 3350	3370 (Ferrite)	3370 (Ferrite)	Modified 3350
	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
	ST506	SMD	ST506	ST506	ST 506
	U: 66.93	U: 80.0	U: 105.18	U: 143.43	U: 12.7
	--	--	--	--	--
	U: 10,416	U: 20,736	U: 10,416	U: 10,416	U: 10,416
	7	5	11	15	2
	1	1	1	1	1
	918	784	918	918	612
	980	735	980	980	750
	9875	10161*	9875	9875	9000
	3600	3500	3600	3600	3600
	Rotary, Voice Coil 30	Rotary, Voice Coil 25	Rotary, Voice Coil 30	Rotary, Voice Coil 30	Band, Stepping Motor 85 (including settling)
	8.3	8.57	8.3	8.3	8.3
	38.3	33.57	38.3	38.3	93.3
	625	1209	625	625	625
	4Q84	5/83	4Q84	4Q84	1Q85
	--	--	--	--	--
	Licensed from Maxtor	*RLL Code	Licensed from Maxtor	Licensed from Maxtor	1.625" High

1984 DISK/TREND REPORT



MANUFACTURER	NIPPON ELECTRIC INDUSTRY	NIPPON ELECTRIC INDUSTRY	NIPPON ELECTRIC INDUSTRY	NIPPON ELECTRIC INDUSTRY	NIPPON ELECTRIC INDUSTRY
DRIVE	RD-2255	RD-4064	RD-4127	RD-4191	RD-4255
DISK/TREND GROUP	5	5	5	5	5
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	Modified 3350	Modified 3350	Modified 3350	Modified 3350	Modified 3350
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	ST 506	ST506	ST 506	ST 506	ST 506
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 25.5	U: 6.4	U: 12.7	U: 19.1	U: 25.5
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 10,416	U: 10,416	U: 10,416	U: 10,416	U: 10,416
Data surfaces per spindle	4	2	4	6	8
Heads per data surface	1	1	1	1	1
Tracks per surface	612	306	306	306	306
Track density (TPI)	750	400	400	400	400
Maximum linear density (BPI)	9000	8200	8200	8200	8200
Rotational speed (RPM)	3600	3600	3600	3600	3600
PERFORMANCE					
Actuator type	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor
Average positioning time (msec)	85 (including settling)	85 (including settling)	85 (including settling)	85 (including settling)	85 (including settling)
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	93.3	93.3	93.3	93.3	93.3
Data transfer rate (KBytes/sec)	625	625	625	625	625
FIRST CUSTOMER SHIPMENT	1Q85	7/83	7/83	7/83	7/83
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	--
COMMENTS	1.625" High				

MANUFACTURER	NIPPON ELECTRIC INDUSTRY	NIPPON PERIPHERALS LTD	NIPPON PERIPHERALS LTD	NIPPON PERIPHERALS LTD	NIPPON PERIPHERALS LTD
DRIVE	RD-4510	NPO2-6	NPO2-13	NPO3-13	NPO3-20
DISK/TREND GROUP	6	5	5	5	5
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	130 mm OD	130 mm OD	130 mm OD	95 mm OD	95 mm OD
Recording medium	40 mm ID Oxide Coated	40 mm ID Oxide Coated	40 mm ID Oxide Coated	25 mm ID Oxide Coated	25 mm ID Oxide Coated
DRIVE: Technology type	Modified 3350	Modified 3350	Modified 3350	Modified 3350	Modified 3350
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	ST 506	ST506	ST506	ST506	ST506
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 51.0	U: 6.67	U: 13.33	U: 13.33	U: 20.0
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 10,416	U: 10,416	U: 10,416	U: 10,416	U: 10,416
Data surfaces per spindle	8	2	4	4	6
Heads per data surface	1	1	1	1	1
Tracks per surface	612	320	320	320	320
Track density (TPI)	750	298	298	440	440
Maximum linear density (BPI)	9000	10200	10200	13500	13500
Rotational speed (RPM)	3600	3600	3600	3600	3600
PERFORMANCE					
Actuator type	Band, Stepping Motor	Rotary, Stepping Motor	Rotary, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor
Average positioning time (msec)	85 (including settling)	95 (including settling)	95 (including settling)	88 (including settling)	88 (including settling)
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	93.3	103.3	103.3	96.3	96.3
Data transfer rate (KBytes/sec)	625	625	625	625	625
FIRST CUSTOMER SHIPMENT	9/84	8/83	8/83	2/85	2/85
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	--
COMMENTS		1.625" High	1.625" High		

1984 DISK/TREND REPORT

MANUFACTURER	NIPPON PERIPHERALS LTD	NIPPON PERIPHERALS LTD	NIPPON PERIPHERALS LTD	NIPPON PERIPHERALS LTD	NIPPON PERIPHERALS LTD
DRIVE	NP03-6	NP04-13T	NP04-20G	NP04-20T	NP04-26F
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	130 mm OD	130 mm OD	130 mm OD	130 mm OD
Recording medium	25 mm ID Oxide Coated	40 mm ID Oxide Coated	40 mm ID Oxide Coated	40 mm ID Oxide Coated	40 mm ID Oxide Coated
DRIVE: Technology type	Modified 3350	Modified 3350	Modified 3350	Modified 3350	Modified 3350
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	ST506	ST506	SA4000	ST506	ST506
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 6.67	U: 13.33	20.0	U: 20.0	U: 26.66
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 10,416	U: 10,416	U: 10,416	U: 10,416	U: 10,416
Data surfaces per spindle	2	4	6	6	8
Heads per data surface	1	1	1	1	1
Tracks per surface	320	320	320	320	320
Track density (TPI)	440	298	298	298	298
Maximum linear density (BPI)	13500	10200	10200	10200	10200
Rotational speed (RPM)	3600	3600	3600	3600	3600
PERFORMANCE					
Actuator type	Band, Stepping Motor	Rotary, Stepping Motor	Rotary, Stepping Motor	Rotary, Stepping Motor	Rotary, Stepping Motor
Average positioning time (msec)	88 (including settling)	95 (including settling)	100 (including settling)	95 (including settling)	95 (including settling)
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	96.3	103.3	108.3	103.3	103.3
Data transfer rate (KBytes/sec)	625	625	625	625	625
FIRST CUSTOMER SHIPMENT	2/85	2/83	1983	2/83	5/83
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	--
COMMENTS					

MANUFACTURER

DRIVE

DISK/TREND GROUP

MARKET

MEDIA: Generic type

Nominal disk diameter

Recording medium

DRIVE: Technology type

Heads

Interface

CAPACITY/RECORDING DENSITY

Total capacity (MBytes) FIXED

REMOVABLE

Capacity per track (Bytes)

Data surfaces per spindle

Heads per data surface

Tracks per surface

Track density (TPI)

Maximum linear density (BPI)

Rotational speed (RPM)

PERFORMANCE

Actuator type

Average positioning time (msec)

Average rotational delay (msec)

Average access time (msec)

Data transfer rate (KBytes/sec)

FIRST CUSTOMER SHIPMENT

U.S. OEM PRICE FOR 100 UNITS

COMMENTS

	NIPPON PERIPHERALS LTD	NIPPON PERIPHERALS LTD	NIPPON PERIPHERALS LTD	NIPPON PERIPHERALS LTD	NIPPON PERIPHERALS LTD
	NP04-36	NP04-50	NP25-A2 NP25-B2 NP25-C2	NP37-A01 NP37-B01	NP75-A01 NP75-B01 NP75-C01
	6	6	8	9	9
	OEM	OEM	PCM	OEM, PCM	PCM
	Fixed	Fixed	Fixed	Fixed	Fixed
	130 mm OD 40 mm ID Plated	130 mm OD 40 mm ID Plated	14"  Oxide Coated	14"  Oxide Coated	14"  Oxide Coated
	Modified 3350	Modified 3350	3350	3370 (Ferrite)	3370 (Ferrite)
	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
	ST506	ST506	IBM	IBM, Special	IBM
			1.144 MB Fixed Head Option		
	U: 36.4	U: 50.9	F: 317.499	U: 680,988 F: 571.392	F: 819.7
	--	--	--	--	--
	U: 10,416	U: 10,416	F: 19,069	F: 31,744	F: 35,616
	5	7	15	12	12
	1	1	2	2	2
	699	699	1110	1500	1918
	754	754	480	635	810
	9375	9375	6425	12128*	12128*
	3600	3600	3600	2964	2964
	Rotary, Voice Coil 40 (including settling)	Rotary, Voice Coil 40 (including settling)	Linear, Voice Coil 20	Dual, Linear, Voice Coil 20	Dual, Linear, Voice Coil 19
	8.3	8.3	8.3	10.12	10.12
	48.3	48.3	28.3	30.12	29.12
	625	625	1198	1859	1859
	11/83	11/83	1977	1982	9/84
	--	--	--	--	--
			PCM 3350	PCM 3370 *RLL Code	PCM 3375 *RLL CODE

1984 DISK/TREND REPORT

## MANUFACTURER

## DRIVE

## DISK/TREND GROUP

## MARKET

## MEDIA: Generic type

Nominal disk diameter

Recording medium

## DRIVE: Technology type

Heads

Interface

## CAPACITY/RECORDING DENSITY

Total capacity (MBytes) FIXED

REMOVABLE

Capacity per track (Bytes)

Data surfaces per spindle

Heads per data surface

Tracks per surface

Track density (TPI)

Maximum linear density (BPI)

Rotational speed (RPM)

## PERFORMANCE

Actuator type

Average positioning time (msec)

Average rotational delay (msec)

Average access time (msec)

Data transfer rate (KBytes/sec)

## FIRST CUSTOMER SHIPMENT

## U.S. OEM PRICE FOR 100 UNITS

## COMMENTS

	NIPPON PERIPHERALS LTD	NIPPON SYSTEMHOUSE	NIPPON SYSTEMHOUSE	NIPPON SYSTEMHOUSE	NIPPON SYSTEMHOUSE
	NP75S	SQ306RD	SQ312RD	SQ325F	SQ328F
	9	1	2	5	6
	OEM	OEM	OEM	OEM	OEM
	Fixed	3.9" Cartridge	3.9" Cartridge	Fixed	Fixed
	14"	100 mm OD 40 mm ID	100 mm OD 40 mm ID	100 mm OD 40 mm ID	100 mm OD 40 mm ID
	Oxide Coated	Plated	Plated	Plated	Plated
	Modified 3350	Modified 3350	Modified 3350	Modified 3350	Modified 3350
	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
	SMD	ST 506	ST 506	ST 506	ST 506
	U: 868.848 F: 756.548	--	--	U: 25.5	U: 38.2
	--	U: 6.38	U: 12.75	--	--
	F: 32,768	U: 10,416	U: 10,416	U: 10,416	U: 10,416
	12	2	2	4	6
	2	1	1	1	1
	1924	306	612	612	612
	810	435	740	764	764
	12128*	12186	12400	12223	12223
	2964	3547	3547	3547	3547
	Dual Linear, Voice Coil 19	Band, Stepping Motor 90 (including settling)	Band, Stepping Motor 90 (including settling)	Band, Stepping Motor 90 (including settling)	Band, Stepping Motor 90 (including settling)
	10.1	8.46	8.46	8.46	8.46
	29.1	98.46	98.46	98.46	98.46
	1859	625	625	625	625
	9/84	3Q84	1985	1985	1985
	--	--	--	--	--
	*RLL Code	Licensed by Syquest Technology. Embedded Servo 1.625" High 4.8" Wide	Licensed by Syquest Technology. Embedded Servo 1.625" High 4.8" Wide	Licensed by Syquest Technology. Embedded Servo 1.625" High 4.8" Wide	Licensed by Syquest Technology. Embedded Servo 1.625" High 4.8" Wide

	NORTHERN TELECOM	NORTHERN TELECOM	NORTHERN TELECOM	NORTHERN TELECOM	NORTHERN TELECOM
MANUFACTURER					
DRIVE	Aspen II	MFD/8204	MFD/8208	MFD/8210	8308
DISK/TREND GROUP	5	6	7	7	8
MARKET	Captive	OEM	OEM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	210 mm OD	200 mm OD	200 mm OD	200 mm OD	200 mm OD
Recording medium	100 mm ID Oxide Coated	63.5 mm ID Oxide Coated	63.5 mm ID Oxide Coated	63.5 mm ID Oxide Coated	63.5 mm ID Oxide Coated
DRIVE: Technology type	3350	Modified 3350	Modified 3350	Modified 3350	3370
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Thin Film
Interface	Northern Telecom	SMD	SMD	SMD	Mod. SMD
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	F: 22.0 U: 26.4	U: 93.6	U: 187.3	U: 234.2	U: 302.9
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 14,700	U: 21,912	U: 21,912	U: 21,912	U: 34,300
Data surfaces per spindle	4	4	8	10	8
Heads per data surface	1	1	1	1	1
Tracks per surface	447	1069	1069	1069	1104
Track density (TPI)	480	1000	1000	1000	1056
Maximum linear density (BPI)	6250	10242	10242	10242	16200 BPI 10800 FRPI
Rotational speed (RPM)	3600	3313	3313	3313	3313
PERFORMANCE					
Actuator type	Rotary, Torque Motor	Rotary, Torque Motor	Rotary, Torque Motor	Rotary, Torque Motor	Rotary, Torque Motor
Average positioning time (msec)	27	23 (256 Byte sector)	23 (256 Byte sector)	23 (256 Byte sector)	20 (256 Byte sector)
Average rotational delay (msec)	8.3	9.0	9.0	9.0	9.0
Average access time (msec)	35.3	32.0	32.0	32.0	29.0
Data transfer rate (KBytes/sec)	869	1209	1209	1209	1895
FIRST CUSTOMER SHIPMENT	1981	9/83	9/83	9/83	12/84
U.S. OEM PRICE FOR 100 UNITS	--	\$3,865	\$4,507	\$5,380	\$5,700
COMMENTS	Embedded Servo	Embedded Servo	Embedded Servo	Embedded Servo	Embedded Servo

1984 DISK/TREND REPORT

MANUFACTURER	NORTHERN TELECOM	OLIVETTI PERIPHERAL EQUIPMENT	OLIVETTI PERIPHERAL EQUIPMENT	OLIVETTI PERIPHERAL EQUIPMENT	OLIVETTI PERIPHERAL EQUIPMENT
DRIVE	8310	HD 512/3	HD 562/11	HD 562/12	HD 562/13
DISK/TREND GROUP	8	5	5	5	5
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	200 mm OD	130 mm OD	130 mm OD	130 mm OD	130 mm OD
Recording medium	63.5 mm ID Oxide Coated	40 mm ID Oxide Coated	40 mm ID Oxide Coated	40 mm ID Oxide Coated	40 mm ID Oxide Coated
DRIVE: Technology type	3370	Modified 3350	Modified 3350	Modified 3350	Modified 3350
Heads	Thin Film	Ferrite	Ferrite	Ferrite	Ferrite
Interface	Mod. SMD	Olivetti	ST506	ST506	ST506
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 378.6	U: 21.7	U: 3.75	U: 7.5	U: 11.25
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 34,300	U: 10,080	U: 10,416	U: 10,416	U: 10,416
Data surfaces per spindle	10	5	2	4	6
Heads per data surface	1	1	1	1	1
Tracks per surface	1104	430	180	180	180
Track density (TPI)	1056	605	254	254	254
Maximum linear density (BPI)	16200 BPI	8166	7820	7820	7820
Rotational speed (RPM)	10800 FRPI 3313	3600	3600	3600	3600
PERFORMANCE					
Actuator type	Rotary, Torque Motor 20 (256 Byte sector)	Linear, Voice Coil 26	Band, Stepping Motor 84 (including settling)	Band, Stepping Motor 84 (including settling)	Band, Stepping Motor 84 (including settling)
Average positioning time (msec)	9.0	8.3	8.3	8.3	8.3
Average rotational delay (msec)	29.0	34.3	92.3	92.3	92.3
Average access time (msec)	1895	605	625	625	625
Data transfer rate (KBytes/sec)					
FIRST CUSTOMER SHIPMENT	12/84	1982	6/82	6/82	6/82
U.S. OEM PRICE FOR 100 UNITS	\$6,028	--	--	--	--
COMMENTS	Embedded Servo				

MANUFACTURER	OLIVETTI PERIPHERAL EQUIPMENT	OLIVETTI PERIPHERAL EQUIPMENT	OLIVETTI PERIPHERAL EQUIPMENT	OLIVETTI PERIPHERAL EQUIPMENT	OLIVETTI PERIPHERAL EQUIPMENT
DRIVE	HD 563/11	HD 563/12	HD 563/13	HD 661/11	HD 661/12
DISK/TREND GROUP	5	5	5	5	5
MARKET	OEM, Captive	OEM, Captive	OEM, Captive	OEM, Captive	OEM, Captive
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	130 mm OD	130 mm OD	130 mm OD	130 mm OD	130 mm OD
Recording medium	40 mm ID Oxide Coated	40 mm ID Oxide Coated	40 mm ID Oxide Coated	40 mm ID Oxide Coated	40 mm ID Oxide Coated
DRIVE: Technology type	Modified 3350	Modified 3350	Modified 3350	3350	3350
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	ST506	ST506	ST506	ST412	ST412
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 6.38	U: 12.76	U: 19.14	U: 6.375	U: 12.75
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 10,416	U: 10,416	U: 10,416	U: 10,417	U: 10,417
Data surfaces per spindle	2	4	6	2	4
Heads per data surface	1	1	1	1	1
Tracks per surface	306	306	306	306	306
Track density (TPI)	345	345	345	345	345
Maximum linear density (BPI)	9074	9074	9074	8952	8952
Rotational speed (RPM)	3600	3600	3600	3600	3600
PERFORMANCE					
Actuator type	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor
Average positioning time (msec)	85 (including settling)	85 (including settling)	85 (including settling)	85 (including settling)	85 (including settling)
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	93.3	93.3	93.3	93.3	93.3
Data transfer rate (KBytes/sec)	625	625	625	625	625
FIRST CUSTOMER SHIPMENT	1983	1983	1983	2Q84	2Q84
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	--
COMMENTS				1.625" High	1.625" High

## 1984 DISK/TREND REPORT



MANUFACTURER	OPTICAL STORAGE INTERNATIONAL	OTARI ELECTRIC CO., LTD.	OTARI ELECTRIC CO., LTD.	OTARI ELECTRIC CO., LTD.	OTARI ELECTRIC CO., LTD.
DRIVE	LaserDrive 1200	C-507	C-514	C-519	C-526
DISK/TREND GROUP	10	5	5	5	5
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	STN 32	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	12"	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	Tellurium/Glass	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	Write-Once Opt.	Modified 3350	Modified 3350	Modified 3350	Modified 3350
Heads	Diode Laser	Ferrite	Ferrite	Ferrite	Ferrite
Interface	SCSI/ISI	ST506	ST506	ST506	ST506
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	--	U: 6.38	U: 12.75	U: 19.13	U: 25.5
REMOVABLE	F: 1.0	--	--	--	--
Capacity per track (Bytes)	F: 32,768	U: 10,417	U: 10,417	U: 10,417	U: 10,417
Data surfaces per spindle	1	2	4	6	8
Heads per data surface	1	1	1	1	1
Tracks per surface	32,000	306	306	306	306
Track density (TPI)	15,875	383	383	383	383
Maximum linear density (BPI)	14,111	8944	8944	8944	8944
Rotational speed (RPM)	480	3600	3600	3600	3600
PERFORMANCE					
Actuator type	Linear, Voice Coil	Rotary, Band Stepping Motor	Rotary, Band Stepping Motor	Rotary, Band Stepping Motor	Rotary, Band Stepping Motor
Average positioning time (msec)	140	90 (including settling)	90 (including settling)	90 (including settling)	90 (including settling)
Average rotational delay (msec)	62.5	8.3	8.3	8.3	8.3
Average access time (msec)	202.5	98.3	98.3	98.3	98.3
Data transfer rate (KBytes/sec)	2000	625	625	625	625
FIRST CUSTOMER SHIPMENT	10/83	1/83	1/83	1/83	1/83
U.S. OEM PRICE FOR 100 UNITS	\$7,400	\$480	\$580	\$680	\$780
COMMENTS	OSI is joint venture of CDC and Philips	Licensed By Disctron	Licensed By Disctron	Licensed By Disctron	Licensed By Disctron

MANUFACTURER	OTARI ELECTRIC CO., LTD.	PERSCI	PERSCI	PERSCI	PERTEC
DRIVE	PWH-107	VF-2221 VT-2221	VF-2222 VT-2222	VT-2422	D3421/D3422
DISK/TREND GROUP	5	1	1	2	1
MARKET	OEM	OEM, Captive	OEM, Captive	OEM	OEM
MEDIA: Generic type	Fixed	2315/5440	2315/5440	5440	5440
Nominal disk diameter	130 mm OD	14"	14"	14"	14"
Recording medium	40 mm ID Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	Modified 3350	2314	2314	2314	2314
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	ST506	Various Options	Various Options	Various Options	Various Options
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 6.38	U: 6.25	U: 6.25	U: 12.5	U: 6.34
REMOVABLE	--	U: 6.25	U: 6.25	U: 12.5	U: 6.34
Capacity per track (Bytes)	U: 10,416	U: 7,812	U: 7,812	U: 15,625	U: 7,812
Data surfaces per spindle	2	4	4	4	4
Heads per data surface	1	1	1	1	1
Tracks per surface	306	408	408	408	406
Track density (TPI)	383	200	200	200	200
Maximum linear density (BPI)	8944	200	200	4400	2200
Rotational speed (RPM)	3600	1500	2400	2400	1500/2400
PERFORMANCE					
Actuator type	Band, Stepping Motor	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil
Average positioning time (msec)	98 (including settling)	35	35	35	40
Average rotational delay (msec)	8.3	20	12.5	12.5	20/12.5
Average access time (msec)	106.3	55	47.5	47.5	60/52.5
Data transfer rate (KBytes/sec)	625	195	312.5	625	195/312.5
FIRST CUSTOMER SHIPMENT	1/84	2Q80	2Q80	2Q80	1977
U.S. OEM PRICE FOR 100 UNITS	\$450				\$3,795
COMMENTS	1.625" High				

MANUFACTURER

DRIVE

DISK/TREND GROUP

MARKET

MEDIA: Generic type

Nominal disk diameter

Recording medium

DRIVE: Technology type

Heads

Interface

CAPACITY/RECORDING DENSITY

Total capacity (MBytes) FIXED

REMOVABLE

Capacity per track (Bytes)

Data surfaces per spindle

Heads per data surface

Tracks per surface

Track density (TPI)

Maximum linear density (BPI)

Rotational speed (RPM)

PERFORMANCE

Actuator type

Average positioning time (msec)

Average rotational delay (msec)

Average access time (msec)

Data transfer rate (KBytes/sec)

FIRST CUSTOMER SHIPMENT

U.S. OEM PRICE FOR 100 UNITS

COMMENTS

PERTEC	PERTEC	PERTEC	PERTEC	PERTEC
D3441/D3442	D3461/D3462	D3481/D3482	DX180	DX240
1	2	2	7	7
OEM	OEM	OEM	OEM	OEM
2315	5440	2315	Fixed	Fixed
14"	14"	14"	200 mm OD 63.5 mm ID	200 mm OD 63.5 mm ID
Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
2314	2314	2314	Modified 3350	Modified 3350
Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Various Options	Various Options	Various Options	ANSI, SMD	ANSI, SMD
U: 6.34	U: 19.03	U: 19.03	U: 180.59	U: 240.79
U: 6.34	U: 6.34	U: 6.34	--	--
U: 7,812	U: 7,812	U: 7,812	U: 20.160	U: 20.160
4	8	8	6	8
1	1	1	1	1
406	406	406	1493	1493
200	200	200	987	987
2200	2200	2200	12022*	12022*
1500/2400	1500/2400	1500/2400	3600	3600
Linear, Voice Coil 40	Linear, Voice Coil 40	Linear, Voice Coil 40	Rotary, Voice Coil 25	Rotary, Voice Coil 25
20/12.5	20/12.5	20/12.5	8.3	8.3
60/52.5	60/52.5	60/52.5	33.3	33.3
195/312.5	195/312.5	195/312.5	1209	1209
1977	1977	1977	1/85	1/85
\$3,975	\$4,720	\$4,720	\$3,865	\$4,125
			*2.7 RLL Code	*2.7 RLL Code

## 1984 DISK/TREND REPORT

MANUFACTURER	PERTEC	PRIAM	PRIAM	PRIAM	PRIAM
DRIVE					
	DX300	504	803	3350	3450
DISK/TREND GROUP	8	6	6	6	6
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	200 mm OD	130 mm OD	200 mm OD	14"	200 mm OD
Recording medium	63.5 mm ID Oxide Coated	40 mm ID Plated	63.5 mm ID Oxide Coated	Oxide Coated	63.5 mm ID Oxide Coated
DRIVE: Technology type	Modified 3350	Modified 3350	Modified 3350	Modified 3350	Modified 3350
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	ANSI, SMD	ST506	Priam, SMD	Priam, SMD	Priam, SMD
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 300.99	U: 86	U: 85.68	U: 33.9	U: 35.28
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 20,160	U: 10,416	U: 20,160	U: 20,160	U: 13,440
Data surfaces per spindle	10	11	5	1.5	5
Heads per data surface	1	1	1	2/1	1
Tracks per surface	1493	755	850	1122	525
Track density (TPI)	987	960	960	480	480
Maximum linear density (BPI)	12022*	9212	9167	6430	6597
Rotational speed (RPM)	3600	3600	3600	3100	3600
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil
Average positioning time (msec)	25	35	35	46	42
Average rotational delay (msec)	8.3	8.3	8.3	9.7	8.3
Average access time (msec)	33.3	43.3	43.3	55.7	50.3
Data transfer rate (KBytes/sec)	1209	625	1209	1040	806
FIRST CUSTOMER SHIPMENT	1/85	3/84	9/83	8/79	4Q80
U.S. OEM PRICE FOR 100 UNITS	\$4,500	\$2,130	\$2,950	\$2,275	\$2,325
COMMENTS	*2.7 RLL Code				

1984 DISK/TREND REPORT

## MANUFACTURER

## DRIVE

## DISK/TREND GROUP

## MARKET

## MEDIA: Generic type

Nominal disk diameter

Recording medium

## DRIVE: Technology type

Heads

Interface

## CAPACITY/RECORDING DENSITY

Total capacity (MBytes) FIXED

REMOVABLE

Capacity per track (Bytes)

Data surfaces per spindle

Heads per data surface

Tracks per surface

Track density (TPI)

Maximum linear density (BPI)

Rotational speed (RPM)

## PERFORMANCE

Actuator type

Average positioning time (msec)

Average rotational delay (msec)

Average access time (msec)

Data transfer rate (KBytes/sec)

## FIRST CUSTOMER SHIPMENT

## U.S. OEM PRICE FOR 100 UNITS

## COMMENTS

	PRIAM	PRIAM	PRIAM	PRIAM	PRIAM
	6650	7050	15450	806	807
	6	6	7	7	8
	OEM	OEM	OEM	OEM	OEM
	Fixed	Fixed	Fixed	Fixed	Fixed
	14"	200 mm OD 63.5 mm ID	14"	200 mm OD 63.5 mm ID	200 mm OD 63.5 mm ID
	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Plated
	Modified 3350	Modified 3350	Modified 3350	Modified 3350	Modified 3350
	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
	Priam, SMD	Priam, SMD	Priam, SMD	Priam, SMD	Priam, SMD
	U: 67.9	U: 70.49	U: 158.5	U: 188.5	U: 330.2
	--	--	--	--	--
	U: 20,160	U: 13,400	U: 20,160	U: 20,160	U: 20,160
	1.5	5	3.5	11	11
	2/1	1	2/1	1	1
	2242	1049	2242	850	1489
	960	960	960	960	1000
	6430	6597	6430	9167	12096
	3100	3600	3100	3600	3600
	Linear, Voice Coil 46	Linear, Voice Coil 42	Linear, Voice Coil 46	Linear, Voice Coil 20	Linear, Voice Coil 25
	9.7	8.3	9.7	8.3	8.3
	55.7	50.3	55.7	28.3	33.3
	1040	806	1040	1210	1210
	3Q80	4Q81	3Q81	5/84	6/84
	\$2,660	\$2,850	\$3,895	\$3,450	\$4,105

MANUFACTURER	PRIAM	QUANTUM	QUANTUM	QUANTUM	QUANTUM
DRIVE					
	808	Q520	Q2010	Q2020	Q530
DISK/TREND GROUP	9	5	5	5	6
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	200 mm OD	130 mm OD	200 mm OD	200 mm OD	130 mm OD
Recording medium	63.5 mm ID Plated	40 mm ID Oxide Coated	63.5 mm ID Oxide Coated	63.5 mm ID Oxide Coated	40 mm ID Oxide Coated
DRIVE: Technology type	Modified 3350	3350	3350	3350	3350
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	Priam, Mod. SMD	ST506	SA1000	SA1000	ST506
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 495.3	U: 21.33	U: 10.66	U: 21.33	U: 31.99
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 30,240	U: 10,416	U: 10,400	U: 10,400	U: 10,416
Data surfaces per spindle	11	4	2	4	6
Heads per data surface	1	1	1	1	1
Tracks per surface	1489	512	512	512	512
Track density (TPI)	1000	591	345	345	591
Maximum linear density (BPI)	18144*	9200	6600	6600	9200
Rotational speed (RPM)	3600	3529	3000	3000	3529
PERFORMANCE					
Actuator type	Linear, Voice Coil	Rotary, Torque Motor	Rotary, Torque Motor	Rotary, Torque Motor	Rotary, Torque Motor
Average positioning time (msec)	25	45	50	55	45
Average rotational delay (msec)	8.3	8.5	10	10	8.5
Average access time (msec)	33.3	53.5	60	65	53.5
Data transfer rate (KBytes/sec)	1810	625	543	543	625
FIRST CUSTOMER SHIPMENT	3Q84	4/83	1Q81	1Q81	4/83
U.S. OEM PRICE FOR 100 UNITS	\$4,630	\$1,245	\$1,350	\$1,625	\$1,365
COMMENTS	*RLL Code				

## 1984 DISK/TREND REPORT

## MANUFACTURER

## DRIVE

## DISK/TREND GROUP

## MARKET

## MEDIA: Generic type

Nominal disk diameter

Recording medium

## DRIVE: Technology type

Heads

Interface

## CAPACITY/RECORDING DENSITY

Total capacity (MBytes) FIXED

REMOVABLE

Capacity per track (Bytes)

Data surfaces per spindle

Heads per data surface

Tracks per surface

Track density (TPI)

Maximum linear density (BPI)

Rotational speed (RPM)

## PERFORMANCE

Actuator type

Average positioning time (msec)

Average rotational delay (msec)

Average access time (msec)

Data transfer rate (KBytes/sec)

## FIRST CUSTOMER SHIPMENT

## U.S. OEM PRICE FOR 100 UNITS

## COMMENTS

QUANTUM	QUANTUM	QUANTUM	QUANTUM	QUME
Q540	Q2030	Q2040	Q2080	R100
6	6	6	6	5
OEM	OEM	OEM	OEM	OEM
Fixed	Fixed	Fixed	Fixed	Fixed
130 mm OD 40 mm ID Oxide Coated	200 mm OD 63.5 mm ID Oxide Coated	200 mm OD 63.5 mm ID Oxide Coated	200 mm OD 63.5 mm ID Oxide Coated	130 mm OD 40 mm ID Plated
3350	3350	3350	3350	Modified 3350
Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
ST506	SA1000	SA1000	SA1000	ST506
U: 42.66	U: 32.0	U: 42.66	U: 85.45	U: 13.34
--	--	--	--	--
U: 10,416	U: 10,400	U: 10,400	U: 10,416	U: 10,416
8	6	8	7	2
1	1	1	1	1
512	512	512	1172	640
591	345	345	789	656
9200	6600	6600	6600	10000
3529	3000	3000	3000	3600
Rotary, Torque Motor 45	Rotary, Torque Motor 60	Rotary, Torque Motor 65	Rotary, Torque Motor 40	Rotary, band, stepping motor 85 (Including settling)
8.5	10	10	10	8.3
53.5	70	75	50	93.3
625	543	543	543	625
4/83	1Q81	1Q81	11/82	4Q84
\$1,485	\$1,950	\$2,275	\$2,800	\$740
				Embedded servo  1.625" high licensed by Tulin

MANUFACTURER

DRIVE

DISK/TREND GROUP

MARKET

MEDIA: Generic type

Nominal disk diameter

Recording medium

DRIVE: Technology type

Heads

Interface

CAPACITY/RECORDING DENSITY

Total capacity (MBytes) FIXED

REMOVABLE

Capacity per track (Bytes)

Data surfaces per spindle

Heads per data surface

Tracks per surface

Track density (TPI)

Maximum linear density (BPI)

Rotational speed (RPM)

PERFORMANCE

Actuator type

Average positioning time (msec)

Average rotational delay (msec)

Average access time (msec)

Data transfer rate (KBytes/sec)

FIRST CUSTOMER SHIPMENT

U.S. OEM PRICE FOR 100 UNITS

COMMENTS

	QUME	QUME	REFERENCE TECHNOLOGY	RODIME	RODIME
	R200	R300	Series 2000	RO 201	RO 202
	5	6	10	5	5
	OEM	OEM	OEM	OEM	OEM
	Fixed	Fixed	NTSC Videodisk	Fixed	Fixed
	130 mm OD 40 mm ID Plated	130 mm OD 40 mm ID Plated	12"  Videodisk/PMMA	130 mm OD 40 mm ID Oxide Coated	130 mm OD 40 mm ID Oxide Coated
	Modified 3350	Modified 3350	Read-Only Opt.	Modified 3350	Modified 3350
	Ferrite	Ferrite	Diode Laser	Ferrite	Ferrite
	ST506	ST506	SCSI	ST506	ST506
	U: 26.7	U: 40.0	--	U: 6.67	U: 13.33
	--	--	F: 1.0	--	--
	U: 10,416	U: 10,416	F: 19,624	U: 10,416	U: 10,416
	4	6	1	2	4
	1	1	1	1	1
	640	640	51,000	320	320
	656	656	14,896	356	356
	10000	10000	24,000	8720	8720
	3600	3600	1800	3600	3600
	Rotary, band, stepping motor 85 (including settling)	Rotary, band, stepping motor 85 (including settling)	Linear, Voice Coil 12.5	Rotary, Band, Stepping Motor 90 (including settling)	Rotary, Band, Stepping Motor 90 (including settling)
	8.3	8.3	16.7	8.3	8.3
	93.3	93.3	141.7	98.3	98.3
	625	625	1000	625	625
	4Q84	4Q84	4Q84	6/82	6/82
	\$890	\$1,150	--	\$565	\$660
	Embedded servo 1.625" high licensed by Tulin	Embedded servo 1.625" high licensed by Tulin	\$8,900		

1984 DISK/TREND REPORT



## MANUFACTURER

## DRIVE

## DISK/TREND GROUP

## MARKET

## MEDIA: Generic type

Nominal disk diameter

Recording medium

## DRIVE: Technology type

Heads

Interface

## CAPACITY/RECORDING DENSITY

Total capacity (MBytes) FIXED

REMOVABLE

Capacity per track (Bytes)

Data surfaces per spindle

Heads per data surface

Tracks per surface

Track density (TPI)

Maximum linear density (BPI)

Rotational speed (RPM)

## PERFORMANCE

Actuator type

Average positioning time (msec)

Average rotational delay (msec)

Average access time (msec)

Data transfer rate (KBytes/sec)

## FIRST CUSTOMER SHIPMENT

## U.S. OEM PRICE FOR 100 UNITS

## COMMENTS

RODIME	RODIME	RODIME	RODIME	RODIME
RO 202E	RO 203	RO 204	RO 251 RO 351	RO 252 RO 352
5	5	5	5	5
OEM	OEM	OEM	OEM	OEM
Fixed	Fixed	Fixed	Fixed	Fixed
130 mm OD 40 mm ID Oxide Coated	130 mm OD 40 mm ID Oxide Coated	130 mm OD 40 mm ID Oxide Coated	96 mm OD 40 mm ID Oxide/Plated	96 mm OD 40 mm ID Oxide/Plated
Modified 3350	Modified 3350	Modified 3350	Modified 3350	Modified 3350
Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
ST506	ST506	ST506	ST506	ST506
U: 26.67	U: 20.0	U: 26.67	U: 6.38	U: 12.75
--	--	--	--	--
U: 10,416	U: 10,416	U: 10,416	U: 10,416	U: 10,416
4	6	8	2	4
1	1	1	1	1
640	320	320	306	306
600	356	356	600	600
10200	8720	8720	11000	11000
3600	3600	3600	3600	3600
Rotary, Band, Stepping Motor 55 (including settling)	Rotary, Band, Stepping Motor 90 (including settling)	Rotary, Band, Stepping Motor 90 (including settling)	Rotary, Band, Stepping Motor 85 (including settling)	Rotary, Band, Stepping Motor 85 (including settling)
8.3	8.3	8.3	8.3	8.3
63.3	98.3	98.3	93.3	93.3
625	625	625	625	625
4Q83	6/82	6/82	9/83	9/83
\$890	\$830	\$990	\$405 (2500)	\$430 (2500)

## MANUFACTURER

## DRIVE

## DISK/TREND GROUP

## MARKET

## MEDIA: Generic type

Nominal disk diameter

Recording medium

## DRIVE: Technology type

Heads

Interface

## CAPACITY/RECORDING DENSITY

Total capacity (MBytes) FIXED

REMOVABLE

Capacity per track (Bytes)

Data surfaces per spindle

Heads per data surface

Tracks per surface

Track density (TPI)

Maximum linear density (BPI)

Rotational speed (RPM)

## PERFORMANCE

Actuator type

Average positioning time (msec)

Average rotational delay (msec)

Average access time (msec)

Data transfer rate (KBytes/sec)

## FIRST CUSTOMER SHIPMENT

## U.S. OEM PRICE FOR 100 UNITS

## COMMENTS

MANUFACTURER	RODIME	RODIME	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY
DRIVE	RO 203E	RO 204E	ST212	ST406	ST412
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	130 mm OD	130 mm OD	130 mm OD	130 mm OD
Recording medium	40 mm ID Oxide Coated	40 mm ID Oxide Coated	40 mm ID Oxide Coated	40 mm ID Oxide Coated	40 mm ID Oxide Coated
DRIVE: Technology type	Modified 3350	Modified 3350	Modified 3350	Modified 3350	Modified 3350
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	ST506	ST506	ST506	ST506	ST506
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 40.0	U: 53.34	U: 12.76	U: 6.38	U: 12.76
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 10,416	U: 10,416	U: 10,416	U: 10,416	U: 10,416
Data surfaces per spindle	6	8	2	2	4
Heads per data surface	1	1	2	1	1
Tracks per surface	640	640	612	306	306
Track density (TPI)	600	600	550	345	345
Maximum linear density (BPI)	10200	10200	10568	9074	9074
Rotational speed (RPM)	3600	3600	3600	3600	3600
PERFORMANCE					
Actuator type	Rotary, Band, Stepping Motor	Rotary, Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor
Average positioning time (msec)	55 (including settling)	55 (including settling)	65 (including settling)	85 (including settling)	85 (including settling)
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	63.3	63.3	73.3	93.3	93.3
Data transfer rate (KBytes/sec)	625	625	625	625	625
FIRST CUSTOMER SHIPMENT	4Q83	4Q83	4Q84	3Q82	2/82
U.S. OEM PRICE FOR 100 UNITS	\$1,365	\$1,515	\$435 (2500)	--	\$420 (2500)
COMMENTS			1.625" High		

MANUFACTURER

DRIVE

DISK/TREND GROUP

MARKET

MEDIA: Generic type

Nominal disk diameter

Recording medium

DRIVE: Technology type

Heads

Interface

CAPACITY/RECORDING DENSITY

Total capacity (MBytes) FIXED

REMOVABLE

Capacity per track (Bytes)

Data surfaces per spindle

Heads per data surface

Tracks per surface

Track density (TPI)

Maximum linear density (BPI)

Rotational speed (RPM)

PERFORMANCE

Actuator type

Average positioning time (msec)

Average rotational delay (msec)

Average access time (msec)

Data transfer rate (KBytes/sec)

FIRST CUSTOMER SHIPMENT

U.S. OEM PRICE FOR 100 UNITS

COMMENTS

	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY	SHUGART
	ST419	ST425	ST506	ST8100	S1004
	5	5	5	7	5
	OEM	OEM	OEM	OEM	OEM
	Fixed	Fixed	Fixed	Fixed	Fixed
	130 mm OD 40 mm ID Oxide Coated	130 mm OD 40 mm ID Oxide Coated	130 mm OD 40 mm ID Oxide Coated	200 mm OD 63.5 mm ID Oxide Coated	200 mm OD 63.5 mm ID Oxide Coated
	Modified 3350	Modified 3350	Modified 3350	3370 (Ferrite)	3340
	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
	ST506	ST506	ST506	SCSI	SA1000
	U: 19.14	U: 25.52	U: 6.38	U: 102.08	U: 10.67
	--	--	--	--	--
	U: 10,416	U: 10,416	U: 10,416	U: 20,832	U: 10,400
	6	4	4	5	4
	1	2	1	1	1
	306	612	153	980	256
	345	550	255	960	172
	9074	10568	7690	10104	6270
	3600	3600	3600	3600	3125
	Band, Stepping Motor 85 (including settling)	Band, Stepping Motor 65 (including settling)	Band, Stepping Motor 170 (including settling)	Linear, Voice Coil 30 (including settling)	Band, Stepping Motor 70 (including settling)
	8.3	8.3	8.3	8.3	9.6
	93.3	73.3	178.3	38.3	79.6
	625	625	625	1250	542.5
	4Q82	4Q83	7/80	--	4Q79
	\$620 (2500)	\$680 (2500)	--	\$1350 (2500)	\$1,113

MANUFACTURER	SHUGART	SHUGART	SHUGART	SHUGART	SHUGART
DRIVE					
	S4004	S4008	S706	S712	S724
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	14"	14"	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	3340	3340	Modified 3350	Modified 3350	Modified 3350
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	SA4000	SA4000	ST506	ST506	ST506
CAPACITY/RECORDING DENSITY	0.144 MB Fixed Head Option	0.144 MB Fixed Head Option			
Total capacity (MBytes) FIXED	U: 14.5	U: 29.0	U: 6.66	U: 13.33	U: 26.66
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 18,000	U: 18,000	U: 10,416	U: 10,416	U: 10,416
Data surfaces per spindle	2	4	2	4	4
Heads per data surface	2	2	1	1	1
Tracks per surface	404	404	320	320	640
Track density (TPI)	172	172	360	360	720
Maximum linear density (BPI)	5534	5534	9036	9036	9036
Rotational speed (RPM)	2964	2964	3600	3600	3600
PERFORMANCE					
Actuator type	Band, Stepping Motor	Band, Stepping Motor	Rotary, Band, Stepping Motor	Rotary, Band, Stepping Motor	Rotary, Band, Stepping Motor
Average positioning time (msec)	65 (including settling)	65 (including settling)	85 (including settling)	85 (including settling)	85 (including settling)
Average rotational delay (msec)	10.1	10.1	8.3	8.3	8.3
Average access time (msec)	75.1	75.1	93.3	93.3	93.3
Data transfer rate (KBytes/sec)	887.5	887.5	625	625	625
FIRST CUSTOMER SHIPMENT	3Q78	3Q78	4/83	6/83	4Q84
U.S. OEM PRICE FOR 100 UNITS	\$1,680	\$2,100	\$450	\$470	--
COMMENTS			1.625" High	1.625" High	1.625" High

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MANUFACTURER	SHUGART	SIEMENS	SIEMENS	SIEMENS	SIEMENS
DRIVE					
	OPTIMEM 1000	3455	3465	3468	3470 3472
DISK/TREND GROUP	10	4	4	4	8
MARKET	OEM	Captive	Captive	Captive	Captive
MEDIA: Generic type	Optimem 1001/2	Special	Special	3336-11	Fixed
Nominal disk diameter	12"	14"	14"	14"	14"
Recording medium	Gold/Glass	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	Write-Once Opt.	3330-11	3330-11	3330-11	3350
Heads	Diode Laser	Ferrite	Ferrite	Ferrite	Ferrite
Interface	SCSI	Siemens	Siemens	Siemens	Siemens
CAPACITY/RECORDING DENSITY					1.115 MB Fixed Head Option
Total capacity (MBytes) FIXED	--	--	--	--	F: 420.25
REMOVABLE	F: 1,000	F: 71.8	F: 143.6	F: 303.2	--
Capacity per track (Bytes)	F: 25,600	F: 19,750	F: 19,750	F: 19,750	F: 16,384
Data surfaces per spindle	1	9	9	19	19
Heads per data surface	1	1	1	1	2
Tracks per surface	40,000	404	808	808	1350
Track density (TPI)	14,500	192	384	384	590
Maximum linear density (BPI)	15,300	6060	6060	6060	6060
Rotational speed (RPM)	1122	2400	2400	2400	2400
PERFORMANCE					
Actuator type	Rotary, Voice Coil 100	Linear, Voice Coil 25	Linear, Voice Coil 25	Linear, Voice Coil 25	Linear, Voice Coil 20
Average positioning time (msec)	100	25	25	25	20
Average rotational delay (msec)	27	12.5	12.5	12.5	12.5
Average access time (msec)	127	37.5	37.5	37.5	32.5
Data transfer rate (KBytes/sec)	1000	806	806	806	806
FIRST CUSTOMER SHIPMENT	2Q84	9/75	12/76	1977	10/78
U.S. OEM PRICE FOR 100 UNITS	\$6900*	--	--	--	--
COMMENTS	*w/o controller				3472 is dual spindle drive with 840 MB total capacity

MANUFACTURER	SORD	SORD	SPERRY	SPERRY	SPERRY
DRIVE					
	HD-503	HD-513	8419	8402-50	8402-75
DISK/TREND GROUP	5	5	3	6	6
MARKET	OEM, Captive	OEM, Captive	Captive	Captive	Captive
MEDIA: Generic type	Fixed	Fixed	SMD	Fixed	Fixed
Nominal disk diameter	130 mm OD	130 mm OD	14"	14"	14"
Recording medium	40 mm ID Oxide Coated	40 mm ID Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	Modified 3350	Modified 3350	3330-11	3350	3350
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	ST 506	ST 506	Univac	Univac	Univac
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 10.0	U: 27.5	--	F: 50.7	F: 76.0
REMOVABLE	--	--	F: 72.3	--	--
Capacity per track (Bytes)	U: 10,416	U: 10,416	F: 16,800	F: 13,312	F: 13,312
Data surfaces per spindle	6	6	7	7	7
Heads per data surface	1	1	1	2	2
Tracks per surface	160	440	815	544	816
Track density (TPI)	254	508	370	476	476
Maximum linear density (BPI)	7690	8853	5050	6366	6366
Rotational speed (RPM)	3600	3600	2800	3600	3600
PERFORMANCE					
Actuator type	Band, Stepping Motor	Band, Stepping Motor	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil
Average positioning time (msec)	76 (including settling)	127 (including settling)	33	35	35
Average rotational delay (msec)	8.3	8.3	10.7	8.3	8.3
Average access time (msec)	84.3	135.3	43.7	43.3	43.3
Data transfer rate (KBytes/sec)	625	625	784	1198	1198
FIRST CUSTOMER SHIPMENT	2/83	5/84	12/80	3/81	3/81
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	--
COMMENTS			System 80	BC/7-900	BC/7-900

MANUFACTURER

DRIVE

DISK/TREND GROUP

MARKET

MEDIA: Generic type

Nominal disk diameter

Recording medium

DRIVE: Technology type

Heads

Interface

CAPACITY/RECORDING DENSITY

Total capacity (MBytes) FIXED

REMOVABLE

Capacity per track (Bytes)

Data surfaces per spindle

Heads per data surface

Tracks per surface

Track density (TPI)

Maximum linear density (BPI)

Rotational speed (RPM)

PERFORMANCE

Actuator type

Average positioning time (msec)

Average rotational delay (msec)

Average access time (msec)

Data transfer rate (KBytes/sec)

FIRST CUSTOMER SHIPMENT

U.S. OEM PRICE FOR 100 UNITS

COMMENTS

	SPERRY	SPERRY	SPERRY	SPERRY	SPERRY
	8402-100	8417	8436	8470	8480
	7	7	7	9	9
	Captive	Captive	Captive	Captive	Captive
	Fixed	Fixed	Fixed	Fixed	Fixed
	14"	14"	14"	14"	14"
	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
	3350	3350	3350	3350	8470
	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
	Univac	Univac	Univac	Univac	Univac
		.86 MB Fixed Head Option		1.524 MB Fixed Head Option	1.524 MB Fixed Head Option
	F: 101.4	F: 118.2	F: 229.15	F: 564.48	F: 564.48
	--	--	--	--	--
	F: 13,312	F: 19,900	F: 25,981	F: 28,224	F: 28,224
	7	7	7	16	16
	2	2	2	2	2
	1088	1100	1260	1250	1250
	476	476	538	538	538
	6366	6366	11139	11134*	11134*
	3600	3400	3600	3600	3600
	Linear, Voice Coil 35	Linear, Voice Coil 35	Linear, Voice Coil 25	Linear, Voice Coil 23	Linear, Voice Coil 23
	8.3	8.82	8.3	8.3	8.3
	43.3	43.82	33.3	31.3	31.3
	1198	1130	2097	2097	2097
	3/81	12/80	8/84	6/80	1Q83
	--	--	--	--	--
	BC/7-900	System 80		*3PM Code	*3PM Code Drive has 4 spindles.

MANUFACTURER	STORAGE TECHNOLOGY CORPORATION	STORAGE TECHNOLOGY CORPORATION	STORAGE TECHNOLOGY CORPORATION	STORAGE TECHNOLOGY CORPORATION	STORAGE TECHNOLOGY CORPORATION
DRIVE	8350-A2 8350-B2 8350-C2	8360-A2 8360-B2	8650-A2 8650-B2	8775	8380-A4 8380-AA4 8380-B4
DISK/TREND GROUP	8	8	9	9	9
MARKET	PCM	PCM	PCM	OEM	PCM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	14"	14"	14"	14"	14"
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	3350	Modified 3350	Modified 3350	Modified 3350	3380
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Thin Film
Interface	IBM	IBM	IBM	SMD	IBM
CAPACITY/RECORDING DENSITY	1.144 MB Fixed Head Option	1.144 MB Fixed Head Option	1.144 MB Fixed Head Option		
Total capacity (MBytes) FIXED	F: 317.5	F: 317.5	F: 635	U: 673.95	F: 1,260
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 19,069	F: 19,069	F: 19,069	U: 19,969	F: 47,476
Data surfaces per spindle	15	15	15	15	15
Heads per data surface	2	2	2	2	2
Tracks per surface	1110	1110	2220	2250	1770
Track density (TPI)	480	957	957	957	*
Maximum linear density (BPI)	6425	6425	6425	6425	*
Rotational speed (RPM)	3600	3600	3600	3600	3620
PERFORMANCE					
Actuator type	Linear, Voice Coil 25	Linear, Voice Coil 23	Linear, Voice Coil 18	Linear, Voice Coil 23	Dual, Linear, Voice Coil 16
Average positioning time (msec)	8.3	8.3	8.3	8.3	8.3
Average rotational delay (msec)	33.3	31.3	26.3	31.3	24.3
Data transfer rate (KBytes/sec)	1198	1198	1198	1198	3000
FIRST CUSTOMER SHIPMENT	4/77	2Q81	5/79	9/82	1983
U.S. OEM PRICE FOR 100 UNITS	--	--	--	\$13,750	--
COMMENTS	PCM 3350 Drive has two spindles	PCM 3350 Drive has two spindles	PCM 3350 Drive has two spindles		PCM 3380 Drive has two spindles *Not Announced

## 1984 DISK/TREND REPORT



## MANUFACTURER

## DRIVE

## DISK/TREND GROUP

## MARKET

## MEDIA: Generic type

Nominal disk diameter

Recording medium

## DRIVE: Technology type

Heads

Interface

## CAPACITY/RECORDING DENSITY

Total capacity (MBytes) FIXED

REMOVABLE

Capacity per track (Bytes)

Data surfaces per spindle

Heads per data surface

Tracks per surface

Track density (TPI)

Maximum linear density (BPI)

Rotational speed (RPM)

## PERFORMANCE

Actuator type

Average positioning time (msec)

Average rotational delay (msec)

Average access time (msec)

Data transfer rate (KBytes/sec)

## FIRST CUSTOMER SHIPMENT

## U.S. OEM PRICE FOR 100 UNITS

## COMMENTS

	STORAGE TECHNOLOGY CORPORATION	SYQUEST TECHNOLOGY	SYQUEST TECHNOLOGY	SYQUEST TECHNOLOGY	SYQUEST TECHNOLOGY
	7640	SQ306RD	SQ312RD	SQ325F	SQ338F
	10	1	2	5	6
	PCM, OEM	OEM	OEM	OEM	OEM
	STC Opt. Cart.	3.9" Cartridge	QPAK SQ200	Fixed	Fixed
	14"	100 mm OD 40 mm ID	100 mm OD 40 mm ID	100 mm OD 40 mm ID	100 mm OD 40 mm ID
	Te/Aluminum	Plated	Plated	Plated	Plated
	Write-Once Opt.	Modified 3350	Modified 3350	Modified 3350	Modified 3350
	HeNe/Diode	Ferrite	Ferrite	Ferrite	Ferrite
	STC	ST506	ST506	ST506	ST506
	--	--	--	U: 25.5	U: 38.2
	F: 4,000	U: 6.38	U: 12.75	--	--
	F:118,500	U: 10,416	U: 10,416	U: 10,416	U: 10,416
	1	2	2	4	6
	1	1	1	1	1
	34,224	306	612	612	612
	13,500	435	740	764	764
	20,000*	12186	12400	12223	12223
	1314	3547	3547	3547	3547
	Linear, Voice Coil	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor
	61.9	90 (including settling)	90 (including settling)	90 (including settling)	90 (including settling)
	22.8	8.46	8.46	8.46	8.46
	84.7	98.46	98.46	98.46	98.46
	3000	625	625	625	625
	1Q85	9/82	July84	Jun84	May84
	--	\$710	\$875	\$850	\$1000
	*2,7 RLL Code Attaches to IBM System/370 with 8880 controller	Embedded Servo 1.625" High 4.8" Wide	Embedded Servo 1.625" High 4.8" Wide	Embedded Servo 1.625" High 4.8" Wide	Embedded Servo 1.625" High 4.8" Wide

MANUFACTURER	TANDON	TANDON	TANDON	TANDON	TANDON
DRIVE					
	TM501	TM502	TM503	TM252	TM703
DISK/TREND GROUP	5	5	5	5	6
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	130 mm OD	130 mm OD	130 mm OD	130 mm OD	130 mm OD
Recording medium	40 mm ID Oxide Coated	40 mm ID Oxide Coated	40 mm ID Oxide Coated	40 mm ID Plated	40 mm ID Plated
DRIVE: Technology type	Modified 3350	Modified 3350	Modified 3350	Modified 3350	Modified 3350
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	ST506	ST506	ST506	ST506	ST506
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 6.38	U: 12.75	U: 19.14	U: 12.75	U: 30.1
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 10,416	U: 10,416	U: 10,416	U: 10,416	U: 10,416
Data surfaces per spindle	2	4	6	4	5
Heads per data surface	1	1	1	1	1
Tracks per surface	306	306	306	306	578
Track density (TPI)	345	345	345	345	600
Maximum linear density (BPI)	9074	9074	9074	9074	9528
Rotational speed (RPM)	3600	3600	3600	3600	3600
PERFORMANCE					
Actuator type	Rotary, Band Stepping Motor 206 (including settling)	Rotary, Band Stepping Motor 206 (including settling)	Rotary, Band Stepping Motor 206 (including settling)	Rotary, Band Stepping Motor 100 (including settling)	Rotary, Voice Coil 39 (including settling)
Average positioning time (msec)	8.3	8.3	8.3	8.3	8.3
Average rotational delay (msec)	214.3	214.3	214.3	108.3	47.3
Average access time (msec)	625	625	625	625	625
Data transfer rate (KBytes/sec)					
FIRST CUSTOMER SHIPMENT	9/82	9/82	9/82	7/83	1/83
U.S. OEM PRICE FOR 100 UNITS	\$398 (2500)	\$418 (2500)	\$473 (2500)	\$456 (2500)	\$945 (2500)
COMMENTS				1.625 " High	

## 1984 DISK/TREND REPORT

MANUFACTURER	TEAC	TEAC	TEAC	TECSTOR	TECSTOR
DRIVE					
	SD-412	SD-506	SD-510	3/83	3/100
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	130 mm OD	130 mm OD	14"	14"
Recording medium	40 mm ID Oxide Coated	40 mm ID Oxide Coated	40 mm ID Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	Modified 3350	Modified 3350	Modified 3350	Modified 3350	Modified 3350
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	ST506	ST506	ST506	SMD	SMD
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 12.76	U: 6.38	U: 12.76	U: 82.9	U: 99.5
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 10,417	U: 10,417	U: 10,416	U: 20,160	U: 20,160
Data surfaces per spindle	4	4	4	2.5	3
Heads per data surface	1	1	1	2	2
Tracks per surface	306	153	306	1646	1646
Track density (TPI)	345	255	345	680	680
Maximum linear density (BPI)	9074	7690	9074	6450	6450
Rotational speed (RPM)	3600	3600	3600	3600	3600
PERFORMANCE					
Actuator type	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Rotary, Voice Coil	Rotary, Voice Coil
Average positioning time (msec)	170 (including settling)	170 (including settling)	85 (including settling)	29	29
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	178.3	178.3	93.3	37.3	37.3
Data transfer rate (KBytes/sec)	625	625	625	1209	1209
FIRST CUSTOMER SHIPMENT	3Q82	3Q82	4/84	2/82	6/82
U.S. OEM PRICE FOR 100 UNITS	--	--	--	\$4,400	\$4,500
COMMENTS	Licensed by Seagate	Licensed by Seagate	1.625" High		

MANUFACTURER	TECSTOR	TECSTOR	TECSTOR	TECSTOR	TEXAS INSTRUMENTS
DRIVE					
	3/166	3/199	3/315	3/332	WD 800-18
DISK/TREND GROUP	7	7	8	8	5
MARKET	OEM	OEM	OEM	OEM	Captive
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	14"	14"	14"	14"	200 mm OD 63.5 mm ID
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	Modified 3350	Modified 3350	Modified 3350	Modified 3350	3350
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	SMD	SMD	SMD	SMD	T.I.
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 165.9	U: 199.1	U: 315.2	U: 331.8	F: 18
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 20,160	U: 20,160	U: 20,160	U: 20,160	F: 9,288
Data surfaces per spindle	5	6	9.5	10	3
Heads per data surface	2	2	2	2	1
Tracks per surface	1646	1646	1646	1646	656
Track density (TPI)	680	680	680	680	478
Maximum linear density (BPI)	6450	6450	6450	6450	6500
Rotational speed (RPM)	3600	3600	3600	3600	3600
PERFORMANCE					
Actuator type	Rotary, Voice Coil 29	Rotary, Voice Coil 29	Rotary, Voice Coil 29	Rotary, Voice Coil 29	Rotary, Voice Coil 40
Average positioning time (msec)	8.3	8.3	8.3	8.3	8.3
Average rotational delay (msec)	37.3	37.3	37.3	37.3	48.3
Average access time (msec)	1209	1209	1209	1209	602
Data transfer rate (KBytes/sec)					
FIRST CUSTOMER SHIPMENT	12/81	6/82	12/82	12/82	4/82
U.S. OEM PRICE FOR 100 UNITS	\$4,850	\$5,000	\$5,600	\$5,700	--
COMMENTS					DS990 Models Mfg. under Megavault license

MANUFACTURER	TEXAS INSTRUMENTS	TOKICO	TOKICO	TOKICO	TOKICO
DRIVE	WD 800-43	DK502-1	DK502-2	DK502-3	DK503-1
DISK/TREND GROUP	6	5	5	5	5
MARKET	Captive	OEM	OEM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	200 mm OD	130 mm OD	130 mm OD	130 mm OD	130 mm OD
Recording medium	63.5 mm ID Oxide Coated	40 mm ID Oxide Coated	40 mm ID Oxide Coated	40 mm ID Oxide Coated	40 mm ID Oxide Coated
DRIVE: Technology type	3350	Modified 3350	Modified 3350	Modified 3350	Modified 3350
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	T.I.	ST506	ST506	ST506	ST506
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	F: 43	U: 13.3	U: 20.0	U: 26.6	U: 6.66
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	F: 9,288	U: 10,416	U: 10,416	U: 10,416	U: 10,416
Data surfaces per spindle	7	4	6	8	2
Heads per data surface	1	1	1	1	1
Tracks per surface	656	320	320	320	320
Track density (TPI)	478	360	360	360	360
Maximum linear density (BPI)	6500	9260	9260	9260	9260
Rotational speed (RPM)	3600	3600	3600	3600	3600
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor
Average positioning time (msec)	40	85 (including settling)	85 (including settling)	85 (including settling)	85 (including settling)
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.6
Average access time (msec)	48.3	93.3	93.3	93.3	93.6
Data transfer rate (KBytes/sec)	602	625	625	625	625
FIRST CUSTOMER SHIPMENT	4/82	10/83	10/83	10/83	10/83
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	--
COMMENTS	DS990 Models  Mfg. under Megavault license				1.625" High

MANUFACTURER	TOKICO	TOSHIBA CORPORATION	TOSHIBA CORPORATION	TOSHIBA CORPORATION	TOSHIBA CORPORATION
DRIVE	DK503-2	MK-800R-32	MK-800R-64	MK-800R-96	MK-50F
DISK/TREND GROUP	5	2	2	2	5
MARKET	OEM	OEM, Captive	OEM, Captive	OEM, Captive	Captive
MEDIA: Generic type	Fixed	CMD	CMD	CMD	Fixed
Nominal disk diameter	130 mm OD 40 mm ID	14"	14"	14"	130 mm OD 40 mm ID
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
DRIVE: Technology type	Modified 3350	3330-11	3330-11	3330-11	Modified 3350
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	ST506	SMD	SMD	SMD	ST506, SASI
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 13.33	U: 16.289	U: 48.868	U: 80.446	U: 12.75
REMOVABLE	--	U: 16.289	U: 16.289	U: 16.289	--
Capacity per track (Bytes)	U: 10,416	U: 20,160	U: 20,160	U: 20,160	U: 10,416
Data surfaces per spindle	4	1 Fixed 1 Removable	3 Fixed 1 Removable	5 Fixed 1 Removable	4
Heads per data surface	1	2 Fixed 1 Removable	2 Fixed 1 Removable	2 Fixed 1 Removable	1
Tracks per surface	320	823	823	823	306
Track density (TPI)	360	367 Fixed 384 Removable	367 Fixed 384 Removable	367 Fixed 384 Removable	345
Maximum linear density (BPI)	9260	6274 Fixed 6038 Removable	6274 Fixed 6038 Removable	6274 Fixed 6038 Removable	9074
Rotational speed (RPM)	3600	3600	3600	3600	3600
PERFORMANCE					
Actuator type	Band, Stepping Motor 85 (including settling)	Fix: Rotary VC Rem: Linear VC	Fix: Rotary VC Rem: Linear VC	Fix: Rotary VC Rem: Linear VC	Band, Stepping Motor 85 (including settling)
Average positioning time (msec)	85	30	30	30	85
Average rotational delay (msec)	8.6	8.3	8.3	8.3	8.3
Average access time (msec)	93.6	38.3	38.3	38.3	93.3
Data transfer rate (KBytes/sec)	625	1209	1209	1209	625
FIRST CUSTOMER SHIPMENT	10/83	2Q80	2Q80	2Q80	2Q83
U.S. OEM PRICE FOR 100 UNITS	--	--	--	--	--
COMMENTS	1.625" High				2.09 Inches High

1984 DISK/TREND REPORT

## MANUFACTURER

## DRIVE

## DISK/TREND GROUP

## MARKET

## MEDIA: Generic type

Nominal disk diameter

Recording medium

## DRIVE: Technology type

Heads

Interface

## CAPACITY/RECORDING DENSITY

Total capacity (MBytes) FIXED

REMOVABLE

Capacity per track (Bytes)

Data surfaces per spindle

Heads per data surface

Tracks per surface

Track density (TPI)

Maximum linear density (BPI)

Rotational speed (RPM)

## PERFORMANCE

Actuator type

Average positioning time (msec)

Average rotational delay (msec)

Average access time (msec)

Data transfer rate (KBytes/sec)

## FIRST CUSTOMER SHIPMENT

## U.S. OEM PRICE FOR 100 UNITS

## COMMENTS

	TOSHIBA CORPORATION	TOSHIBA CORPORATION	TOSHIBA CORPORATION	TOSHIBA CORPORATION	TOSHIBA CORPORATION
	MK-80F-10	MK-80F-20	MK-80F-30	MK-181F	MK-182F
	5	5	6	6	6
	OEM, Captive	OEM, Captive	OEM, Captive	Captive, OEM	Captive, OEM
	Fixed	Fixed	Fixed	Fixed	Fixed
	210 mm OD	210 mm OD	210 mm OD	210 mm OD	210 mm OD
	100 mm ID	100 mm ID	100 mm ID	100 mm ID	100 mm ID
	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
	Modified 3350	Modified 3350	Modified 3350	Modified 3350	Modified 3350
	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
	SMD	SMD	SMD	SMD	SMD
	U: 15.3	U: 23.0	U: 38.3	U: 49.8	U: 83.0
	--	--	--	--	--
	U: 20,160	U: 20,160	U: 20,160	U: 20,160	U: 20,160
	2	3	5	3	5
	1	1	1	1	1
	380	380	380	823	823
	450	450	450	900	900
	8824	8824	8824	6,000 FCI 9,000 BPI	6,000 FCI 9,000 BPI
	3600	3600	3600	3600	3600
	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
	40	40	40	35	35
	8.3	8.3	8.3	8.3	8.3
	48.3	48.3	48.3	43.3	43.3
	1210	1210	1210	1210	1210
	2081	2081	2081	2083	2083
	--	--	--	--	--

MANUFACTURER	TOSHIBA CORPORATION	TOSHIBA CORPORATION	TOSHIBA CORPORATION	TULIN	TULIN
DRIVE	MK-184F	MK-186F	DF-0400	TL213	TL226
DISK/TREND GROUP	7	7	10	5	5
MARKET	Captive, OEM	Captive, OEM	OEM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Toshiba Cart.	Fixed	Fixed
Nominal disk diameter	210 mm OD	210 mm OD	12"	130 mm OD	130 mm OD
Recording medium	100 mm ID Oxide Coated	100 mm ID Oxide Coated	TeC/PMMA	40 mm ID Plated	40 mm ID Plated
DRIVE: Technology type	Modified 3350	Modified 3350	Write-Once Opt.	Modified 3350	Modified 3350
Heads	Ferrite	Ferrite	Laser Diode	Ferrite	Ferrite
Interface	SMD	SMD	GP1B	ST506	ST506
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 116.1	U: 165.9	--	U: 13.34	U: 26.7
REMOVABLE	--	--	F:1,800(1 side)	--	--
Capacity per track (Bytes)	U: 20,160	U: 20,160	F: 40,000	U: 10,416	U: 10,416
Data surfaces per spindle	7	10	1	2	4
Heads per data surface	1	1	1	1	1
Tracks per surface	823	823	45,000	640	640
Track density (TPI)	900	900	16,000	656	656
Maximum linear density (BPI)	6,000 FCI	6,000 FCI		10,000	10,000
Rotational speed (RPM)	9,000 BPI 3600	9,000 BPI 3600	240/480	3600	3600
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Linear, Voice Coil	Rotary, band, stepping motor	Rotary, band stepping motor
Average positioning time (msec)	35	35	500	85 (Including settling)	85 (Including settling)
Average rotational delay (msec)	8.3	8.3	125/62.5	8.3	8.3
Average access time (msec)	43.3	43.3	625/562.5	93.3	93.3
Data transfer rate (KBytes/sec)	1210	1210	500	625	625
FIRST CUSTOMER SHIPMENT	2Q83	4Q83	4Q84	3/84	3/84
U.S. OEM PRICE FOR 100 UNITS	--	--	--	\$650	\$850
COMMENTS				Embedded servo 1.625" high	Embedded servo 1.625" high



MANUFACTURER

DRIVE

DISK/TREND GROUP

MARKET

MEDIA: Generic type

Nominal disk diameter

Recording medium

DRIVE: Technology type

Heads

Interface

CAPACITY/RECORDING DENSITY

Total capacity (MBytes) FIXED

REMOVABLE

Capacity per track (Bytes)

Data surfaces per spindle

Heads per data surface

Tracks per surface

Track density (TPI)

Maximum linear density (BPI)

Rotational speed (RPM)

PERFORMANCE

Actuator type

Average positioning time (msec)

Average rotational delay (msec)

Average access time (msec)

Data transfer rate (KBytes/sec)

FIRST CUSTOMER SHIPMENT

U.S. OEM PRICE FOR 100 UNITS

COMMENTS

	TULIN	VERMONT RESEARCH	VERMONT RESEARCH	VERMONT RESEARCH	VERTEX PERIPHERALS
	TL240	8010	8520	5017-4	V130
	5	1	2	2	6
	OEM	OEM	OEM	OEM	OEM
	Fixed	8" Cartridge	8" Cartridge	5440	Fixed
	130 mm OD 40 mm ID Plated	200 mm OD 63.5 mm ID Oxide Coated	200 mm OD 63.5 mm ID Oxide Coated	14" Oxide Coated	130 mm OD 40 mm ID Plated
	Modified 3350	Modified 3350	Modified 3350	3330-11	3370 (Ferrite)
	Ferrite ST506	Ferrite VRL, SASI, ANSI	Ferrite VRL, SASI, ANSI	Ferrite VRL, SASI, ANSI X3T9/1226	Ferrite ST506
	U: 40.0	--	F: 9.7	F: 26.2	U: 30.8
	--	F: 9.7	F: 9.7	F: 26.2	--
	U: 10,416	F: 8,192	F: 8,192	F: 12,800	U: 10,416
	6	2	4	4	3
	1	1	1	1	1
	640	596	596	1024	987
	656	500	500	500	960
	10,000	6000	6000	4000	9897
	3600	3600	3600	3165	3600
	Rotary, band, stepping motor 85 (Including settling)	Linear, Voice Coil 55	Linear, Voice Coil 60	Linear, Voice Coil 45	Rotary, Voice Coil 30
	8.3	8.3	8.3	9.5	8.3
	93.3	53.3	68.3	54.5	38.3
	625	625	625	673	625
	3/84	2Q83	2Q83	1975	4Q83
	\$1,055	\$3,000	\$3,500	\$13,065	\$1,480
	Embedded servo 1.625" high	Embedded Servo	Embedded Servo	Embedded Servo	

MANUFACTURER	VERTEX PERIPHERALS	VERTEX PERIPHERALS	VERTEX PERIPHERALS	VICTOR COMPANY OF JAPAN	VICTOR COMPANY OF JAPAN
DRIVE	V150	V170	V185	JD-5006	JD-5012
DISK/TREND GROUP	6	6	6	5	5
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	Fixed	Fixed	Fixed	Fixed	Fixed
Nominal disk diameter	130 mm OD	130 mm OD	130 mm OD	130 mm OD	130 mm OD
Recording medium	40 mm ID Plated	40 mm ID Plated	40 mm ID Plated	40 mm ID Oxide Coated	40 mm ID Oxide Coated
DRIVE: Technology type	3370 (Ferrite)	3370 (Ferrite)	3370 (Ferrite)	Modified 3350	Modified 3350
Heads	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
Interface	ST506	ST506	ST506	ST506	ST506
CAPACITY/RECORDING DENSITY					
Total capacity (MBytes) FIXED	U: 51.4	U: 72.0	U: 85.0	U: 6.38	U: 12.76
REMOVABLE	--	--	--	--	--
Capacity per track (Bytes)	U: 10,416	U: 10,416	U: 10,416	U: 10,416	U: 10,416
Data surfaces per spindle	5	7	7	2	4
Heads per data surface	1	1	1	1	1
Tracks per surface	987	987	1166	306	306
Track density (TPI)	960	960	1000	345	345
Maximum linear density (BPI)	9897	9897	10979	9000	9000
Rotational speed (RPM)	3600	3600	3600	3600	3600
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Band, Stepping Motor	Band, Stepping Motor
Average positioning time (msec)	30	30	30	97 (including settling)	97 (including settling)
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Average access time (msec)	38.3	38.3	38.3	105.3	105.3
Data transfer rate (KBytes/sec)	625	625	625	625	625
FIRST CUSTOMER SHIPMENT	4Q83	4Q83	3Q84	--	--
U.S. OEM PRICE FOR 100 UNITS	\$1,700	\$2,050	\$2,195	--	--
COMMENTS				1.625" High	1.625" High

1984 DISK/TREND REPORT

MANUFACTURER

DRIVE

DISK/TREND GROUP

MARKET

MEDIA: Generic type

Nominal disk diameter

Recording medium

DRIVE: Technology type

Heads

Interface

CAPACITY/RECORDING DENSITY

Total capacity (MBytes) FIXED

REMOVABLE

Capacity per track (Bytes)

Data surfaces per spindle

Heads per data surface

Tracks per surface

Track density (TPI)

Maximum linear density (BPI)

Rotational speed (RPM)

PERFORMANCE

Actuator type

Average positioning time (msec)

Average rotational delay (msec)

Average access time (msec)

Data transfer rate (KBytes/sec)

FIRST CUSTOMER SHIPMENT

U.S. OEM PRICE FOR 100 UNITS

COMMENTS

	WESTERN DYNEX	WESTERN DYNEX	WESTERN DYNEX	WESTERN DYNEX	XEBEC
	WD-505	DD-6121	DD-6122	DD-6221	4000 Owl
	1	1	1	1	5
	OEM	OEM	OEM	OEM	OEM
	5.25" Cartridge	2315/5440	2315/5440	2315/5440	Fixed
	130 mm OD 40 mm ID Oxide Coated	14" Oxide Coated	14" Oxide Coated	14" Oxide Coated	130 mm OD 40 mm ID Oxide Coated
	Modified 3350	2314	2314	2314	Modified 3350
	Ferrite	Ferrite	Ferrite	Ferrite	Ferrite
	ST506	Various Options	Various Options	Various Options	SASI
	--	--	--	U: 3.13	F: 10.65
	F: 6.38	U: 3.13	U: 6.25	U: 3.13	--
	U: 10,416	U: 7,812	U: 7,812	U: 7,812	F: 8,704
	2	2	2	4	4
	1	1	1	1	1
	306	203	406	203	306
	345	100	200	100	367
	9022	2200	2200	2200	8842
	3600	1500/2400	1500/2400	1500/2400	3600
	Band, Stepping Motor 45 (including settling)	Linear, Voice Coil 35	Linear, Voice Coil 35	Linear, Voice Coil 35	Band, Stepping Motor 85 (including settling)
	8.3	20/12.5	20/12.5	20/12.5	8.3
	53.3	55/47.5	55/47.5	55/47.5	93.3
	625	195/312.5	195/312.5	195/312.5	625
	3Q84	1972	1973	1972	4Q84
	--	--	--	--	\$795
					1.625" High





MANUFACTURER PROFILES

All manufacturers now producing moving head disk drives, or which have indicated specific plans to enter the market, are listed in this section. Also listed are manufacturers of optical disk drives which have announced specific products or are expected to soon do so. The heading "1983 disk sales" refers to the DISK/TREND estimate of moving head rigid disk drive sales only -- no sales of other drive types are included, nor are sales of parts or other disk drive related products such as controllers. "1983 total net sales" covers the fiscal year ending in 1983 for each firm unless noted otherwise, or for the parent company if the disk drive manufacturer is a subsidiary. Northern Telecom is listed with the U.S. firms for convenience.

U.S. Manufacturers

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

Cybernex, an ambitious independent manufacturer of thin film heads, established AST in late 1983, to design and manufacture advanced small disk drives using thin film heads. The first announced products are half high 5.25" drives with capacities up to 202 MB, with first deliveries promised by the end of 1984.

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

213/882-6500

Alpha Data is a privately held manufacturer of head-per-track disk drives. The firm has announced several variations of a 14" moving head drive using plated disks. The current version has 128 MB capacity and 18 ms average access time, achieved by using 10 heads per data surface.

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

303/772-2601

1983 disk sales: \$2,400,000

Organized in 1981 by a group of industry veterans with high performance disk drive experience at Storage Technology, Amcodyne started first shipments of its 8" disk cartridge drive (26 MB fixed/26 MB removable) in early 1983. The firm's second product, an 8" fixed disk drive with 224 MB capacity, is planned for delivery in late 1984. Both are high performance drives targeted at the SMD interface market.

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

415/367-2011

1983 disk sales: \$40,800,000

1983 total net sales: \$6,074,000,000

Net income: \$103,000

While most of Ampex' disk drive revenues have been derived from disk pack drives in recent years, the balance is now shifting to 14" and 5.25" Winchester models. A previously announced 8" fixed disk drive was dropped in 1983, victim of an overly lengthy development period. The existing 14" rack mounted OEM Winchester drives were successfully introduced in 1981, before several competitive drives. Ampex took a license from Rodime for 5.25" drives, with production now underway at Hong Kong.

APPLE COMPUTER, INC.  
20525 Mariani Avenue  
Cupertino, CA 95014

408/996-1010

1983 total net sales: \$983,000,000

Net income: \$76,700,000

After several on-and-off programs to develop disk drives for internal production, Apple finally started production for 5.25" Winchester drives in mid-1984. The initial drive is being used in the Lisa system, with the expectation that other applications will be added as production increases.

APPLIED INFORMATION MEMORIES  
776 Sycamore Drive  
Milpitas, CA 95035

408/263-9321

Started in 1982 to develop high capacity 5.25" drives using perpendicular recording, AIM has changed direction and has developed 5.25" fixed disk drives using longitudinal recording. Delivery of its first drive, with 133 MB capacity and 18 millisecond average seek time, is starting in the second half of 1984, and a 250 MB version is scheduled for early 1985. Disks will be internally produced using a hybrid plated/sputtering process, and a new production facility has been established in Austin, Texas.

APPLIED PERIPHERAL SYSTEMS  
 Subsidiary of Dyan Corporation  
 555 East Brokaw Road  
 San Jose, CA 95112

408/995-6700

1983 disk sales: \$1,400,000  
 1983 total net sales: \$180,000,000

Net income: \$7,700,000

Applied Peripheral Systems was established in 1982, when Dyan split Dastek into two entities: Development and manufacture of thin film heads stayed with Dastek, and the previously announced disk drives became the responsibility of APS. The firm's OEM 14" fixed disk drives now offer 200 to 640 MB capacities, using thin film heads with oxide coated Dyan disks, and with transfer rates up to 2 MB/second. Production shipments are underway, but still small.

ATASI CORPORATION  
 2075 Zanker Road  
 San Jose, CA 95131

408/995-0335

1983 disk sales: \$14,900,000

Atasi is a privately held firm started in 1981 by disk industry veterans to manufacture high capacity 5.25" Winchester fixed drives. Products with capacities from 19 to 46 MB have been in production since late 1982, giving Atasi an opportunity to secure an attractive market share through early delivery. Atasi's drives are aimed at the high performance end of the 5.25" market, with 33 ms average access times, using linear voice coil actuators. Atasi's agreed upon acquisition by Seagate fell through early in 1984, followed by a management reorganization.

ATHENAEUM TECHNOLOGY, INC.  
 105 Bay State Drive  
 Braintree, MA 02184

617/848-8388

Athenaeum was started in 1982 to develop and manufacture 5.25" disk drives in two initial configurations: A disk cartridge drive with 12 MB fixed and 12 MB removable capacity, plus a fixed disk drive with 38 MB capacity. The firm has had difficulty in obtaining financing for start of production, and has ceased operations.

BALL COMPUTER PRODUCTS  
 Division of Ball Corporation  
 P.O. Box 589  
 Broomfield, CO 80020

303/469-5511

After several years of producing disk pack drives of the SMD type, Ball is now phasing out this product line, after previously deciding not to invest in development of Winchester technology drives.



BURROUGHS CORPORATION  
Burroughs Place  
Detroit, MI 48232

313/972-7000

After many years of captive disk drive production, Burroughs acquired Memorex in late 1981. All Burroughs disk drive operations have now been consolidated in the firm's Memorex subsidiary and are reviewed under the heading for that organization.

CARDIFF TECHNOLOGY, INC.  
1354 Sea Village Drive  
Cardiff-by-the-Sea, CA 92007

619/942-0665

Cardiff was originally established in 1982 as a subsidiary of Innovative Data Technology, a manufacturer of small tape drives, with a plan to introduce a family of 5.25" disk cartridge drives. Cardiff was spun off by IDT in August, 1984, and hopes to be in production by early 1985. Initial product emphasis will be placed on a 5.25" drive with 20 MB fixed and 20 MB removable capacity.

CENTURY DATA SYSTEMS, INC.  
Subsidiary of Xerox Corporation  
1270 North Kraemer Boulevard  
Anaheim, CA 92806

714/632-0400

1983 disk sales: \$60,500,000  
1983 total net sales: \$8,463,500,000      Net income: \$466,400,000

Century's total sales have been static in the last few years, with products in production before the acquisition by Xerox in 1979 still providing most of the revenue. Disk cartridge drives, inherited from Xerox' Diablo subsidiary, were phased out in 1981. Century is pinning its future hopes on the higher capacity 14" fixed diskdrives introduced during the past two years, plus the 8" disk cartridge drive announced in mid-1982.

COGITO SYSTEMS CORPORATION  
2355 Zanker Road  
San Jose, CA 95131

408/942-8262

Cogito started operations in 1982, with funding from Chin Fong Investments, Ltd., a Taiwan organization which also owns Magnex, a thin film head manufacturer. Cogito's first products are half high 5.25" Winchester drives, with production start-up in mid-1983.

COMPUTER MEMORIES, INC.  
9216 Eton Avenue  
Chatsworth, CA 91311

213/709-6445

1983 disk sales: \$40,900,000  
1983 total net sales: \$16,027,000

Net income: \$1,211,000

CMI started shipments of 5.25" fixed Winchester drives in 1981, and has been successful in developing a stable customer base, with a very respectable market share. One of those customers, Intel Corporation, has purchased 20% of the company, along with rights to manufacture CMI products. But IBM is certainly CMI's most notable customer, with major purchases of 20 MB drives used in the PC AT. CMI has rapidly expanded its product line with half high versions and with higher capacity drives with capacities up to 40 MB.

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

612/853-8100

1983 disk sales: \$1,037,100,000  
1983 total net sales: \$4,583,000,000

Net income: \$162,000,000

In 1982 Control Data's share of OEM rigid disk drive revenues was 45.2% of the worldwide total, the first time in several years it fell below 50%, and in 1983 fell to 29.7%. CDC total OEM revenues actually declined slightly, during a year when worldwide OEM revenues jumped 47.8%. The firm's area of product weakness has been in fast-growing small fixed drive products and in certain high-end drives impacted by newer Japanese drives. Building on successful product lines in 14" disk cartridges, storage module drives, large disk pack drives, plus mid-range and large fixed disk drives, CDC has now introduced 8-9" diameter drives in most of the same product areas. Currently, many of the older OEM drives have peaked in shipments because of competition from newer configurations. However, the new CDC drives are now in production and are being well received by the firm's large, loyal customer base. Disk drives sold by Control Data are designed and manufactured by Magnetic Peripherals, Inc., a joint venture with ownership now shared by CDC, Honeywell, Sperry and Bull Peripherals. Control Data manages the joint venture and has exclusive responsibility for sales of its products in the OEM market. Drives made by MPI for sale with any of the parent company's systems are considered captive CDC drives for the purposes of DISK/TREND statistics, and captive drives for both parents are a significant portion of MPI shipments. Control Data has been a participant in the plug compatible disk drive market for several years, but its late start in the 3380 market prompted the firm to announce recently that it will phase out of the PCM market in 1985.

DATA GENERAL CORPORATION  
4400 Computer Drive  
Westboro, MA 01581

617/366-8911

1983 disk sales: \$88,300,000  
1983 total net sales: \$829,000,000

Net income: \$23,100,000

Data General manufactured all disk drive requirements internally for years, covering its requirements with several captive disk cartridge, disk pack and 14" Winchester drives. Despite the 1981 addition of a higher capacity Control Data OEM 14" Winchester to its product line, Data General has continued with introduction of internally developed drives, adding low end 8" drives in 1982, plus a 354 MB 14" fixed drive in 1983, subsequently extended to 592 MB in late 1984.

DATAPoint CORPORATION  
9725 Datapoint Drive  
San Antonio, TX 78285

515/699-7000

1983 disk sales: \$7,600,000

For several years, Datapoint manufactured captive 14" disk cartridge drives at its Magnetic Storage Division in Sunnyvale, California, under a manufacturing license originally obtained from Wangco. During the last half of 1981 the firm started deliveries of a 5.25" Winchester drive using internally manufactured plated disks. However, in mid-1984 Datapoint sold the Sunnyvale operation to Xebec, which will continue to provide disk drives to Datapoint on an OEM basis.

DIGITAL EQUIPMENT CORPORATION  
146 Main Street  
Maynard, MA 01754

617/897-5111

1983 disk sales: \$442,500,000  
1983 total net sales: \$4,271,854,000

Net income: \$283,622,000

Until recently, DEC's rigid disk drive revenues for captive products have been derived from disk cartridge drives, notably the high volume RL02. However, in 1981 a new family of 14" Winchester drives started to appear. The product with the greatest revenue expectations is the RA81, a 14" rack mounted Winchester drive with a formatted capacity of 456 MB; the other major drive in the group is the RA60, a rack mounted disk pack drive with 205 MB formatted capacity. These were DEC's first internally designed and produced high end disk drives, and the manufacturing startup for the drives and their controller was painful, but now underway. DEC's new drives will replace older drives purchased externally on an OEM basis, and all are expected to reach large production quantities. In late 1983, the Aztec, a long-delayed 8" disk cartridge drive was announced, superseding the 14" RL02.

DISC TECH ONE  
849 Ward Drive  
Santa Barbara, CA 93111

805/964-3535

1983 disk sales: \$1,400,000

In 1982 Disc Tech One acquired from M/A-Com the Ohio Scientific disk drive operation (previously owned by Okidata). Recently, the firm announced an agreement in principle to merge with Lifetech Industries Corporation, a San Diego hearing aid manufacturer. The announced intent of the merger will be to provide the additional financing needed to more fully develop production facilities for the 14" Winchester drives Disc Tech One started with, later supplemented with 8" Winchesters acquired from 3M and the Disctron 5.25" Winchesters acquired from CCT.

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

408/946-6692

1983 disk sales: \$16,700,000

1983 total net sales: \$80,700,000

Net income: (\$24,500,000)

CCT established Disctron from the combination of Data Peripherals and Rotating Memory Systems, following the acquisition of RMS in mid-1982. The 8" drives from the Data Peripherals line remain in production, but the RMS 5.25" Winchester product line was sold in 1984 to Disc Tech One. CCT has acquired a license to manufacture plated disks with the Ampex Alar process, and its Ultradisc subsidiary will produce disks for the OEM disk market.

DMA SYSTEMS  
601 Pine Avenue  
Goleta, CA 93117

805/683-3811

1983 disk sales: \$20,800,000

DMA Systems successfully started shipments of its 5.25" 5/5 MB fixed-removable disk cartridge drive in 1982, and has established a leadership position in the 5.25" disk cartridge field. More recently, capacities have been doubled on the fixed/removable drives, and an 11 MB half high has been put into production. Manufacturing licenses have been sold to Memorex, which so far is making disk cartridges but not the drives, and to Newbury Data, which started manufacturing the drives in England this year.

EPELO CORPORATION  
 Subsidiary of Xebec Corporation  
 2090 Concourse Drive  
 San Jose, CA 95131

408/263-4100

Following Frank Gibeau's departure as founding president of Atasi, he formed Epelo, with Xebec now holding a majority interest. Although the firm has not yet announced its products, it is expected to introduce high performance small diameter disk drives in mid-1985, probably making use of some Xebec internally manufactured components.

EVOTEK CORPORATION  
 1220 Page Avenue  
 Fremont, CA 94538

415/490-3100

Evotek was formed in 1981 to manufacture 5.25" fixed disk drives, with capacities ranging from 7 to 51 MB. The company had a difficult production startup phase and gave up manufacturing disk drives in late 1983. The remaining plated media operation was sold to Xidex recently.

HEWLETT-PACKARD COMPANY  
 Disc Memory Division  
 11403 Chinden Boulevard  
 Boise, ID 83707

208/376-6000

1983 disk sales: \$269,100,000  
 1983 total net sales: \$4,710,000,000      Net income: \$432,000,000

Hewlett-Packard has an extensive manufacturing operation for captive disk drives at Boise, established in 1977 and since expanded, supplemented in mid-1983 with a new \$50 million facility in Bristol, England. H-P makes disk cartridge, disk pack, and small fixed Winchester disk drives, all using 14" oxide coated disks. The newest products are 404 MB drives using 3330 technology, first shipped as a fixed drive in late 1981 and released as a removable disk pack drive in 1983. A new 132 MB 14" drive was also introduced in early 1983. The industry expects H-P to become a major producer of small fixed disk drives using advanced recording technology.

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

213/706-2505

1982 disk sales: None

Ibis is one of the most ambitious of the industry's many start up companies, due to the technical complexity of the planned product. After tentative introductions of OEM and PCM versions of a 3380 equivalent drive using composite manganese zinc heads and plated disks, Ibis has retrenched its operations, to concentrate on a parallel track version of the drive.

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INFORMATION STORAGE, INC.  
2768 Janitell Road  
Colorado Springs, CO 80906

ISI was started in 1983 by Steve Popovich, formerly president of Optical Peripherals Laboratory, the Philips and Control Data joint venture for optical disk drive development later folded into Optical Storage International. ISI has been funded by CPT and Tallgrass, each of which will have rights to products, and plans to introduce a write-once optical disk drive in the 100 MB range with a 5.25" form factor in mid-1985.

INTERNATIONAL BUSINESS MACHINES CORPORATION  
Route 22  
Armonk, NY 10504

914/765-1900

1983 disk sales: \$3,579,000,000

1983 total net sales: \$40,180,000,000

Net income: \$5,485,000,000

After an embarrassing and expensive period in which IBM had difficulty in establishing quantity production for its new generation of thin film head drives, things are now going much better. The 3370, 3375 and 3380 are being shipped in surprisingly large quantities from plants in the U.S., Europe and Japan. The industry now expects IBM to introduce a double density version of the 3380 in the first half of 1985. IBM's first significant OEM sales of disk drives were made in early 1984, and involved the 3380 -- both Siemens and Honeywell are buying the drive. For small disk drives sold on a broad basis, it may be very difficult for IBM to set competitive OEM prices, since the company can't afford to undercut the end user pricing established for the same drives when sold as detachable drives. On the other side of the coin, IBM has become for the moment the world's largest buyer of OEM disk drives, at least on a unit total basis. The firm's 5.25" disk drive requirements for personal computers and other systems have driven it to purchase OEM drives from at least five outside suppliers. In 1985, IBM is expected to make waves throughout the industry, as it introduces new drives, ranging from 14" to 3.5" disk diameter. The PCM vendors will be confronted with a double density 3380. And the outside suppliers of 5.25" drives will be affected by large new IBM internal manufacturing programs for 3.5" drives, which will find homes with single user personal computers, and 5.25" drives with higher capacities, which will be widely used with multiple user systems.

INTERNATIONAL MEMORIES, INC.  
Subsidiary of Onyx+IMI, Inc.  
10381 Bandley Drive  
Cupertino, CA 95014

408/446-9779

1983 disk sales: \$65,100,000

1983 total net sales: \$74,218,000

Net income: \$3,661,000

Despite a major boost in production due to an IBM contract for 5.25" Winchester drives, IMI's parent company has announced it will close out

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the disk drive manufacturing operation in early 1985, after existing commitments have been fulfilled. Although announcing a variety of newer drives, including half high models and high capacity drives, IMI failed to get the new products into production promptly, and was left with a bleak sales outlook for next year. A large proportion of IMI's non-IBM sales involved shipments through Onyx and Corvus, a firm sharing many investors with IMI -- and the firm had never been successful in establishing a broader customer base.

JOSEPHINE COUNTY TECHNOLOGY, INC.

1899 N.W. Hawthorne  
Grants Pass, OR 97526

503/494-5678

Josephine County Technology was started by disk drive industry veterans trying to escape the smog of San Fernando Valley. The firm plans to be in production by the close of 1984 with half high 5.25" Winchester drives, designed to be produced at extremely low cost.

KENNEDY COMPANY

Subsidiary of Magnetics & Electronics, Inc.  
a subsidiary of Allegheny International, Inc.  
1600 South Shamrock Avenue  
Monrovia, CA 91001

213/357-8831

1983 disk sales: \$5,900,000

1983 total net sales: \$2,348,000,000

Net income: \$28,300,000

Kennedy entered the OEM 14" Winchester disk drive business in 1978 with unspectacular results, as the company gradually acquired the production expertise needed to make the products it had announced. An 82 MB drive in this product line is now the main revenue producer, and a 165 MB version was added in late 1982. In addition to its own 41 and 82 MB 8" drives, Kennedy acquired in mid-1982 the BASF 8" Winchester product line. In 1984, a 165 MB 8" drive was added to the Kennedy product line.

LAPINE TECHNOLOGY CORPORATION

1111 Space Park Drive  
Santa Clara, CA 95054

408/986-8676

LaPine Technology was formed in July, 1983, to develop and manufacture 3.5" Winchester drives. The founders' experience includes several notable disk drive manufacturers. Announcement of 5 and 10 MB drives was made at the 1984 NCC, with first production planned for early 1985.

MAXTOR CORPORATION  
150 River Oaks Parkway  
San Jose, CA 95134

408/942-1700

1982 disk sales: None

Maxtor was formed in 1982 to develop and manufacture high capacity 5.25" Winchester disk drives for the OEM market, and has become the most controversial new disk drive company in years. Maxtor startled its competitors by announcing late in 1982 a family of 5.25" drives with up to 140 MB capacity. These drives, which are now in production, maintain the standard Seagate transfer rate of five megabits per second, and offer an average access time of 30 milliseconds. Eight disks are used, twice the number any other manufacturer has attempted to place in a 5.25" drive, by positioning the drive motor inside the disk's inner diameter. At the 1983 NCC, Maxtor turned up the heat again with the announcement of models with up to 380 MB, a capacity achieved with more tracks per surface and doubling the transfer rate, and now promised for late 1984 delivery. In an attempt to pave the way for the drive's higher transfer rate, Maxtor personnel led in establishment of the proposed ESDI10 megabit/second interface standard. Despite profound skepticism by competitors, Maxtor is positioned for big things if it can establish quantity production for the products already announced.

MEGAVAULT  
6431 Independence Avenue  
Woodland Hills, CA 91367

213/884-7300

SLI, a veteran industry supplier of voice coil actuators, changed its name in 1982 to reflect its new emphasis on complete disk drives. A Megavault kit is used by Texas Instruments in their current 8" Winchesters. Megavault's own 8" Winchester product line covers a capacity range from 83 to 212 MB, with choice of SCSI, SMD or ANSI interfaces.

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

408/987-1000

1983 Memorex disk sales: \$60,900,000  
1983 Burroughs disk sales: \$206,300,000  
1983 total net sales: \$4,296,500,000

Net income: \$196,900,000

Memorex was acquired by Burroughs in late 1981, and Burroughs has placed all disk drive development and manufacturing responsibility for the entire company in the Memorex organization. First production deliveries of the firm's 3380 equivalent drive were made in mid-September, 1983, as promised -- and Memorex has been trying to ramp up shipments, but various problems with heads, media and other factors have kept the production level through 1984 below plan. The Memorex OEM disk drive product line really consists

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only of 200 MB disk pack drives sold mostly to DEC, plus the resale of smaller diameter drives manufactured by others. Internally developed drives using Memorex produced 5.25" plated disks, with capacity up to 70 MB, have been announced but are not yet in volume production. The major DEC purchases of disk pack drives have declined in favor of internally manufactured drives. One of the first major projects at Memorex under Burroughs management, already satisfactorily completed, was development of controllers to make possible the use of large Memorex disk drives with Burroughs systems -- thus creating another sizeable market for Memorex drives, a captive one.

MICRODATA CORPORATION  
 Subsidiary of McDonnell Douglas Corporation  
 17481 Red Hill Avenue  
 Irvine, CA 92714

714/250-1000

1983 disk sales: \$42,500,000

1983 total net sales: \$8,111,000,000

Net income: \$274,900,000

Microdata's disk drive activity is now completely a captive operation in support of the firm's computer systems business. The 14" Reflex line of Winchester drives has been converted to the 3350 technology Reflex II version, and probably will not go beyond that point.

MICROCOMPUTER MEMORIES, INC.  
 7444 Valjean Avenue  
 Van Nuys, CA 91406

818/782-2222

MMI was formed quietly in 1982 to develop a 3.5" Winchester drive, and managed to go public in January, 1984, before the big 1984 decline in technology stocks. The firm has been shipping a 12 MB drive in 1984 and has announced a 4-platter 25 MB version to be available in first quarter of 1985.

MICROPOLIS CORPORATION  
 21123 Nordhoff Street  
 Chatsworth, CA 91311

213/709-3300

1983 disk sales: \$31,800,000

1983 total net sales: \$51,598,000

Net income: \$3,536,000

Known as the originator of high capacity 5.25" flexible disk drives, Micropolis entered the 8" Winchester disk drive market in 1979, and has become a factor in the marketplace, after the usual Winchester early production problems. The company has embarked on an ambitious development program for small high performance Winchester disk drives. Announced 8" drives cover capacities up to 331 MB and 5.25" drives go up to 170 MB.

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

415/961-2212

1983 disk sales: \$3,400,000

Microscience International was formed early in 1982 by experienced disk drive engineering managers. The firm started shipments in mid-1983 for its half high 5.25" 12 MB drive, and added a 25 MB version in mid-1984. The drive uses plated disks, and has several innovative design features intended to improve reliability.

MINISCRIBE CORPORATION  
 1871 Lefthand Circle  
 Longmont, CO 80501

303/656-6000

1983 disk sales: \$77,000,000

1983 total net sales: \$76,591,000

Net income: \$4,788,000

Production of Miniscribe's 5.25" Winchester drives started in late 1981, stayed at modest levels through most of 1982, then soared starting in late 1982 as IBM started taking 5.25" Winchester deliveries for the personal computer program. Other major OEM customers were subsequently added, and the company is definitely in a strong second place position in worldwide shipments of 5.25" Winchester drives. It's not been an easy life, however, with drastic changes in IBM's procurements in 1984, coupled with the adverse fortunes of some of Miniscribe's customers which have lost market share in the personal computer wars to IBM. Miniscribe started shipping half high 5.25" drives in the first half of 1983, and has added additional half high models, including 25 MB drives. Before the end of 1984, the firm is expected to formally announce its 3.5" drives and higher capacity 5.25" models.

NEW WORLD COMPUTER COMPANY, INC.  
 6670 Amador Plaza Road  
 Dublin, CA 94568

415/463-9292

1983 total net sales: \$9,000

Net income: (\$2,106,000)

New World Computer is the industry's perennial startup company. The firm was organized in 1977, and in 1979 announced an unconventional 8" disk drive with multiple heads per slider. The product line went through various model revisions over the years, eventually becoming a removable cartridge drive using 5.25" plated disks, while retaining the concept of using several heads on each slider. The firm was not able to successfully start production and subsequently was merged with LAN Systems, Inc. The New World Computer name was retained, but the company is under new management, and has been moved to Northern California from its original Orange County location. The emphasis is now on a subsystem version of the drive which is being sold to value added resellers and large end users.

NORTHERN TELECOM, INC.

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

615/256-5900

1983 disk sales: \$25,500,000

1983 total net sales: \$2,542,000,000      Net income: \$207,000,000  
 (Basis: C\$ 1.30 = U.S.\$1)

Northern Telecom manufactures captive disk drives at Minneapolis for small computer systems. The principal product still in production is an 8" fixed Winchester technology drive with 22 MB formatted capacity. In 1983 Northern Telecom also formed the Memory Systems Division in Ann Arbor, Michigan, which is shipping a family of high performance 8" Winchester drives, with capacities up to 378 MB.

OPTICAL STORAGE INTERNATIONAL

Joint venture of Philips and Control Data  
 3333 Scott Boulevard  
 Santa Clara, CA 95052

408/496-3333

OSI was formed in early 1984 to design, manufacture and market optical disk drives and the required media. It has assumed responsibility for the two parents' earlier joint ventures, Optical Media Laboratory in Holland and Optical Peripherals Laboratory in Colorado. The first OSI product is a 1 gigabyte write-once drive using 12 tellurium/glass disks, with delivery of evaluation units now starting.

PER SCI, INC.

Subsidiary of EF Industries  
 12624 Daphne  
 Hawthorne, CA 20250

213/777-7536

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

PRIAM CORPORATION

20 West Montague Expressway  
 San Jose, CA 95134

408/946-4600

1983 disk sales: \$83,300,000

1983 total net sales: \$63,448,000      Net income: \$4,795,000  
 (FY ending 6/30/83)

Priam became a significant supplier of OEM Winchester disk drives in 1981, as volume production was achieved for the firm's original line of mid-

range 14" drives and shipments of 8" drives got underway. 8" Winchesters with capacities up to 330 MB are now in production, and a 495 MB version is promised this year. 5.25" drives with 86 MB capacity are also starting into production. Priam has continued to limit its product line to high performance OEM disk drives, but with an emphasis on producibility.

QUANTUM CORPORATION  
1804 McCarthy Boulevard  
Milpitas, CA 95035

408/262-1100

1983 disk sales: \$60,600,000

1983 total net sales: \$67,069,000(FY end 3/84) Net income: \$10,673,000

Quantum's original game plan was to provide a low-cost upgrade for the market created by Shugart Associates' SA 1000 8" Winchester drives. The Quantum plan worked very well, and the firm has become a high growth operation. The 10 MB SA 1000 was a major product, and its customer base welcomed the 20, 30 and 40 MB 8" Quantum drives, which provided additional capacity with the same interface and file organization. 5.25" drives with similar capacities were added in 1983, and are enjoying excellent growth. The firm is expected to add to the 5.25" product line and has set up a separate subsidiary led by key Quantum managers, QEW Corporation, to develop other small drives.

QUME CORPORATION  
Subsidiary of International Telephone & Telegraph Corporation  
2350 Qume Drive  
San Jose, CA 95150

408/942-4000

1983 total net sales: 14,155,000,000

Net income: \$675,000,000

Qume entered the floppy drive business in 1979, with products originally licensed from YE Data. Qume plans to manufacture and sell half high 5.25" Winchester drives under license from Tulin, a start-up company financed by ITT. Qume's drives initially will be similar to Tulin's, providing a second sourcing function.

REFERENCE TECHNOLOGY, INC.  
1832 North 55th Street  
Boulder, CO 80301

303/449-4157

Reference Technology was formed in March, 1982, to develop and market a read-only optical disk drive system, in which video laserdisks designed for NTSC television programs are used to replicate either digital data or images. The first product uses a 12" disk, with replication services available from 3M, and will be sold as an OEM product. Target markets are owners of specialized databases.

SEAGATE TECHNOLOGY  
920 Disc Drive  
Scotts Valley, CA 95066

408/438-6550

1983 disk sales: \$221,700,000  
1983 total net sales: \$110,441,000(FY end 6/83) Net income: \$13,089,000

The term "Seagate compatible" has become part of the industry's language. In 1981, Seagate shipped two thirds of the 5.25" drives produced world-wide, with 35,000 units -- and another defacto standard was created. In 1982, Seagate's many new competitors nibbled the company's worldwide share of low end 5.25" Winchesters down to 40%, but the firm held almost the same market share in 1983. Seagate's future is expected to be in two directions -- up in capacity and down in size. Announcements at the 1984 Fall Comdex are expected to include a high end 5.25" drive and 3.5" 10 and 20 MB drives. The existing single platter 12 MB half high 5.25" ST212 will be supplemented with the 25 MB two platter ST225. Seagate has taken the lead in moving production for its high volume drives offshore, with major layoffs of employees in California.

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

408/733-0100

1983 disk sales: \$56,700,000  
1983 total net sales: \$8,463,500,000 Net income: \$466,400,000

Shugart Associates took advantage of its early leadership in flexible disk drives with its 1979 introduction of an early low-end 14" Winchester drive, the 14" SA 4000. But the 8" SA 1000, a year later, was the real winner, until competition at the same capacities from 5.25" drives became severe. Unfortunately, Shugart Associates' performance with newer rigid disk drives was not as good. Delays in the SA 1100 capacity upgrade for the SA 1000 enabled Quantum to dominate that market segment, and similar delays for the SA 600 5.25" Winchester prevented Shugart from securing a significant share of the booming 5.25" market. Special new internal programs to establish entrepreneurial-style emphasis on high priority development projects seem to be paying off for Shugart, however, and the firm is an early participant in the half high 5.25" Winchester market and in 12" write-once optical disk drives, through its Optimem subsidiary.

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

303/673-5151

1983 disk sales: \$81,800,000  
1983 total net sales: \$886,626,000 Net income: (\$40,867,000)

STC doubled its PCM drive shipments in 1981, and did even better with its PCM drive revenues, because of the transition to double density 3350 type

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drives. But PCM disk drive vendors hit the wall in 1982, as IBM 3380 shipments started in earnest, and 1983 saw a collapse in shipment rates. STC was faced with the need to scale back production, well before its next generation of IBM compatible drives was ready for production. Like other PCM disk drive manufacturers, STC hoped to start shipping 3380 equivalent drives in third quarter of 1983, but failed. Volume shipments didn't start until early 1984, but it looks like the firm might achieve its revised 1984 plan for 5,000 drives. All these delays have been tough on the financial results, however, and losses continue, combined with substantial layoffs.

SYQUEST TECHNOLOGY  
47923 Warm Springs Boulevard  
Fremont, CA 94538

415/490-7511

1983 disk sales: \$1,700,000

SyQuest was started in early 1982 to design and manufacture disk drives using 3.9" (100 mm) plated disks, in both fixed and removable disk configurations. SyQuest's plan was extremely ambitious, with a production start up scheduled before the end of 1982 and very large quantities planned for 1983. Unfortunately, technical problems with the drive severely compromised the big plans, and the firm didn't get into volume production with a reliable drive until late 1983. Since that time, however, the SyQuest drive has sold well in the personal computer add-on market, filling a demand for removable media drives with higher capacity than the floppy drives offered by IBM. A license has been taken by Nippon Systemhouse for sales in Japan, and SyQuest has been negotiating with U.S. drive manufacturers in an attempt to establish the second source most system manufacturers demand for OEM disk drives.

TANDON CORPORATION  
20320 Prairie Street  
Chatsworth, CA 91311

213/993-6644

1983 disk sales: \$48,100,000

1983 total net sales: \$303,369,000

Net income: \$23,658,000

Tandon's growth rate in flexible disk drives exceeds other U.S. manufacturers, and the firm is making a successful bid to become a major supplier of 5.25" Winchester drives. Consistent with the firm's philosophy of maximum practical vertical integration, Tandon internally manufactures a very high proportion of its drives' content, including plated disks. In contrast to its largest 5.25" Winchester competitors, Seagate and Miniscribe, Tandon was not able to sell these products to IBM, and was late in establishing production for half high models. As a result, in 1983 the company was in third place in worldwide shipments for 5.25" Winchesters.

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

213/842-0077

1983 disk sales: \$6,300,000

Tecstor acquired rights in 1981 to a 14" Winchester drive developed by BASF in Europe, but never placed in quantity production. Tecstor's production started at the end of 1981, and the firm now offers a family of high performance 14" fixed disk drives with capacities from 82.9 to 331.8 MB. While all of these drives offer interface and file compatibility with several of the Control Data drives in the SMD interface family, the two models over 300 MB are best positioned to develop significant market share.

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

713/937-2000

1983 disk sales: \$78,000,000

1983 total net sales: \$4,579,800,000

Net income: (\$145,400,000)

TI is assembling 8" Winchesters for captive use with TI computer systems, under a license from Megavault, but is phasing out production of 5.25" Winchesters. The 5.25" drives were manufactured for captive use, originally under a Seagate Technology license. TI had planned to use the 5.25" drives as its entry point into the OEM disk drive market, but withdrew that program in 1983 after limited success.

TULIN CORPORATION  
2393 Qume Drive  
San Jose, CA 95131

408/942-1717

Tulin started production shipments of its family of half high 5.25" Winchester disk drives in March, 1984. With initial funding from ITT, the parent of neighboring Qume Corporation, and founders with extensive disk drive industry backgrounds, Tulin's drives range from 13 MB to 40 MB.

VERMONT RESEARCH CORPORATION  
Precision Park  
North Springfield, VT 05156

802/886-2256

1983 disk sales: \$2,300,000

1983 total net sales: \$10,100,000

Net income: (\$1,488,000)

VRC has been primarily a manufacturer of head-per-track disk drives and magnetic drum memories, with manufacturing both in Vermont and England. Lower demand for these memory devices has caused flat sales and a shrinkage in the company's staff. A 14" high capacity disk cartridge drive with

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embedded servo has been produced for several years for militarized computer systems. In 2nd quarter of 1983, VRC started shipping fixed/removable and removable-only disk cartridge drives using the Dysan 8" disk cartridge.

VERTEX PERIPHERALS  
2150 Bering Drive  
San Jose, CA 95131

408/942-0606

1983 disk sales: \$1,500,000

Vertex was started in 1982, with founders primarily from Shugart Associates, to manufacture high capacity 5.25" Winchester disk drives. Drives with 30.8, 51.4 and 72 MB capacity, and offering 30 milliseconds average access, were first shipped in fourth quarter, 1983, and an 85 MB drive was added in late 1984.

WESTERN DYNEX CORPORATION  
3536 West Osborn Road  
Phoenix, AZ 85019

602/269-6401

1983 disk sales: \$5,200,000

Western Dynex managed to stay profitable in the 14" disk cartridge drive business longer than most others, because of its highly efficient, low cost manufacturing operation. But OEM shipments of disk cartridge drives below 12 MB capacity are falling off fast, and Western Dynex has elected to enter the 5.25" disk cartridge race, with first deliveries scheduled for the second half of this year. The drive will use the Dysan 5.25" cartridge, and was originally intended to be Seagate compatible. With Seagate's withdrawal of its announced disk cartridge drive, Western Dynex becomes the only company in the industry to offer a removable-only 5.25" disk cartridge drive as its sole product in the field. Rather than emphasize OEM sales, Western Dynex is expected to develop subsystems aimed at specific vertical markets.

XEBEC  
2055 Gateway Place  
San Jose, CA 95110

408/287-2700

1983 total net sales: \$57,487,000

Net income: \$3,794,000

Xebec's management has been looking for an entry point into the disk drive manufacturing business for years, as an extension of the firm's success in producing high-volume controllers. In 1984, they found several entry points. In April, Xebec acquired the Datapoint Sunnyvale operations, which included production of plated disks and a 5.25" Winchester drive. Also in the Spring, the company funded Frank Gibeau's Epelo start-up for high performance small disk drives, and acquired a majority interest. And at the NCC, the Owl, an internally manufactured half high 5.25" drive with built-in SASI, and a 3.5" Winchester to be produced next year, were shown.

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Japanese Manufacturers

(Exchange basis: 240 Yen = \$1)

## FUJITSU LIMITED

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

(03)216-3211

1983 disk sales: \$693,600,000

1983 total net sales: \$3,986,763,000

Net income: \$201,104,000

Fujitsu is known as the leading manufacturer of computers for the Japanese domestic market and a worldwide factor in computer export markets. But the extent of Fujitsu's disk drive business is less well appreciated. In 1982 the company moved up to third place in worldwide total disk drive revenues. Fujitsu has transitioned from heavy reliance on removable disk drives to a product line consisting mainly of fixed disk drives in all capacity ranges and in several disk diameters. The company's most impressive captive drives are 10.5" models which provide the Fujitsu answer to IBM's 3370 and 3380 drives. Fujitsu has also offered most of its captive drives in OEM versions, using industry standard OEM interfaces, and is now the only non-U.S. firm to achieve any significant penetration of the U.S. market for OEM rigid disk drives. Particularly effective in the OEM market have been several fixed disk drives: The high performance 14" 84/168 MB, 8" 48/84/168 MB drives, and the 10.5" 474 MB "Eagle" high performance drive with 1.8 MB/sec transfer rate. During 1984 higher capacity versions of several existing OEM drives were announced.

## HITACHI, LTD.

6-2, Otemachi, 2-chome  
Chiyoda-ku, Tokyo 100

(03)270-2111

1983 disk sales: \$275,200,000

1983 total net sales: \$16,431,946,000

Net income: \$627,245,000

While Hitachi is Japan's largest manufacturer of electrical and electronic equipment, it is only the third largest Japanese manufacturer of computer systems. While the firm no longer manufactures removable disk drives, it currently makes a wide range of Winchester technology fixed disk drives which are sold as captive drives with Hitachi computer systems and, in several cases, as OEM drives. In addition to significant OEM sales of smaller capacity fixed disk drives, Hitachi also sells IBM compatible 635 MB and 3380 equivalent drives to National Advanced Systems for distribution with NAS systems in the U.S., and in 1983 started selling 3380 equivalent drives to BASF for distribution in the European PCM market.

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

(045) 531-1231

1983 total net sales: \$1,044,488,000

Net income: \$51,204,000

Matsushita Communication Industrial is a member of the Matsushita Electric industrial group, which is a worldwide giant in appliances and electronics. MCI has been the licensee for Shugart Associates' flexible disk drives in Japan for many years, and currently manufactures most of the Shugart Associates floppy models for the Japanese OEM market. In 1981, MCI announced several Winchester technology fixed disk drives, including low end 5.25" drives and a family of 8" Winchester drives of its own design, using linear voice coil actuators. The drives were later dropped as specific OEM products, but it is believed the firm is prepared to ship them as part of systems manufactured on a contract basis.

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

(03) 218-2111

1983 disk sales: \$35,400,000

1983 total net sales: \$6,489,833,000

Net income: \$145,920,000

In addition to being one of Japan's leading electronic and electrical products manufacturers, Mitsubishi Electric is a leader in the domestic small business systems market. The company is phasing out of production of a variety of removable disk types and adding small and mid-range Winchester technology drives. Captive shipments are the major portion of Mitsubishi's disk drive shipments, but the firm has a growing OEM business in 14", 8" and 5.25" Winchester drives.

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

(03) 454-1111

1983 disk sales: \$419,000,000

1983 total net sales: \$6,012,746,000

Net income: \$33,031,000

NEC has defined its product area as communications and computers, with computer products currently accounting for about one fourth of the firm's total revenues. Except for continuing production of large disk pack drives, all current disk drive production involves fixed disk drives, from large to small configurations, for both captive and OEM markets. Fixed disk drives include 14", 8" and 5.25" disk diameters, with large scale production for 8 and 5.25" drives.

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

(03) 613-1111

1983 disk sales: \$6,600,000

1983 total net sales: \$88,617,000

Net income: \$425,000

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

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

(0466) 26-8211

1983 disk sales: \$40,300,000

Fujitsu and Hitachi own NPL equally as a joint venture. NPL has the charter to develop advanced disk drives and other magnetic peripherals, and has developed its own versions of most IBM new disk drives introduced since the 3340. Drives developed by NPL may be sold by that firm or the designs may be adapted to the specific requirements of the parent companies and produced by those firms as captive drives. Currently, the major portion of NPL's independent sales are to BASF, which markets PCM drives in Europe, and to Memorex, which markets 3370 equivalent drives in Europe and the U.S. These shipments are treated as PCM shipments by NPL in DISK/TREND statistics to avoid distortion of PCM market totals.

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

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

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

(03) 333-9631

1983 total net sales: \$29,504,000

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

SORD COMPUTER CORPORATION  
20-7, Masago 5-chome  
Chiba-shi, Chiba 260

(0472) 79-2611

1983 disk sales: \$9,600,000

1983 total net sales: \$64,192,000

Net income: \$3,988,000

Sord is the entrepreneurial wonder of the Japanese computer industry, growing from its founding in the early 1970's to become a major player in the Japanese domestic personal computer industry. The firm offers a wide variety of microcomputer based systems, and has developed its own advanced operating system. Production of 5.25" Winchester disk drives for captive use with Sord systems started in 1983.

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

(0422) 53-1111

1983 disk sales: \$2,000,000

1983 total net sales: \$221,496,000

Net income: 4,942,000

TEAC has taken steps in recent years to expand into computer peripherals, in recognition of slow growth in the worldwide market for quality audio tape decks, its major product area. TEAC has shipped 5.25" flexible disk drives since 1978, with rapid growth. 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. Production started in the second half of 1982, and the firm added a 12 MB half high drive in 1983, for worldwide distribution

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

(044) 244-3111

1983 disk sales: \$6,000,000  
1983 total net sales: \$338,492,000

Net income: \$5,538,000

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

TOSHIBA CORPORATION  
1-6, Uchisaiwaicho 1-chome  
Chiyoda-ku, Tokyo 100

(03) 501-5411

1983 disk sales: \$185,000,000  
1983 total net sales: \$10,004,217,000

Net income: \$160,158,000

Toshiba is a major factor in consumer electric and electronic products, plus a wide range of industrial electronic products and heavy electric power equipment. The company also has a leading position in the Japanese office computer market. Rigid disk drive production is concentrated in captive products, including disk cartridge and disk pack drives, plus newer Winchester technology fixed disk drives in low- and mid-range capacities, in both 14" and 8" disk diameters. Selected drives are also sold in the Japanese OEM disk drive market.

European Manufacturers

(Exchange basis indicated for each firm)

BASF AG

D-6700 Ludwigshafen

West Germany

(0621) 4 00 81

1983 disk sales: \$4,000,000

1983 total net sales: \$15,140,000,000      Net income: \$206,800,000  
(Basis: DM 2.40 = U.S.\$1)

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

## BULL PERIPHERALS

Subsidiary of Compagnie des Machines Bull

94, Avenue Gambetta

75960 Paris Cedex 20

France

(1) 360 02 22

1983 disk sales: \$79,300,000

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

HIGHTRACK COMPUTER TECHNIK GMBH  
Bundesallee 36/37  
D-1000 Berlin 31  
West Germany

(030) 86 04 97

Hightrack attempted for several years to complete the design for 8" Winchester drives, and start production in Berlin in a cooperative arrangement with Nixdorf. However, the deal fell through, and Hightrack, lacking the resources to continue, has closed down its facilities.

ISOT  
51, Chapaev St.  
Sofia, Bulgaria

1983 disk sales: \$101,400,000

Disk drives manufactured by ISOT, the Bulgarian state computer organization, are exported throughout Eastern Bloc countries by Isotimpex, the foreign trade organization for Bulgarian computer equipment and other electronic products. Isotimpex is currently marketing drives compatible with IBM 2314 and 3330 disk pack drives, plus disk cartridge drives and ISOT's newest product, a 14" 80 MB disk pack drive similar to Control Data's storage module drives.

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

(0784) 51388

1983 disk sales: \$16,600,000

Newbury Data is the new name for the organization known previously as Data Recording Equipment, or DRE. Disk drive products now sold by Newbury Data were manufactured for several years by a joint venture company owned by DRI, its parent firm (which in turn is controlled by an agency of the British government), and Magnetic Peripherals, Inc., the U.S. disk drive development and manufacturing firm managed by Control Data. The joint venture, was dissolved last year, and DRI regained ownership. Newbury Data is now continuing to sell under license some of the CDC products previously made by the joint venture, but is placing emphasis on new disk drives to be produced under manufacturing licenses with other U.S. firms. Newbury Data has agreed with DMA Systems on a license for the DMA 5.25" disk cartridge drives, and is also starting production on Maxtor 140 MB 5.25" drives under a license from that firm.

NIXDORF COMPUTER AG  
 Furstenallee 7  
 4790 Paderborn  
 West Germany

(05251) 2 00 1

1983 disk sales: \$80,000,000

Nixdorf's business has grown by an average 23% per year during the past five years, and the firm has undertaken various programs to control costs through internal manufacturing programs. Nixdorf now manufactures storage module drives in Germany, under a license from Control Data, for captive shipment with Nixdorf systems, and is expected to start production soon for its own internally developed 8" Winchester drives.

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

(0125) 525

1983 disk sales: \$62,400,000

Under Olivetti's current management, the firm has undertaken numerous changes to modernize the company's product lines and drop out of older lines. The Olivetti Peripheral Equipment organization represented a consolidation of the firm's printer and disk memory activities in 1980. This organization has established production for 5.25" Winchester disk drives at Ivrea, with both captive and OEM markets in mind. In 1983, Olivetti withdrew from Irwin Olivetti, the Ann Arbor, Michigan, firm which was to have had marketing responsibility for Olivetti's peripherals in the U.S. The big change in Olivetti's lifestyle during the past year was purchase of a 25% share in the company by American Telephone and Telegraph, and adoption of an Olivetti-designed personal computer for distribution by AT&T. Production of small disk drives for this program is now in a rapid growth phase.

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

213/882-0030

1983 disk sales: \$6,400,000

Pertec, a pioneer manufacturer of OEM 14" disk cartridge drives, was acquired by Triumph Adler in early 1980, and is expected to sell the organization to a U.S. company before the close of 1984. After struggling to bring its disk drive line up to date, the initial 8" Winchester drives, announced a few years ago, was been dropped in favor of a new 8" 300 MB drive. Meanwhile, the old disk cartridge line, although declining, provides monthly cash flow.

## 1984 DISK/TREND REPORT



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

(0592) 757441

1983 disk sales: \$35,300,000  
 1983 total net sales: \$27,609,000 (FY end 9/83) Net income: \$4,649,000  
 (Basis: Pound = \$1.45)

Rodime is a rare European phenomenon: A successful 5.25" OEM disk drive start up company, which has proceeded to become the first disk drive manufacturer to achieve large volume production of 3.5" Winchester drives. After being formed in late 1980 by key personnel from the Burroughs facility in Glenrothes, Rodime met its schedule for shipments in 1981, and achieved a healthy growth rate in 1982 and 1983. Ampex acquired a license to sell and manufacture the Rodime drives in the United States. Rodime has expanded its product line to include 5.25" models with as much as 53 MB capacity.

ROM CONTROL DATA S.R.L.  
 Bucharest  
 Romania

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

SIEMENS AG  
 Data and Information Systems Group  
 Otto-Hahn-Ring 6  
 D-8000 Munchen 83  
 West Germany

1983 disk sales: \$38,000,000  
 1983 total net sales: \$15,788,202,000 Net income: \$297,278,000  
 (Basis: DM 2.50 = U.S.\$1)

Siemens manufactures rigid disk drives of its own design for captive use with its mainframe systems, which continue to be a major factor in the European computer market, though a small part of Siemens total revenue. Existing products include several disk pack drives and a large fixed disk drive using 3350 technology. Siemens has indicated that it will announce a 5.25" Winchester disk drive with capacities up to 300 MB at the 1984 Fall Comdex, with plans to sell it in the U.S. and European OEM disk drive markets.