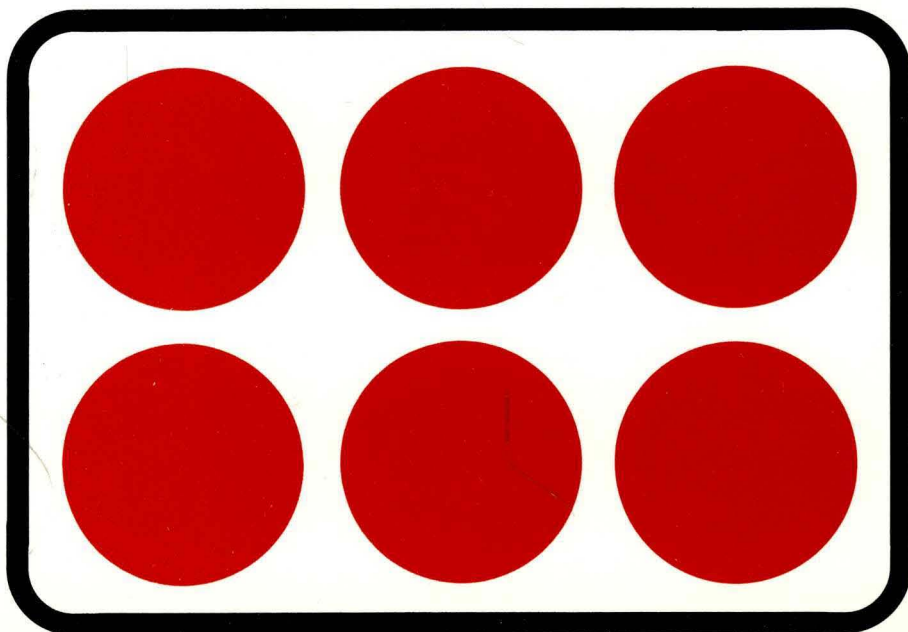


## 1988 DISK/TREND<sup>®</sup> REPORT

FLEXIBLE  
DISK  
DRIVES



# 1988 DISK/TREND<sup>®</sup> REPORT

FLEXIBLE DISK DRIVES

November, 1988

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## FOREWORD

Microfloppy drives have assumed shipment leadership in the flexible disk drive industry, which is now dedicated primarily to production of OEM drives. Reflecting continuing growth in the personal computer market, total floppy drive shipments are enjoying healthy growth, and some of the leading manufacturers are increasing shipments even faster.

Unfortunately, the continuing pressure on average unit prices is expected to continue indefinitely. Despite increasing unit shipments, we expect total floppy drive revenues to flatten out and decline after 1989. Unless the number of active floppy drive producers declines, which is not considered probable in the near future, making a profit in this industry will continue to require outstanding manufacturing efficiency.

This is the twelfth year of the DISK/TREND Report, which is now published in three volumes, including the report on optical disk drives, first published in 1986. A separate report on rigid disk drives was published in October. Starting this year, all tables and specifications used in each report are also available on diskette.

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

James N. Porter

Robert H. Katzive

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## INTRODUCTION

### Different numbers, but no change in product groups

As regular users of the DISK/TREND Report know, we have followed a deliberate policy of avoiding revision of the DISK/TREND product groups until changes in the industry make it necessary to do so. So, we waited until last year to combine one side and two sided 8 inch drives into a single product group and to establish a separate group for floppy drives with more than 5 megabytes capacity.

We are now considering further changes for the 1989 edition of the report. At this point, it is likely that we will combine one side and two sided 5.25 inch drives into a single group, due to the shrinking shipment levels of one side drives. In addition, we will be watching the micro-floppy group closely, with the possibility that we will split 2.0 inch drives into a separate group if the shipments increase rapidly. The spiral track floppy drive group will also be watched closely as shipments decline, and the product group will be dropped when appropriate.

In the meantime, we have revised the numbers used to identify each group, due to changes made earlier in the rigid disk drive groups. Here is the list of product groups used in this report:

<u>Group number</u>	<u>Products</u>
13.	8 inch drives, one and two sides
14.	5.25 inch drives, one side
15.	5.25 inch drives, two sides
16.	Microfloppy drives, one and two sides
17.	High capacity flexible disk drives, over 5 megabytes
18.	Spiral track drives

### This information will help you use the report

- \* All unit totals are given in spindles. A disk drive containing two spindles is counted in DISK/TREND statistics as two drives.
- \* All disk drive revenues are reported at the level of the first public sale, at the estimated transaction price, whether the sale occurs at the captive end user, PCM or OEM levels.
- \* Prices for most OEM drives sold in the United States are shown, usually at the 500 unit level. When prices for higher quantities have been used, the applicable quantity is shown in parentheses. Please remember that prices may be changed without notice by the manufacturers.

## Summary

### Industry size

The floppy disk drive industry ended 1987 with better results than anticipated in last year's DISK/TREND Report. Worldwide unit shipments of all floppy drives were 30.3 million drives, two million more than expected, and total revenues were \$2.7 billion, up 8.7% over the previous year. Underlying the good news was a strong personal computer market: Introduction of the IBM PS/2 and strong growth for the Apple Macintosh, portable computers and other new systems helped to double microfloppy shipments; and surprising momentum for PC AT clones maintained slight growth in shipments for two sided 5.25 inch drives for one more year.

We have also raised the forecasts for succeeding years, with average annual shipments expected to increase 7.4% through 1991, reaching 40.3 million drives in that year. We expect total floppy drive revenue to increase marginally for two years, however, and then to decline slightly. Unfortunately, the unit shipment increases cannot overcome the negative effects on revenue of continually declining unit prices and the transition to newer drives at lower basic prices. The continuous reduction in captive drive revenues also contributes to a lower combined total.

The withdrawal of U.S. manufacturers from the floppy drive industry is now almost complete, except for the emerging high capacity floppy drive market. Several interesting small U.S. firms are pioneering the effort to develop high capacity floppies which could capture a potentially large future market from other technology approaches, such as tape cartridges, removable rigid disks and erasable optical disks.

TABLE 1  
CONSOLIDATED WORLDWIDE REVENUES  
ALL EXISTING FLEXIBLE DISK DRIVE GROUPS  
REVENUE SUMMARY

	-----DISK DRIVE REVENUES, BY SHIPMENT DESTINATION (\$M)-----									
	1987		1988		1989		1990		1991	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM Captive	23.2	35.2	13.3	20.1	6.9	10.5	--	--	--	--
Other U.S. Captive	22.0	38.5	7.0	13.0	--	--	--	--	--	--
TOTAL U.S. CAPTIVE	45.2	73.7	20.3	33.1	6.9	10.5	--	--	--	--
PCM	38.2	45.9	41.1	51.4	45.7	57.7	45.3	58.5	41.5	54.5
OEM	27.4	38.8	18.5	27.5	26.5	36.4	42.7	54.3	61.2	82.1
TOTAL U.S. NON-CAPTIVE	65.6	84.7	59.6	78.9	72.2	94.1	88.0	112.8	102.7	136.6
TOTAL U.S. REVENUES	110.8	158.4	79.9	112.0	79.1	104.6	88.0	112.8	102.7	136.6
Non-U.S. Manufacturers										
Captive	56.9	692.8	61.4	651.5	65.2	645.2	73.8	620.8	85.2	577.4
PCM	--	--	--	--	--	--	--	--	--	--
OEM	882.2	1,840.0	961.8	2,014.1	1,006.7	2,088.7	1,099.7	2,075.4	1,166.0	2,015.8
TOTAL NON-U.S. REVENUES	939.1	2,532.8	1,023.2	2,665.6	1,071.9	2,733.9	1,173.5	2,696.2	1,251.2	2,593.2
Worldwide Recap										
TOTAL WORLDWIDE REVENUES	1,049.9	2,691.2	1,103.1	2,777.6	1,151.0	2,838.5	1,261.5	2,809.0	1,353.9	2,729.8



### Marketing channels

The list of manufacturers participating in the flexible disk drive industry seems to be in an era of stability, with 56 companies in 1988, only one less than last year.

There are now 36 Asian flexible disk drive manufacturers, the same number as a year ago. 21 are Japanese companies, and these firms, of course, generate about 98% of the current worldwide revenue for OEM floppy drives. 10 U.S. companies are still producing floppy drives, but the floppy drive programs at IBM and Digital Equipment are approaching end of life and most other U.S. manufacturers currently generate very small revenues from floppy drives, except Iomega, which is now the U.S. leader in revenues.

The share of worldwide revenues held by captive drive producers, which was 54% five years ago, was down to 28.5% in 1987, and is forecasted to decline to 21.2% in 1991. The biggest contributor to this trend has been the phase-out of most captive floppy drive production by IBM and other U.S. system manufacturers, in favor of purchases from producers of OEM drives.

Users of the DISK/TREND Report should note that revenues are reported at the level of each drive's first public sale. The price used for each drive is the estimated value at the first time it is sold to a non-affiliated buyer, at captive end user, PCM or OEM levels. 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.

TABLE 2  
 CONSOLIDATED WORLDWIDE REVENUES  
 ALL EXISTING FLEXIBLE DISK DRIVE GROUPS  
 MARKET CLASS REVIEW

## REVENUE SUMMARY

WORLDWIDE REVENUES BY MANUFACTURER TYPE	-----1987-----		-----Forecast-----							
	---Revenues---		-----1988-----		-----1989-----		-----1990-----		-----1991-----	
	\$M	%	\$M	%	\$M	%	\$M	%	\$M	%
-----										
U.S. Manufacturers										
-----										
IBM Captive	35.2 -73.6%	1.3%	20.1 -42.9%	.7%	10.5 -47.8%	.3%	-- --	--	-- --	--
Other U.S. Captive	38.5 -39.4%	1.4%	13.0 -66.2%	.4%	-- --	--	-- --	--	-- --	--
PCM	45.9 -35.5%	1.7%	51.4 +12.0%	1.8%	57.7 +12.3%	2.0%	58.5 +1.4%	2.0%	54.5 -6.8%	1.9%
OEM	38.8 -63.2%	1.4%	27.5 -29.1%	.9%	36.4 +32.4%	1.2%	54.3 +49.2%	1.9%	82.1 +51.2%	3.0%
Total U.S. Manufacturers	158.4 -57.6%	5.8%	112.0 -29.3%	3.8%	104.6 -6.6%	3.5%	112.8 +7.8%	3.9%	136.6 +21.1%	4.9%
-----										
Non-U.S. Manufacturers										
-----										
Captive	692.8 +15.8%	25.7%	651.5 -6.0%	23.4%	645.2 -1.0%	22.7%	620.8 -3.8%	22.1%	577.4 -7.0%	21.1%
OEM	1,840.0 +22.4%	68.5%	2,014.1 +9.5%	72.8%	2,088.7 +3.7%	73.8%	2,075.4 -.6%	74.0%	2,015.8 -2.9%	74.0%
Total Non-U.S. Manufacturers	2,532.8 +20.5%	94.2%	2,665.6 +5.2%	96.2%	2,733.9 +2.6%	96.5%	2,696.2 -1.4%	96.1%	2,593.2 -3.8%	95.1%
-----										
Worldwide Recap										
-----										
Captive	766.5 -3.6%	28.5%	684.6 -10.7%	24.6%	655.7 -4.2%	23.1%	620.8 -5.3%	22.1%	577.4 -7.0%	21.2%
PCM	45.9 -35.5%	1.7%	51.4 +12.0%	1.9%	57.7 +12.3%	2.0%	58.5 +1.4%	2.1%	54.5 -6.8%	2.0%
OEM	1,878.8 +16.8%	69.8%	2,041.6 +8.7%	73.5%	2,125.1 +4.1%	74.9%	2,129.7 +.2%	75.8%	2,097.9 -1.5%	76.8%
Total All Manufacturers	2,691.2 +8.7%	100.0%	2,777.6 +3.2%	100.0%	2,838.5 +2.2%	100.0%	2,809.0 -1.0%	100.0%	2,729.8 -2.8%	100.0%

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

Product mix

Despite unexpected strength in 1988 shipments of two sided 5.25 inch drives, an even stronger market for 3.5 inch drives has boosted micro-floppies into the lead for the first time. Unit shipments doubled in 1977, totaling 12.3 million drives for the year, and the average unit shipment increase forecasted for the five years covered in this report is 38.7%. However, the average revenue increase during the same period is lower, reflecting a continuing reduction of average OEM unit prices.

1988 is now expected to be the peak year for shipments of two sided 5.25 inch drives, with 15.3 million units, dropping to 10.8 million drives in 1991. Two sided 5.25 inch drives received their big boost from usage with IBM's original personal computer series in the first half of the 1980's. But 3.5 inch microfloppy drives gained momentum in the mid-1980's from endorsements by Hewlett-Packard, Apple Computer and several Japanese system manufacturers, and the 1987 introduction of IBM's PS/2 personal computers, all of which use 3.5 inch floppy drives, have made micro-floppies the dominant configuration. However, the loyalty of the PC AT customer base will reduce the rate of decline for two sided 5.25 inch drive shipments to only -10.8% per year in the 1989-91 period.

All other floppy drive groups are expected to decline through 1991, except for high capacity floppy drives over 5 megabytes, a product group which incorporates Iomega's Bernoulli principle drives, existing 8 and 5.25 inch drives in the 6 to 24 megabyte range, and new 3.5 inch drives with initial capacities in the 9 to 20 megabyte range. High growth rates are expected for this group, with unit shipments reaching 751,000 drives by 1991, as backup requirements for small systems become more pressing.

Figure 1  
 CHANGING PRODUCT MIX  
 WORLDWIDE FLEXIBLE DISK DRIVE SHIPMENTS  
 CONSOLIDATED REVENUE

Cumulative  
 Worldwide  
 Revenue  
 (Millions)

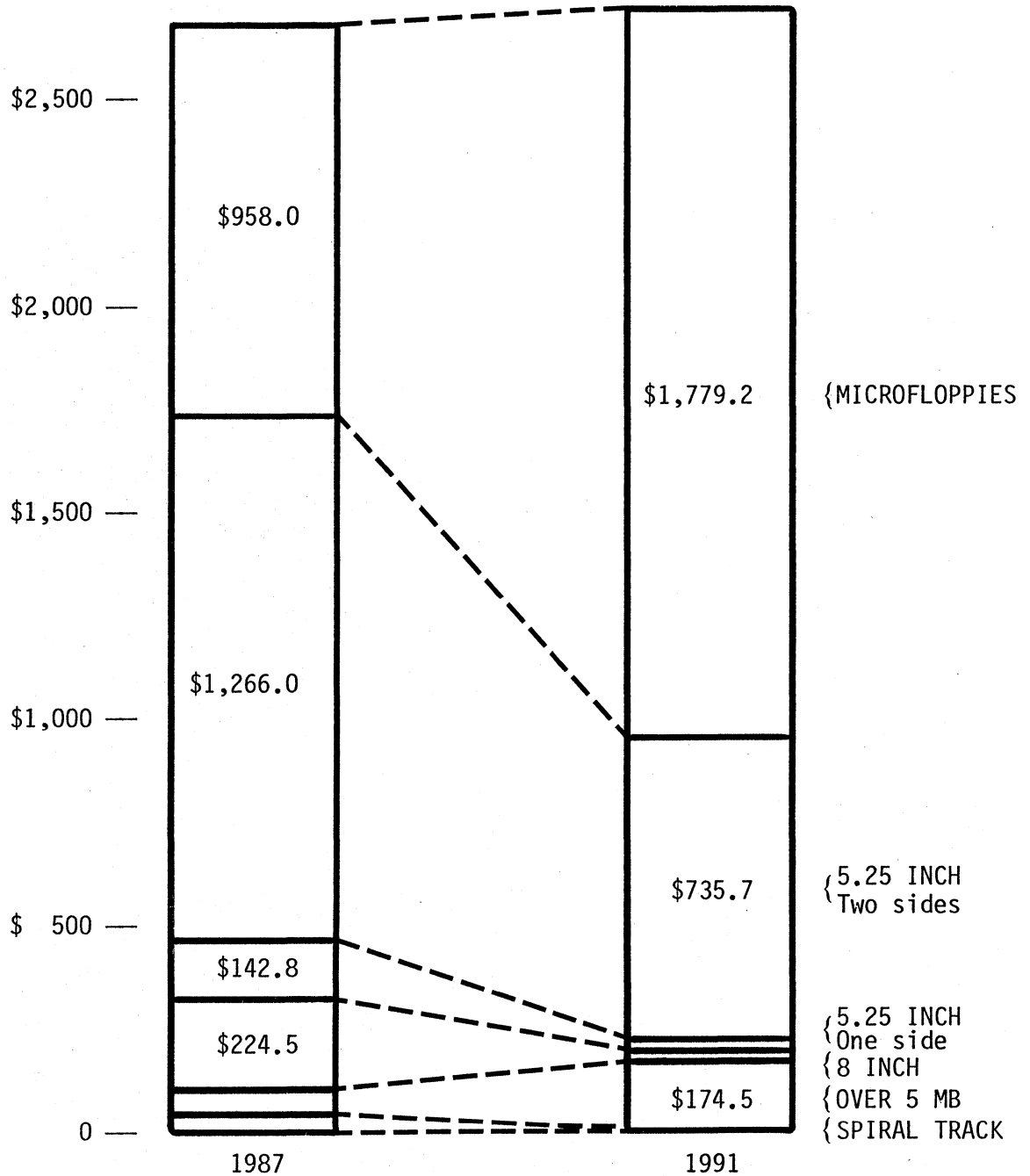


TABLE 3  
WORLDWIDE SHIPMENTS  
PRODUCT CATEGORY SUMMARY  
ALL MANUFACTURERS

Units: Thousands Dollars: \$ Million		-----1987----- ---Shipments--- Ship % -----		-----1988----- Ship % -----		-----1989----- Ship % -----		-----Forecast----- -----1990----- Ship % -----		-----1991----- Ship % -----	
8 INCH DRIVES -----											
	Units	434.1	-24.3	363.5	-16.2	225.0	-38.1	87.0	-61.3	48.0	-44.8
	\$M	224.5	-42.7	164.5	-26.7	99.0	-39.8	36.1	-63.5	16.8	-53.4
5.25 INCH DRIVES -----											
One Side	Units	1,502.4	-21.4	952.0	-36.6	545.0	-42.7	288.0	-47.1	120.0	-58.3
	\$M	142.8	-13.7	92.8	-35.0	52.1	-43.8	33.8	-35.1	20.9	-38.1
Two Sides	Units	14,729.7	+2.5	15,250.0	+3.5	14,220.0	-6.7	12,524.0	-11.9	10,791.0	-13.8
	\$M	1,266.0	-2.2	1,193.5	-5.7	1,072.2	-10.1	904.3	-15.6	735.7	-18.6
5.25 INCH TOTAL	Units	16,232.1	+ .3	16,202.0	- .1	14,765.0	-8.8	12,812.0	-13.2	10,911.0	-14.8
	\$M	1,408.8	-3.5	1,286.3	-8.6	1,124.3	-12.5	938.1	-16.5	756.6	-19.3
MICROFLOPPY DRIVES -----											
	Units	12,337.3	+99.0	17,150.0	+39.0	21,317.0	+24.2	25,410.0	+19.2	28,485.0	+12.1
	\$M	958.0	+96.7	1,230.0	+28.3	1,495.1	+21.5	1,692.4	+13.1	1,779.2	+5.1
DRIVES OVER 5 MEGABYTES -----											
	Units	111.2	-2.0	128.4	+15.4	230.0	+79.1	410.0	+78.2	751.0	+83.1
	\$M	67.3	-32.0	76.6	+13.8	108.1	+41.1	136.5	+26.2	174.5	+27.8
SPIRAL TRACK DRIVES -----											
	Units	1,157.2	-11.7	720.0	-37.7	430.0	-40.2	210.0	-51.1	95.0	-54.7
	\$M	32.6	-11.8	20.2	-38.0	12.0	-40.5	5.9	-50.8	2.7	-54.2
TOTAL ALL DRIVES -----											
	Units	30,271.9	+23.6	34,563.9	+14.1	36,967.0	+6.9	38,929.0	+5.3	40,290.0	+3.4
	\$M	2,691.2	+8.7	2,777.6	+3.2	2,838.5	+2.1	2,809.0	-1.0	2,729.8	-2.8

Figure 2  
CHANGING PRODUCT MIX  
WORLDWIDE FLEXIBLE DISK DRIVE SHIPMENTS  
ALL MANUFACTURERS

Worldwide  
Shipments  
(000 units)

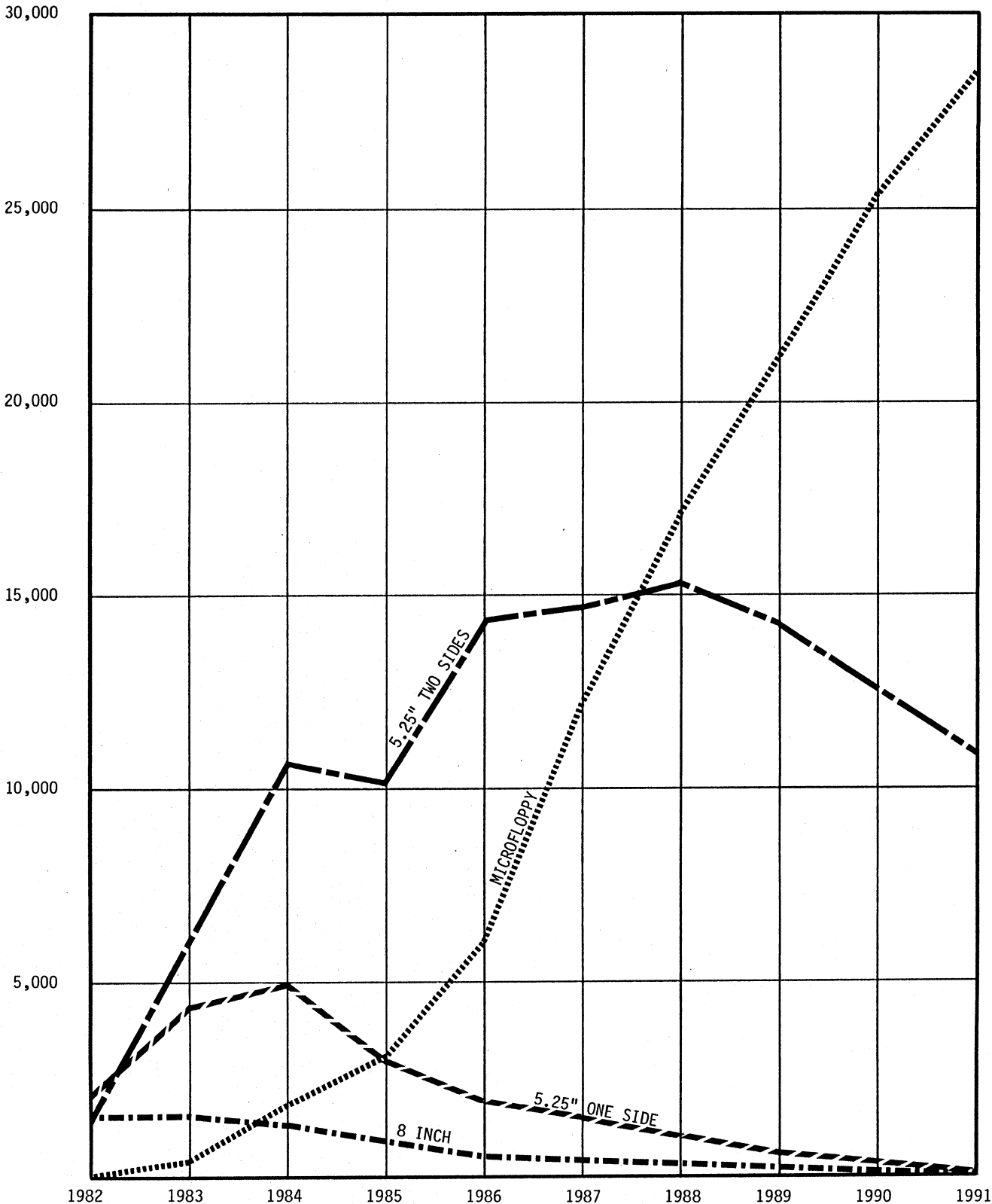


TABLE 4  
WORLDWIDE SHIPMENTS  
PRODUCT CATEGORY SUMMARY  
MANUFACTURERS OF OEM DRIVES

Units: Thousands  
Dollars: \$ Million

Units: Thousands Dollars:		1987		1988		1989		Forecast 1990		1991	
\$ Million		Shipments		Ship		Ship		Ship		Ship	
			%		%		%		%		%
8 INCH DRIVES											
	Units	282.6	-8.9	243.5	-13.8	143.0	-41.2	58.0	-59.4	34.0	-41.3
	\$M	84.7	-11.8	68.1	-19.5	38.8	-43.0	18.2	-53.0	9.1	-50.0
5.25 INCH DRIVES											
One Side	Units	1,373.4	-21.4	873.0	-36.4	500.0	-42.7	250.0	-50.0	90.0	-64.0
	\$M	78.7	-6.9	52.8	-32.9	29.1	-44.8	14.0	-51.8	4.9	-65.0
Two Sides	Units	13,634.7	+2.4	14,304.5	+4.9	13,472.0	-5.8	11,999.0	-10.9	10,499.0	-12.5
	\$M	919.9	-7.6	919.1	-.0	857.5	-6.7	754.6	-12.0	651.1	-13.7
5.25 INCH TOTAL	Units	15,008.1	-.4	15,177.5	+1.1	13,972.0	-7.9	12,249.0	-12.3	10,589.0	-13.5
	\$M	998.6	-7.5	971.9	-2.6	886.6	-8.7	768.6	-13.3	656.0	-14.6
MICROFLOPPY DRIVES											
	Units	11,295.3	+96.5	15,770.0	+39.6	19,537.0	+23.8	23,214.0	+18.8	26,077.0	+12.3
	\$M	741.5	+101.5	962.2	+29.7	1,150.5	+19.5	1,273.4	+10.6	1,326.4	+4.1
DRIVES OVER 5 MEGABYTES											
	Units	46.4	+45.4	43.4	-6.4	102.0	+135.0	241.0	+136.2	523.0	+117.0
	\$M	21.4	-23.2	19.2	-10.2	37.2	+93.7	63.6	+70.9	103.7	+63.0
SPIRAL TRACK DRIVES											
	Units	1,157.2	-11.7	720.0	-37.7	430.0	-40.2	210.0	-51.1	95.0	-54.7
	\$M	32.6	-11.8	20.2	-38.0	12.0	-40.5	5.9	-50.8	2.7	-54.2
TOTAL ALL DRIVES											
	Units	27,789.6	+23.7	31,954.4	+14.9	34,184.0	+6.9	35,972.0	+5.2	37,318.0	+3.7
	\$M	1,878.8	+16.8	2,041.6	+8.6	2,125.1	+4.0	2,129.7	+.2	2,097.9	-1.4

Figure 3  
CHANGING PRODUCT MIX  
WORLDWIDE FLEXIBLE DISK DRIVE SHIPMENTS  
MANUFACTURERS OF OEM DRIVES

Worldwide  
Shipments  
(000 units)

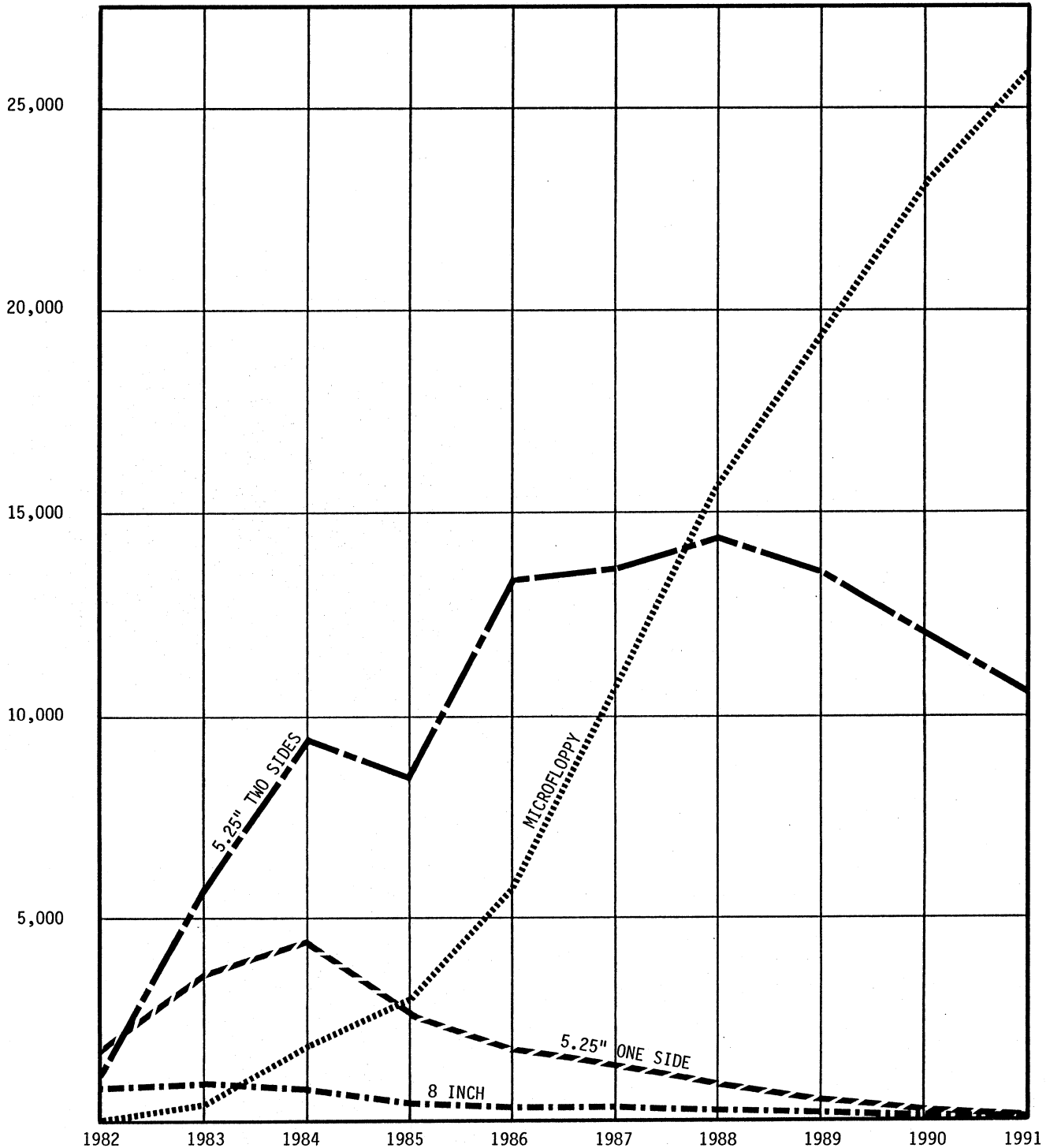




TABLE 5

## 1987 ESTIMATED MARKET SHARES

WORLDWIDE REVENUES OF ALL FLEXIBLE MAGNETIC DISK DRIVES  
(Value of non-U.S. currencies estimated at average 1987 rates)

	CAPTIVE		OEM*		TOTAL INDUSTRY	
	\$M	%	\$M	%	\$M	%
U.S. MANUFACTURERS						
Digital Equipment	28.0	3.7	--	--	28.0	1.0
IBM	35.2	4.6	--	--	35.2	1.3
Iomega	--	--	59.3	3.1	59.3	2.2
Other U.S.	10.5	1.4	25.4	1.3	35.9	1.3
U.S. Total	73.7	9.6	84.7	4.4	158.4	5.9
NON-U.S. MANUFACTURERS						
Alps Electric	--	--	211.8	11.0	211.8	7.9
Canon	44.0	5.7	37.2	1.9	81.2	3.0
Chinon	--	--	63.2	3.3	63.2	2.3
Citizen	--	--	29.3	1.5	29.3	1.1
Fujitsu	--	--	69.6	3.6	69.6	2.6
Matsushita Communication Ind.	--	--	240.8	12.5	240.8	8.9
Matsushita Electronic Compon.	--	--	55.7	2.9	55.7	2.1
Mitsubishi Electric	16.1	2.1	177.4	9.2	193.5	7.2
Mitsumi Electric	--	--	70.9	3.7	70.9	2.6
NEC	409.5	53.4	84.6	4.4	494.1	18.4
Peripheral Data Systems	33.5	4.4	.9	--	34.4	1.3
Seiko Epson	53.4	7.0	54.9	2.9	108.3	4.0
Sony	18.2	2.4	207.1	10.8	225.3	8.4
Teac	--	--	179.9	9.3	179.9	6.7
Toshiba	77.1	10.1	111.7	5.8	188.8	7.0
Y-E Data	2.9	.4	125.7	6.5	128.6	4.8
Other Non-U.S.	38.1	5.0	119.3	6.2	157.4	5.8
Non-U.S. Total	692.8	90.4	1,840.0	95.6	2,532.8	94.1
Worldwide Total	766.5	100.0	1,924.7	100.0	2,691.2	100.0

\*Includes PCM drives.

TABLE 6

Codes: C = Captive  
P = PCM  
O = OEM

Numbers in table  
indicate TPI

CURRENT PRODUCT LINES  
MANUFACTURERS OF FLEXIBLE DISK DRIVES

DISK/TREND PRODUCT GROUP:		13	14	15	16	17	18
U.S. MANUFACTURERS	TYPE	8 INCH	5.25 INCH ONE SIDE	5.25 INCH TWO SIDES	MICRO FLOPPIES	HIGH CAPACITY >5 MB	SPIRAL TRACK
Brier Technology	O					777,1555	
Digital Equipment	C		96				
Eastman Kodak/Verbatim	C,O			192		333,384	
Genisco	O				135		
IBM	C	48					
Insite Peripherals	O					1250	
Iomega	P,O					300,570,641,1095	
Miltope	O	48					
Qume	O					333,666	
Shugart	O	48					
<u>ASIAN MANUFACTURERS</u>							
Alps Electric	O		48	48,96	135		
Asia Commercial	O		48	48,96			
Brother	C,O				67.5,135		
Canon	C,O			48,96	135		
Chinon	P,O		48	48,96	135		
Citizen	C,O				135		
Copal	O			48,96	135		
Ergo	C,O			48			
Fujitsu	O			48,96	135		
GoldStar Telecommunication	C,O			48,96	135		
Hitachi	C,O	48		96		96,125	
Ho Shin	O		48	48,96			
Hyundai Electronics	C,O				135		
Konica	O					480	
Lung Hwa	O		48				
Mantec Technology	O		48	48			
Matsushita Communication Indust.	O	48		48,96	135,254	542	
Matsushita Electronic Components	O				100,200,135		
Mitsubishi	C,O	48		48,96	135		
Mitsumi Electric	O			48,96	67.5,135		59
NEC	C,O	48		48,96	135	406	
Oceanic	P,O		48	48			
Oriental Precision	C,O		48	48,96			
Ricoh	C,O	48		48,96			
Roctec	O		48	48,96			
Samsung Electronics	C,O			48,96			
Sankyo Seiki	O				135		
Seiko Epson	C,O			48,96	135		
Sony	C,O				135,254		
Teac	O			48,96	135		
Tecmate	O		48	48,96	135		
Teco	O				135		
Toshiba	C,O			48,96	135		
Video Technology	P,O		48				
Weltec Digital	P,O			48,96			
Y-E Data	O	48		48,96	67.5,135		
<u>SOUTH AMERICAN MANUFACTURERS</u>							
Cobra	C	48					
Elebra Informatica	O		48,96	48,96			
Flexdisc	O		48	48,96			
Multidigit	O		48	48,96			
<u>EUROPEAN MANUFACTURERS</u>							
Elcomatic	O	48,96					
ISOT	C,O	48	48	48,96			
Kovo (Zbrojovka Brno)	O	48					
Magyar Optikai Muvek	O	48	48,96	48,96			
Peripheral Data Systems	C,O		48				
Robotron	C,O		48,96				

### Application mix

The versatile personal computer now performs many tasks. The expanding role of personal computers has displaced much of the specialized computer hardware which formed the core of the early market for floppy drives. 77.5% of 1987 floppy drive unit shipments were used with office personal computers.

DISK/TREND forecasts anticipate that 75.3% of 1991 unit shipments, totaling 30.2 million drives, will still be used with personal computers, with only a modest loss in share to the more rapidly growing home computer market. In 1987 two sided 5.25 inch drives still held a shipment lead of almost two million drives over microfloppies, but by 1991 microfloppies are expected to dominate personal computer applications by more than 2 to 1 over 5.25 inch floppies.

Consumer and hobby applications used 5.6% of 1987 shipments, a lower level than shown in last year's DISK/TREND Report due to reclassification of some systems previously included. It is expected that this application will grow faster than any other, and by 1991 will consume 12.8% of all floppy drive shipments, totaling 5.2 million units. 5.25 inch one side drives accounted for more than half of 1987 shipments for consumer and hobby applications, but microfloppies are expected to provide most of the 1991 shipment total.

Dedicated application office systems and workstations, including the remnants of the traditional word processing market, held 8% of 1987 shipments, split equally between 5.25 inch drives and microfloppy drives. This application is expected to decline to 5.9% of 1991 shipments, of which almost 80% will be microfloppies, as personal computers continue to invade older office markets.

TABLE 7  
FLEXIBLE DISK DRIVE APPLICATIONS SUMMARY  
CONSOLIDATED WORLDWIDE SHIPMENTS

	-----1987 Estimate-----						-----1991 Projection-----					
	All FDD*	8" All Types	5.25" One Side	5.25" Two Sides	Micro Floppy	Over 5 MB	All FDD*	8" All Types	5.25" One Side	5.25" Two Sides	Micro Floppy	Over 5 MB
<b>MAINFRAME/SUPERMINI</b>												
General purpose												
Units (000)	50.9	45.3	5.6	--	--	--	47.0	3.8	--	43.2	--	--
Share %	0.2%	10.4%	0.3%	--	--	--	0.1%	8.0%	--	0.4%	--	--
<b>MINICOMPUTERS AND</b>												
MULTIPLE USER MICROS												
Including networks												
Units (000)	1,203.4	140.2	33.7	964.8	62.9	1.8	976.4	19.7	1.2	561.1	341.8	52.6
Share %	4.1%	32.3%	2.2%	6.5%	0.5%	1.6%	2.4%	41.0%	1.0%	5.2%	1.2%	7.0%
<b>PERSONAL COMPUTERS</b>												
Single user												
Units (000)	22,579.3	101.8	613.1	11,832.4	9,950.0	82.0	30,226.1	2.4	13.2	8,794.7	20,822.5	593.3
Share %	77.5%	23.4%	40.8%	80.3%	80.6%	73.7%	75.3%	5.0%	11.0%	81.5%	73.1%	79.0%
<b>OFFICE SYSTEMS</b>												
AND WORKSTATIONS												
Dedicated application												
Units (000)	2,316.0	88.0	--	1,123.8	1,103.0	1.2	2,364.5	8.2	--	474.8	1,851.5	30.0
Share %	8.0%	20.2%	--	7.6%	8.9%	1.0%	5.9%	17.0%	--	4.4%	6.5%	4.0%
<b>NON-OFFICE SYSTEMS</b>												
AND WORKSTATIONS												
Dedicated application												
Units (000)	1,147.1	41.5	--	645.2	434.3	26.1	998.4	13.4	--	539.6	370.3	75.1
Share %	3.9%	9.5%	--	4.3%	3.5%	23.4%	2.5%	28.0%	--	5.0%	1.3%	10.0%
<b>CONSUMER AND</b>												
HOBBY COMPUTERS												
Units (000)	1,618.3	--	850.1	73.6	694.6	--	5,163.9	--	105.6	215.8	4,842.5	--
Share %	5.6%	--	56.5%	0.5%	5.6%	--	12.8%	--	88.0%	2.0%	17.0%	--
<b>OTHER</b>												
APPLICATIONS												
Units (000)	199.7	17.2	--	89.9	92.5	0.1	418.7	0.5	--	161.8	256.4	--
Share %	0.7%	3.9%	--	0.6%	0.7%	0.0%	1.0%	1.0%	--	1.5%	0.9%	--
<b>TOTAL, ALL</b>												
APPLICATIONS*												
Units (000)	29,114.7	434.1	1,502.4	14,729.7	12,337.3	111.2	40,195.0	48.0	120.0	10,791.0	28,485.0	751.0
Share %	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

\*Does not include spiral track floppy drives.

TECHNICAL REVIEWCompeting technologies

The flexible disk drive remains the peripheral of choice where a reliable and inexpensive method of program interchange or data storage is needed. While other technologies have made minor inroads in these applications, the only effective competitor to a flexible disk drive remains a higher capacity flexible disk drive. The unique combination of low cost, random access and media removability provided by flexible disk drives is the reason for their success; any competing technology must offer significant improvements at a competitive price.

As do rigid disk drives, flexible disk drives continue to evolve. New form factors, higher capacities, more effective designs and lower cost manufacturing methods are continually making floppy drives more cost effective against competitive data storage technologies. Consequently, alternate technologies continue to have limited success in breaking into floppies' established markets. The rate of innovation currently enjoyed by floppy drives isn't decreasing -- high capacity floppy drives now entering the market will provide stiff competition for older data storage products, and new technologies and capabilities will be introduced annually for the next several years.

A few alternative storage technologies briefly reviewed below have potential to challenge flexible disk drives in selected markets:

- \* Small rigid disk drives: Rapid growth of small Winchester drives has displaced large quantities of floppy drives which otherwise would have been sold, but availability of these rigid disk drives has probably also served to increase the size of the total market for small computer systems, and therefore boost the market for floppy drives. For almost all small fixed disk drives installed, a

companion removable media recording device is necessary to provide for software distribution, save/restore of programs and files, and backup to protect against hardware, software or operator failure. Most of the time, that removable device is a floppy disk drive. With the arrival of 3.5 inch floppy drives in IBM and laptop systems, many organizations have had to increase the total number of floppy drives owned in order to maintain a universal data interchange capability among their PC populations.

The rigid disk challenge to flexible disk drives is most effectively presented by both disk cartridge drives and small fixed disk drives. Small disk cartridge drives are one of the best ways to accomplish fast save/restore of files, and offer access times fast enough to be satisfactory as basic system disks, in lieu of fixed Winchester drives. Availability has been the limiting factor in growth of the disk cartridge share of this market, with only a few manufacturers in production. If floppy disk drives having capacities of 5 megabytes or more are successful, removable rigid disk drives will be less attractive as floppy disk replacements. Such high capacity floppy drives have been introduced by several companies. Specialized products, such as the Iomega Bernoulli disk drives, also provide competition for rigid disk drives.

- \* Stretched surface recording: Another candidate is the stretched surface recording (SSR) technology developed by 3M. SSR has been the subject of drive development programs by other manufacturers for both removable cartridge and fixed drive formats. In either implementation, a magnetic recording layer is placed upon a plastic film which is then stretched across concentric cylindrical rings. The chief characteristic of this technology is that it allows a head to fly on an air cushion backed by a deformable surface that bulges slightly in the region under the head. This provides the close head-media separation needed for high capacity, but also makes the product head-crash proof. The capacity of such a product will be similar to that of a Winchester disk drive of similar diameter, but the cost could eventually be substantially less because the SSR disk has the potential of being fabricated at much lower cost than an aluminum substrate disk. After an apparently promising start, 3M elected to reduce the scale of its development program, but other major firms have shown interest in working with 3M on commercial development. SSR must still be counted a prospective contender.
- \* Read-only optical disks: The read-only optical disk category is dominated by the CD-ROM. Storage capacities of 550 to 600 megabytes are typical of these products. CD-ROM technology borrows heavily from the designs of the 4.72 inch CD audio players now in volume production. CD-ROM acceptance benefits from industry agreement on the CD standards developed jointly by Sony and Philips and the format standard developed by the High Sierra group. In addition to the 4.72 inch CD-ROM, which is limited in capability, high

performance 12 inch read-only drives are being shipped by Reference Technology. Most read-only optical drives are essentially part of a software distribution system and will be used with small systems to provide personal access to large amounts of information. They are expected to have no impact on the floppy drive's role in providing backup capabilities for small systems and to have minimal impact on the use of floppy disks for distribution of software for personal computers and other small systems.

- \* Non-reversible optical disks: The first optical disk recording systems to enter the market are "non-reversible" or "write-once" systems. After many years of costly development programs undertaken by European, American and Japanese manufacturers, write-once 5.25 inch and 12 inch drives are being shipped in modest quantities.

Because they have track densities approaching 16,000 tracks per inch, write-once drives are capable of higher areal densities than magnetic recording techniques now in use. Capacity can range from about 100 megabytes per disk side to over three gigabytes. A high percentage of the drives are being used in mass storage systems which access large numbers of optical disks under system control.

High cost, high capacity, and write-once related system complexities mean that there will be no impact by write-once disks on floppy drives used in their traditional roles. Even the highest capacity floppy drives using conventional technologies will not compete with write-once drives -- the product classes and applications are mutually exclusive.

- \* Erasable optical disks: The possibility for real inroads into the market for magnetic disk drives, including high capacity floppy disk drives, exists with reversible optical disk systems. This will occur when either of the principal proposed technologies reaches the status of a reliable and low cost production product. Magneto-optical recording has seen development activity for more than twenty years, and "phase change" optical recording has attracted considerable attention during the past few years. Low-end erasable optical drives offer the promise of higher capacities and average access times equivalent to those offered by many of today's small magnetic rigid disk drives. The first commercial products on the market appeared as 5.25 inch drives in 1988 and offer removable media in the range of 256 to over 500 megabytes per disk side. The NeXT computer supplies only an optical disk for data interchange: There is no floppy disk offered on the system.

Most current magneto-optical development programs involve using a low power laser to change the magnetic state of the active layer on a disk. The laser raises temperature of the active layer into the Curie point range while a magnetic field is present, causing individual magnetic domains on the disk to align with the direction of the external field. Changes in magnetic orientation are detected

during reading, as the affected spot on the disk causes a small rotation in the polarized light reflected from the surface or transmitted through the disk. However, magneto-optical disks have not yet shown the ability to overwrite in place. Each individual sector must be erased before the sector can be rewritten again, reducing performance. All commercial erasable optical drives currently use magneto-optical recording.

Phase change optical recording involves a different type of amorphous coating, in which individual spots on the disk are changed by polarized light from a crystalline state, during which light is reflected, to a noncrystalline state, during which light is absorbed. Fujitsu has revealed a comparable process in which different crystalline states are used to vary reflectivity. Several other firms, such as Philips and Matsushita also have active programs. Erasable phase change technology could be commercialized as early as 1990.

A third technology, potentially the least expensive to manufacture, is erasable dye/polymer. As of yet, only limited success has been obtained with this technique because developers have not been able to demonstrate an adequately large number of write/erase cycles. Tandy corporation has indicated its intent to offer a low cost erasable optical drive using dye-polymer technology and a CD-like mechanism in the early 1990s.

Individual firms are also working on other proposed reversible optical recording technologies, but none 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.

Drive and media costs for erasable optical storage are far above the costs of conventional floppy technology, and it is unlikely that floppy drives below 5 megabytes will be impacted. However, competition between very low end optical drives and very high end floppy drives is expected in a few years. The capacity range of such products (none yet in production) is likely to lie in the range of 50-80 megabytes, and they will be produced in 3.5 inch formats. Verbatim is expected to be in production in 1989 on a magneto-optic 3.5 inch drive with over 60 megabyte capacity, but the price will be relatively high. Drive prices will eventually be comparable with high end floppy drives, although floppy media will probably remain less expensive than optical media. Both products will compete against tape drives for save/restore applications in small systems and personal computers and will be appropriate for program and data interchange for the more powerful personal computers.

- \* Magnetic bubbles: If regarded as a specialized data storage product, magnetic bubbles still occupy a viable market niche, despite a serious loss of credibility after the 1981 departure of National



Semiconductor, Texas Instruments and Rockwell International from the field. Intel announced its exit from the market in 1986. The rate at which the market for magnetic bubbles developed was clearly not acceptable for the drop-outs, which had plans for much more immediate returns on their investments.

The bubble program of Intel Magnetics was 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 attracted a variety of customers in specialized and harsh environment applications -- at least sufficient to establish quantity production and start down the learning curve-- but in 1986 sold its bubble memory business to MemTech Technology Corp. Nevertheless, the non-volatility of magnetic bubbles and their suitability for capacities too small to be cost-effective for magnetic disk drives remain attractive to system manufacturers for applications such as industrial control systems, robots, point of sale terminals, portable computers, medical instrumentation, avionic systems and militarized systems.

Bubble memories for both military and industrial system applications are being made by Magnesys, which was formed in 1983. In 1988, Magnesys licensed Science Applications International Corporation (SAIC), a defense contractor, as a second manufacturing source. Magnesys has begun offering bubble cartridge storage systems in 360 and 720 kilobyte configurations, but the price is ten to fifteen times that of equivalent flexible disk drives.

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.

The future market available to magnetic bubbles will be directly proportional to their price level as compared to magnetic disk for equivalent capacities. For the next five years, it remains unlikely that bubbles' prices will approach disks' prices -- and bubbles' main markets will be smaller and more specialized.

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

- \* Tape drives: When disk drive capacities used with small computer systems rise above 20-30 megabytes, the functional requirements for a removable media backup device frequently cannot be met by to-

day's flexible disk drives. Floppies' comparatively limited capacity is usually adequate for systems on which the typical file is also small, such as with word processing systems, many small business systems, and most personal computers. But if files are typically large, if a data base management system is used, or if it is necessary to back up an entire rigid disk for protection at the end of each day, most of today's floppies are usually not the best answer. However, the new high capacity floppies being developed by Insite Peripherals, NEC, Brier Technology, DTC and others may improve the position of the floppy drive as a backup vehicle.

Digital cassette and tape cartridge drives were available before most of today's floppy drives, but shipments of these drives have never approached those for floppies. The reasons lie in the inability of tape drives to offer fast direct access to individual records, generally higher prices for the tape drives, and until recently, a lack of industry-wide standards for interfaces and media interchange. Today, however, the pressing demand for backup devices that can handle the higher capacities offered by the newest small Winchester drives has expanded the opportunity for small tape drives and, potentially, for high capacity floppy drives.

The streaming tape cartridge drives now offered by several manufacturers are achieving a major penetration of this market. Streamers have been available from a few suppliers during the past few years, but with different interfaces and recording formats from each manufacturer -- a situation which discouraged many system manufacturers from investing in the controller and software development needed to use these drives. However, the advent of high capacity small Winchester drives has provided the stimulus for most of the tape cartridge drive manufacturers to quickly agree on common standards for interfaces and recording formats.

These standards, plus new tape cartridge drives designed to the same form factor as 3.5 inch and 5.25 inch Winchesters, are resulting in major penetration by tape cartridge streamers in the backup market for Winchesters in the 20-30 megabyte range and above. Will this development displace conventional flexible disk drives? No, not significantly, since floppies in the 1 to 2 megabyte range have never had a major market opportunity with higher capacity 3.5 inch and 5.25 inch Winchesters, except for applications using files small enough to fit a floppy. The new generation of high capacity floppy drives will extend the capacity range over which floppies can compete for a role as a backup device to 30-40 megabytes. Anything larger probably will create a demand for tape streamers, helical scan tape drives, or removable rigid disk drives. In any event, floppy drives will undoubtedly continue to be used on many small systems with large capacity Winchester drives. Their role will include software distribution, and remaining a convenient backup method for the small files which usually accompany the large ones.

- \* Semiconductor memory: Semiconductor memory is still too expensive to compete directly with floppy disks. Even today's 256 Kbit DRAM chip costs between two to three dollars in OEM quantity; a set of chips equivalent to a 360 KB floppy disk will cost over \$16. The temporary shortages of memory chips have increased these prices significantly in the short term. Furthermore, the EEPROM or battery-backed SRAM chips required to preserve data during power off periods cost even more, nor is it certain that they will be available in the high densities anticipated for future DRAMs. Although chips may be reliable, the integrity of the interconnections between removable media containing chips and a socket is less certain than that of the current head/magnetic media interface. However, the price of semiconductor memory is coming down. The chip cost per megabyte is expected to be in the range of one dollar by the mid-nineties for DRAMs and about two dollars per megabyte for SRAMs. By comparison, floppy disk media is expected to cost about fifty cents per megabyte in the same period. However, for semiconductor memory to advance as expected, difficult problems in manufacturing technology must be overcome -- especially those concerned with producing narrower line widths -- and the rate of development will slow down as the costs and lead times of advanced manufacturing and production equipment climb.

Small plastic cards containing IC memories ranging from 8 kilobytes to over 250 kilobytes in capacity may challenge floppy disk drives in selected applications such as games, medical history storage, programming for electronic musical instruments, and type font storage for printers. Typically the size of a credit card, the cards may contain a PROM, EPROM, or EEPROM depending upon whether the application requires read-only, write-once or rewritable storage. While more expensive than floppy disk media, the cards are less vulnerable, though not immune, to handling damage. The IC card has been promoted more widely in Europe and Japan than in the U.S.

#### Flexible disk drive enhancements

IBM developed most of the basic technology used in flexible disk drives, but has failed to introduce a successful new floppy drive since the two sided 8 inch drive in 1976. In 1985, IBM announced that it would phase out production of floppy disk drives, but production has continued at a low level throughout 1988. In the late 1970s, Shugart Associates shrunk IBM's original technology down to the 5.25 inch format, pulling off one of the most influential repackaging jobs of all time.

The floppy formats which have created the most impact in recent years are the Sony 3.5 inch microfloppy and the Nippon Telephone & Telegraph 1.6 megabyte version of the 5.25 inch drive. Without IBM's heavy-handed leadership, the industry has taken years to find its way to a consensus on these formats, while passing others by. And after all the confusion, IBM finally endorsed both the 3.5 inch and 1.6 megabyte 5.25 inch formats through product introductions. 2.0 inch drives are now in the wings awaiting major sponsors among OEM customers.

The lesson of recent years is that there are many potential technical improvements in flexible disk drive recording technology, each waiting for the backing of an influential firm in the industry. It is expected that by using improved head positioning systems and high capacity media, manufacturers of flexible disk drives will be able to expand capacity well beyond 40 megabytes. Here are some of the leading areas of potential advancements in flexible disk recording technology:

- \* Media: The polyester substrate used with flexible disks suffers from limitations in its dimensional stability which derive from the manufacturing process used. As a result, today's mainstream floppy drive products using open loop head positioning systems for low cost are limited to 48 TPI with 8 inch drives, 96/100 TPI with 5.25 inch drives, and 135 TPI with microfloppy drives. The relatively small tonnage of polyester required for diskettes did not inspire plastics manufacturers to invest heavily in research targeted at dimensional stability improvements until the last few years, when the quantities became too large to ignore. However, the magnetic recording industry has been actively developing several methods of increasing linear and track recording density.

Longitudinal particulate coatings: The conventional 8 inch and 5.25 inch diskettes used for the last 10 years, with 300 Oersted oxide coatings, have generally been recorded at 5,000 to 6,000 flux reversals per inch. The 600 Oersted cobalt modified oxide coatings now used in high density 5.25 inch and microfloppy diskettes from several manufacturers are used in numerous production drives at 8,000 to 10,000 FCI, and special types are available for use at even higher densities. The 2.0 megabyte

3.5 inch drives from several manufacturers use diskettes at 17,434 FCI, and recently announced 4 megabyte 3.5 inch drives record at 34,868 FCI. Matsushita Communication Industrial has made a preliminary announcement of a 3.5 inch drive using metal particle media that stores 16 megabytes. The Iomega Bernoulli 5.25 inch drives record data at over 17,000 FCI, using a diskette with similar coercivity but a thinner coating. In 1988, Qume introduced a 24 megabyte floppy drive recording at 24,000 BPI. The Brier Technology 3.5 inch 21 megabyte drive, now announced for early 1989 delivery, will utilize an effective BPI of 26,000 using run length limited code.

Several manufacturers of flexible media and magnetic particles have promising programs underway to improve the density of longitudinal particulate recording. Based on the information available, it appears that conventional recording methods are being stretched at least to 35,000 FCI now and can be extended further within a few years. Longitudinal particulate recording has many good years left, with the full exploitation of its potential recording density probably to be paced primarily by market forces.

Isotropic coatings: It is theoretically possible, by reducing the length of magnetic particles, which are normally very long and thin, to resolve magnetic flux changes at much higher densities. It has been demonstrated that such diskettes could be recorded at up to 50,000 BPI. Since diskettes suitable for isotropic recording may be produced in great quantities on coating equipment widely used by media manufacturers today, this technology could be of great interest to the industry if certain thermal instability problems associated with cobalt modification of very small particles can be resolved.

Perpendicular recording: Perpendicular recording offers great potential for increased recording densities on flexible disks. The flying head technology used with rigid disks requires a high revolution rate, which results in very high data transfer rates with perpendicular recording -- faster than most systems and controllers are now ready to handle. However, the contact recording method used with flexible disk drives and the slower rates of revolution encountered, combined with the very high densities of perpendicular recording, could produce transfer rates comparable to the small Winchester disk drives now in wide use.

Several firms have announced tentative specifications for small flexible disk drives using perpendicular recording. Sony's experimental 3.5 inch drive provides 4 megabytes using 65,500 FCI. Matsushita Electric has claimed the capability to record at 70,000 FCI. Toshiba has pioneered development of barium ferrite recording technology for flexible disk drives, and after several years of tentative market exploration has announced a 4

megabyte drive with production planned for 1988. Toshiba's design maintains the industry standard open loop 135 TPI density, and the program has been joined by Teac and other drive and media producers. All of these 4 megabyte drives claim full compatibility with 1.0 and 2.0 megabyte media.

Many planned flexible disk drives using perpendicular recording employ disks with sputtered chromium-cobalt magnetic surfaces. Sputtering technology is highly developed, but throughput is relatively slow, because it is usually a batch process. If the millions of low cost diskettes necessary to support any significant penetration of the flexible disk market by perpendicular recording are to be produced by sputtering, major improvements in production rates are probably necessary. Continuous sputtering production processes have been announced by the Japanese firms which have active drive/media programs in the field.

- \* Track density: As discussed above, media dimensional stability limitations effectively hold track densities to the ranges now employed, if low cost open loop head positioning systems are to be used. It is possible to increase track densities through the use of prerecorded servo information on disks combined with a closed loop head positioning system, but the industry has been slow to move in that direction because of the general desire to hold costs as low as possible and lack of an industry standard.

Initially, two manufacturers of high capacity 5.25 inch drives attempted to develop the high capacity market using different methods of achieving higher track density. However, Amlyn's late production start spoiled its chance for acceptance of the reference track technology employed in its 3.2 megabyte drive, and the firm closed down operations.

Drivetec was more successful in getting started, however, and began shipping its 3.3 megabyte two sided drive in mid-1983. Drivetec used embedded servo information on each diskette to provide tracking information and insure media interchange. Drivetec has since ceased operations, but licensed its technology to Eastman Kodak. Eastman Kodak started production of the 3.3 megabyte drive in 1984, and, in 1985, introduced 6.6 and 12 megabyte drives operating at 384 and 333 TPI, respectively. The 12 megabyte unit offers 75 millisecond average access time using a voice coil positioner.

Iomega developed a unique design, widely known as the Bernoulli box, that reaches 641 tracks per inch in a media cartridge of unconventional design. Production began in 1983. The Iomega design uses the hydraulic effects of the rapidly spinning disk to properly position the media relative to the head.

Konica's drive achieves a track density of 480 TPI using a two-stage servo system. An optical sensor is used for coarse positioning and an embedded closed-loop servo provides fine positioning

using prewritten servo information. Other firms have examined the possibility of increasing track density using techniques borrowed from optical drive designs.

Brier Technology, a new start-up firm, has announced one of the most ambitious projects -- a 3.5 inch drive using standard, but preformatted, floppy media and offering a capacity of 21.4 megabytes and 35 millisecond average head positioning time. A track density of 777 TPI is used. Brier expects to be in production in 1989. Insite Peripherals, which has achieved a track density of 1,250 TPI using optical tracking of grooves burned into the diskette coating with a laser. Brier has announced future availability of a drive with 1,555 TPI and 43.2 megabytes that may become available in late 1989.

Companies offering high capacity drives will find an interesting market with specialized system manufacturers needing floppies with more capacity. In addition, there will be a significant add-on market associated with personal computers that will fill the need of many users for removable media with more capacity. The long term outlook for these products, however, will probably be determined by the position IBM will eventually have to take on high capacity floppies. The lack of standardization that exists between the approaches of various manufacturers will hamper market acceptance until the manufacturers get together on a common approach or IBM's decision makes up the industry's mind.

- \* Heads: The new generations of high capacity floppy drives are using improved heads, including metal-in-gap heads, to achieve higher linear recording density. For instance, Y-E Data uses a MIG head to achieve a recording density of 34,868 BPI on its 4 megabyte drive. Other firms are also expected to adopt MIG heads as floppy drive capacity climbs.

Another significant innovation is the adoption of multi-gap head arrays to provide multiple density capability. This feature allows backward compatibility in the new generation of 3.5 inch drives with capacities of 4 megabytes and higher now entering the market. A particularly innovative approach has been proposed by Springer Technologies, which is developing an array of thin film heads to provide a high degree of media interchange and compatibility.

- \* Servo technology: The higher track densities being employed in the new generations of flexible disk drives require the use of voice coil positioning mechanisms and sophisticated track following methods. Some, such as Brier's multiple frequency embedded servo and Insite's optical tracking scheme, are innovative and have the potential to set new standards if widely adopted by other companies. Brier writes a servo track on the media at a frequency much lower than the data recording frequency, then uses filtering to separate the readback signal into a data component and a servo tracking component. Insite uses a laser to burn tracks into the media surface, and employs simple optics with an inexpensive LED light source to

monitor head position. Stamping of the grooves into the substrate is a future possibility.

- \* Disk diameter: In 1987, smaller diameter flexible disk drives began to receive some notice. 2.0 inch drives have been announced by two firms, but no obvious standard has emerged. While Matsushita Communication Industrial's design approach has mapped a standard 3.5 inch drive format onto 2.0 inch media, Sony has been making a drive and media based upon a video drive used in the Mavica camera. While the specifications are impressive -- 819 kilobyte formatted capacity, 14.3 mbps data transfer rate and 3600 RPM rotation rate -- incompatibility with standard floppy disk drive controllers will impede acceptance.



## DEFINITIONS

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

### MARKET CLASSIFICATION

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

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

Example:

- \* Drives made by Seiko Epson and sold in an Epson system are considered captive, if internally manufactured or made by a subsidiary.

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

Example:

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

PCM: Disk drives sold or leased by "plug compatible manufacturers" directly to end users; shipments of internally manufactured drives by computer manufacturers or system OEMs are not included unless supplied in plug compatible configurations for installation with systems supplied by other manufacturers. This category is not limited to plug compatible drives installed on IBM systems. It includes any drives which are suitably equipped to be connected without additional hardware to systems of all types, including minicomputers and small business systems.

Example:

- \* Disk drives sold by Iomega to end users of IBM or Apple systems.

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. Distributors and dealers are arbitrarily included in OEM totals.

Example:

- \* OEM drives sold by independent drive manufacturers to IBM for use with personal computers are considered to be OEM drives.
- \* Standard OEM drives sold by drive manufacturers to distributors or dealers are considered to be OEM drives.

#### GEOGRAPHIC CLASSIFICATION

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

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

Examples:

- \* An OEM shipment to a Europe-based system manufacturer is included in worldwide totals, even if the drive is integrated into a system within the U.S.
- \* An OEM shipment to a U.S.-based system manufacturer is included in U.S. totals, even if the drive is integrated into a system in Hong Kong, regardless of the final destination of systems in which the drives are used.

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

Example:

- \* Shugart Corporation is considered a U.S. manufacturer, even though Shugart manufactures disk drives in non-U.S. locations.
- \* Alps Electric is considered a non-U.S. manufacturer, even though some of the firm's floppy drives are manufactured in the U.S.

## UNITS OF MEASUREMENT

Spindles: The basic unit in counting disk drives. One spindle or spindle disk assembly consists of the disk drive mechanism required to utilize a single disk or disk stack. All DISK/TREND unit totals are counted in spindles, even though some drive configurations, such as the DEC RX02 include more than one 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 the complete unit is used. Sale prices are estimated public sale transaction prices, whether at captive end user, PCM or OEM levels. All prices are in 1988 constant dollars.

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

Examples:

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

## APPLICATIONS

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

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

Minicomputers and multiple-user microcomputers: Disk drives associated with small general purpose processors typically serving multiple users. This category also includes network file servers. Examples include: IBM AS/400, AT&T 3B2, Hewlett-Packard 3000.

Personal computers: Includes disk drives attached to a general purpose microcomputer typically used by a single user in a professional or business environment. Examples: Compaq 386/25, IBM PC/AT, IBM PS/2, Apple Macintosh II.

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

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

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

Other applications: Any application not included above.



FLEXIBLE DISK DRIVES, 8 INCHCoverage

Examples of flexible disk drives in this group include:

One side

Elcomatic	ACP 500
Kovo (Zbrojovka Brno)	Consul 7113
Magyar Optikai Muvek	Momflex 6400
Miltope	DD 400
Shugart	801, 848-1

Two sides

Elcomatic	ACP 700
Hitachi	FDD-412
IBM	4964, 4966
ISOT	ES 5083
Matsushita Communication Ind.	JA-751
Miltope	DD 450, DD 550
Mitsubishi Electric	M2896-63
NEC	FD 1165
Ricoh	RF8160
Shugart	851, 848-2
Y-E Data	YD-180

In view of the continuing decline in shipments for 8 inch flexible disk drives, the DISK/TREND Report now combines all 8 inch drives into a single product group, replacing the previous separate groups for one and two sided drives.

Most of the flexible disk drives in this group use IBM's recording formats for 8 inch flexible disks, either "Diskette 1" for one side drives, "Diskette 2" for two sided standard density or "Diskette 2D" for two sided double density. IBM's diskette magazine drive is included in the group, since it uses standard media in a conventional drive, fed by a diskette-changing mechanism.

Drives using special recording formats to achieve higher capacity than the IBM standard are offered by only one manufacturer. Elcomatic's

ACP 1500 provides 3.2 megabytes by using 96 TPI and normal recording densities. Burroughs' high capacity floppy drives, which pioneered the use of a reference track for head positioning, are no longer in production.

The "full size" OEM drives in this group were generally designed to the same physical dimensions as the Shugart 801. Most of the OEM 8 inch drives introduced during the 1980's were "half high" models, which now constitute most of the industry's shipments of 8 inch floppy drives.

#### Market status

DISK/TREND estimate of total market size:

<u>Worldwide sales (\$M)</u>	<u>1987</u>	<u>1988</u>	<u>1989</u>	<u>1990</u>	<u>1991</u>
U.S. manufacturers	46.9	28.8	16.0	2.3	1.6
All manufacturers	224.5	164.5	99.0	36.1	16.8

The long, slow decline of shipments in this product group is continuing as expected. Worldwide annual shipments for 8 inch one sided drives peaked in 1981, at 746,600 units, and two sided drives peaked two years later, with 1,275,900 units. Total shipments in 1987 for all 8 inch drives were 434,100 drives, mostly half high two sided models.

In recent years, the largest factor in maintaining shipments of drives in this product group at a high level has been heavy use of the two sided 8 inch format in the Japanese domestic market. But the tide has turned, as 1.6 megabyte 5.25 inch drives have been designed into more of the newer Japanese office computers. The advent of 1.6 and 2.0 megabyte 3.5 inch drives has further impacted the market for 8 inch drives.

U.S. production of 8 inch drives dropped to 54,400 units in 1987, and is expected to be only 34,000 drives in 1988, compared with shipments by non-U.S. manufacturers of 379,700 in 1987 and a forecast of 329,500 for

1988. The low U.S. total is attributed to the fact that U.S. system manufacturers have long since shifted to smaller diameter floppy drives for personal computers, specialized workstations and most terminals, leaving systems now approaching the end of their manufacturing cycles as the principal remaining market for 8 inch floppy drives.

Shugart Associates, after years of decline under inept Xerox ownership, was sold in early 1986. The Narlinger Group acquired the 8 inch floppy product line, now down to modest production levels, and the Shugart company name. It now operates as Shugart Corporation and manufactures the 8 inch floppy drive product lines purchased from Xerox, Siemens, Tandon and Control Data. Shugart now provides most of the remaining U.S. OEM shipments.

Y-E Data continues to dominate recent OEM shipments in this group, with 41.4% of 1987 worldwide shipments, followed by Shugart with 11.3% and Mitsubishi Electric with 9.9%.

#### Marketing trends

Worldwide shipments of 8 inch drives are forecasted to decline by an average of 48% during the next three years, dropping to 48,000 units in 1991. U.S. shipments in 1991 will be confined to militarized models with long production cycles, and the remaining non-U.S. markets will be limited primarily to Eastern Bloc and domestic Japan.

It is believed that this product group's current lack of vigor is traceable to a combination of factors: (1) Rapid development of the 5.25 and 3.5 inch formats, offering capacities equalling those of 8 inch drives at much lower prices, (2) Reliability problems most manufacturers experienced with 8 inch, two sided drives in the late 1970's, which kept many



OEMs from committing to the format, and (3) Lack of further development of the 8 inch drive format by IBM, which inhibited manufacturers of OEM drives from investing in higher density versions.

In Japan's domestic market, demand for 8 inch drives continued to grow after the U.S. market started to decline. Most manufacturers of small office computer systems felt the pressure to move to desktop versions of their older systems, and the 1.6 megabyte 5.25 inch floppy drive developed under the sponsorship of Nippon Telephone & Telegraph made it possible to do so. More recent availability of 3.5 inch drives in this capacity range have intensified the problem for 8 inch drives.

But the knockout punch for 8 inch drives was delivered by IBM, their originator. IBM used 1.6 megabyte 5.25 inch drives in the PC AT and other small systems, with a resulting drop in production of 8 inch drives. IBM has de-emphasized internal production of flexible disk drives, in view of the ready availability of all types of floppy drives at depressed OEM price levels, and internal production of 8 inch drives is now at low levels, with the end forecasted for 1989.

#### Technical trends

With the exception of limited programs by Burroughs, PerSci, and Elcomatic, there have been few serious attempts to introduce higher capacity drives in this group.

The key reason that development of 8 inch drives has been stuck at 1.6 megabytes since 1976 is IBM's lack of innovation in the area. Since the existing 8 inch diskette's physical design and recording format were defined by IBM, and because of IBM's dominant leadership in the applications for 8 inch, two sided floppies, most manufacturers of OEM drives

hesitated to attempt the introduction of their own improvements, even though some had undertaken development programs.

Several OEM drive manufacturers were ready to introduce new drives for years, with most planning various track following methods, to make possible increased track density. These plans were generally set back by the reliability problems which were experienced by two sided 8 inch floppy drives until the end of the 1970's, and by the hope of most manufacturers that IBM would take the lead in establishing a new high capacity format, preferably with an improved, higher density media standard.

After all the waiting, the momentum has passed to the smaller diameter floppy formats. After observing the high growth of desktop and portable systems, most manufacturers remaining in the flexible disk drive business are now putting their development resources into smaller drives.

#### Forecasting assumptions

1. IBM will continue the transition to smaller floppy drives for new versions of its personal computer and other small systems, and will end internal production of 8 inch drives by 1989.
2. The Japanese domestic market will continue to move away from 8 inch, two sided floppy drives, in favor of high capacity 5.25 inch and 3.5 inch drives.
3. System manufacturers will continue to move to smaller drives, causing a continuing reduction in OEM shipments of 8 inch drives.

TABLE 8  
FLEXIBLE DISK DRIVES, 8 INCH  
REVENUE SUMMARY

	-----DISK DRIVE REVENUES, BY SHIPMENT DESTINATION (\$M)-----									
	1987		1988		1989		1990		1991	
	Revenues									
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
-----										
U.S. Manufacturers										
IBM Captive	23.2	35.2	13.3	20.1	6.9	10.5	--	--	--	--
Other U.S. Captive	--	--	--	--	--	--	--	--	--	--
TOTAL U.S. CAPTIVE	23.2	35.2	13.3	20.1	6.9	10.5	--	--	--	--
PCM	--	--	--	--	--	--	--	--	--	--
OEM	8.4	11.7	6.4	8.7	4.0	5.5	1.3	2.3	1.3	1.6
TOTAL U.S. NON-CAPTIVE	8.4	11.7	6.4	8.7	4.0	5.5	1.3	2.3	1.3	1.6
TOTAL U.S. REVENUES	31.6	46.9	19.7	28.8	10.9	16.0	1.3	2.3	1.3	1.6
-----										
Non-U.S. Manufacturers										
Captive	4.0	104.6	--	76.3	--	49.7	--	17.9	--	7.7
PCM	--	--	--	--	--	--	--	--	--	--
OEM	9.1	73.0	14.0	59.4	5.1	33.3	1.9	15.9	.6	7.5
TOTAL NON-U.S. REVENUES	13.1	177.6	14.0	135.7	5.1	83.0	1.9	33.8	.6	15.2
-----										
Worldwide Recap										
TOTAL WORLDWIDE REVENUES	44.7	224.5	33.7	164.5	16.0	99.0	3.2	36.1	1.9	16.8
-----										
OEM Average Price (\$000)	.347	.300	.294	.280	.289	.271	.337	.314	.487	.268
-----										

TABLE 9  
FLEXIBLE DISK DRIVES, 8 INCH  
UNIT SHIPMENT SUMMARY

	-----DISK DRIVE UNIT SHIPMENTS, BY SHIPMENT DESTINATION (000)-----									
	1987		-----Forecast-----							
	---Shipments---		1988		1989		1990		1991	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
	----	----	----	----	----	----	----	----	----	----
U.S. Manufacturers										
-----										
IBM Captive	14.5	22.0	8.6	13.0	4.6	7.0	--	--	--	--
Other U.S. Captive	--	--	--	--	--	--	--	--	--	--
TOTAL U.S. CAPTIVE	14.5	22.0	8.6	13.0	4.6	7.0	--	--	--	--
PCM	--	--	--	--	--	--	--	--	--	--
OEM	21.4	32.4	13.5	21.0	9.5	13.0	2.5	4.0	.9	1.0
TOTAL U.S. NON-CAPTIVE	21.4	32.4	13.5	21.0	9.5	13.0	2.5	4.0	.9	1.0
TOTAL U.S. SHIPMENTS	35.9	54.4	22.1	34.0	14.1	20.0	2.5	4.0	.9	1.0
Non-U.S. Manufacturers										
-----										
Captive	5.0	129.5	--	107.0	--	75.0	--	29.0	--	14.0
PCM	--	--	--	--	--	--	--	--	--	--
OEM	29.0	250.2	56.0	222.5	22.0	130.0	7.0	54.0	3.0	33.0
TOTAL NON-U.S. SHIPMENTS	34.0	379.7	56.0	329.5	22.0	205.0	7.0	83.0	3.0	47.0
Worldwide Recap										
-----										
TOTAL WORLDWIDE SHIPMENTS	69.9	434.1	78.1	363.5	36.1	225.0	9.5	87.0	3.9	48.0
Cumulative Shipments										
-----										
IBM	1,203.3	1,769.4	1,211.9	1,782.4	1,216.5	1,789.4	1,216.5	1,789.4	1,216.5	1,789.4
Non-IBM	4,010.9	9,562.9	4,080.4	9,913.4	4,111.9	10,131.4	4,121.4	10,218.4	4,125.3	10,266.4
WORLDWIDE TOTAL	5,214.2	11,332.3	5,292.3	11,695.8	5,328.4	11,920.8	5,337.9	12,007.8	5,341.8	12,055.8

TABLE 10  
FLEXIBLE DISK DRIVES, 8 INCH  
WORLDWIDE SHIPMENTS (000)  
DRIVE HEIGHT ANALYSIS

	1987		Forecast							
	Units	%	Units	%	Units	%	Units	%	Units	%
<b>U.S. MANUFACTURERS</b>										
Captive Total	22.0		13.0		7.0		--		--	
Full Size	22.0	100.0	13.0	100.0	7.0	100.0	--	--	--	--
OEM Total	32.4		21.0		13.0		4.0		1.0	
Full Size	22.4	69.2	14.0	66.8	7.5	57.8	1.0	25.0	.5	50.1
Half High	10.0	30.8	7.0	33.2	5.5	42.2	3.0	75.0	.5	49.9
Total U.S.	54.4		34.0		20.0		4.0		1.0	
Full Size	44.4	81.7	27.0	79.5	14.5	72.6	1.0	25.0	.5	50.1
Half High	10.0	18.3	7.0	20.5	5.5	27.4	3.0	75.0	.5	49.9
<b>NON-U.S. MANUFACTURERS</b>										
Captive Total	129.5		107.0		75.0		29.0		14.0	
Full Size	4.0	3.1	4.0	3.7	2.0	2.7	1.0	3.4	--	--
Half High	125.5	96.9	103.0	96.3	73.0	97.3	28.0	96.6	14.0	100.0
OEM Total	250.2		222.5		130.0		54.0		33.0	
Full Size	51.0	20.4	28.5	12.8	18.0	13.8	9.0	16.7	3.0	9.1
Half High	199.2	79.6	194.0	87.2	112.0	86.2	45.0	83.3	30.0	90.9
Total Non-U.S.	379.7		329.5		205.0		83.0		47.0	
Full Size	55.0	14.5	32.5	9.9	20.0	9.8	10.0	12.0	3.0	6.4
Half High	324.7	85.5	297.0	90.1	185.0	90.2	73.0	88.0	44.0	93.6
<b>WORLDWIDE RECAP</b>										
Total Worldwide Shipments	434.1		363.5		225.0		87.0		48.0	
	-24.4%		-16.2%		-38.1%		-61.3%		-44.8%	
Full Size	99.4	22.9	59.5	16.4	34.5	15.3	11.0	12.6	3.5	7.3
	-47.2%		-40.1%		-42.0%		-68.1%		-68.1%	
Half High	334.7	77.1	304.0	83.6	190.5	84.7	76.0	87.4	44.5	92.7
	-13.2%		-9.1%		-37.3%		-60.1%		-41.4%	

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

TABLE 11  
FLEXIBLE DISK DRIVES, 8 INCH  
APPLICATIONS SUMMARY  
Percentage of Worldwide Shipments

APPLICATION	1987 Estimate		1991 Projection	
	Units (000)	%	Units (000)	%
MAINFRAME/SUPERMINI General purpose	45.3	10.4	3.8	8.0
MINICOMPUTERS AND MULTI-USER MICROS Business and professional, including networks	140.3	32.3	19.7	41.0
PERSONAL COMPUTERS Business and professional, single user	101.8	23.4	2.4	5.0
OFFICE SYSTEMS AND WORKSTATIONS Dedicated application	88.0	20.3	8.2	17.0
NON-OFFICE SYSTEMS AND WORKSTATIONS Technical, distribution, medical, other specialized	41.5	9.6	13.4	28.0
CONSUMER AND HOBBY COMPUTERS	--	--	--	--
OTHER APPLICATIONS	17.2	4.0	.5	1.0
Total	434.1	100.0	48.0	100.0

TABLE 12  
FLEXIBLE DISK DRIVES, 8 INCH  
MARKET SHARE SUMMARY  
Worldwide Shipments of Non-Captive Disk Drives

Drive Manufacturers	1987 Net Shipments			
	To United States Destinations		Worldwide	
	Units (000)	%	Units (000)	%
Y-E Data	10.0	19.8	117.0	41.5
Shugart Corporation	21.0	41.7	32.0	11.3
Mitsubishi Electric	15.0	29.8	28.0	9.9
MOM	--	--	27.0	9.6
ISOT	--	--	21.0	7.4
Other U.S.	0.4	0.8	0.4	0.1
Other Non-U.S.	4.0	7.9	57.2	20.2
	-----	-----	-----	-----
TOTAL	50.4	100.0	282.6	100.0





## FLEXIBLE DISK DRIVES, 5.25 INCH, ONE SIDE

### Coverage

Examples of flexible disk drives in this group include:

#### 48 tracks per inch

Asia Commercial	FD-103
Chinon	FZ-501A
Flexdisc	FF450
Ho Shin	HS-550
ISOT	ES 5088M
Lung Hwa	LDD-103SSA
Magyar Optikai Muvek	MF 54S
Mantec	MTL-FD102E/C
Multidigit	DF0211
Oceanic	OC-118, OH-2
Oriental Precision	OFD-543
Peripheral Data Systems	MFDD-110
Robotron	K 5600.10
Roctec	RF501A
Tecmate	MT-501A
Video Technology	FDM 110

#### 96/100 tracks per inch

Digital Equipment	RX50
Magyar Optikai Muvek	MF 58S
Robotron	K 5600.20

The basic standards for physical size and recording format for this product group were created by the introduction of the Shugart SA 400, the original minifloppy, in 1976. Early growth in small microcomputer systems inspired several innovative one side 5.25 inch drives, some of which achieved success until the industry's movement to two sided versions.

An early pioneer was Micropolis, which introduced 100 TPI 5.25 inch drives in 1977, matching the 77 track standard recording format of 8 inch floppy drives. In 1980 Tandon and Micro Peripherals joined Micropolis in setting a 96 TPI standard, which established the 80 tracks per side format now widely used with both one and two sided drives.

Because of the continued shrinkage in the physical size of computer systems, reduced drive height became an extremely active area of innovation. BASF introduced drives in 1978 which were two thirds the height of the SA 400's 3.25 inches, but sales of two thirds high drives by BASF and others were modest. However, half high drives, pioneered by Tandon and Alps Electric, are now offered by most drive manufacturers, and have become the dominant physical size standard for floppy drives using 5.25 inch diskettes.

Other innovative one side 5.25 inch drives have been introduced, with varying levels of success. Early in 1982, Amlyn started shipping a drive using a special cartridge of five diskettes, each recorded on one side at 170 TPI and 9500 BPI. This drive had limited success, and Amlyn has discontinued operations. With first shipments also in 1982, Digital Equipment Corporation offers a one side drive which uses a single head positioning system for two diskettes, for use with DEC personal computers.

#### Market status

DISK/TREND estimate of total market size:

<u>Worldwide sales (\$M)</u>	<u>1987</u>	<u>1988</u>	<u>1989</u>	<u>1990</u>	<u>1991</u>
U.S. manufacturers	29.2	13.7	--	--	--
All manufacturers	142.8	92.8	52.1	33.8	20.9

Although personal computers made one side 5.25 inch drives the leading floppy format in the early 1980s, the drives in this product group have now been passed over by system designers for new computer applications. Shipments for this product group reached a peak of almost 5 million drives in 1984, climaxing 8 years of nonstop growth. But 1987 shipments were down to 1,502,400 drives, and the forecasted worldwide total

for 1988 is expected to drop below one million units for the first time since 1980.

Non-U.S. manufacturers have provided the bulk of shipments in this group in recent years, with shipments by U.S. producers expected to be down to an estimated 32,000 drives in 1988, consisting mostly of the remaining captive shipments of RX05 drives by Digital Equipment. Shipments by non-U.S. manufacturers totaled 1,438,400 drives in 1987, with a further decline to 920,000 forecasted for 1988.

Most captive production of 5.25 inch, one side drives in Western countries has been discontinued, with the 1985 end of captive programs by Tandy, Shugart, Philips and Olivetti -- leaving Digital Equipment's RX50 as the only major captive drive still in production. Eastern Bloc captive shipments are starting to grow, however, as several countries start to place emphasis on development of personal computer industries.

OEM drive shipments continue to dominate the totals, led by Alps Electric's large sales to Apple and other personal computer manufacturers. Alps' 850,000 drives represented 61.9% of worldwide non-captive shipments for 1987.

#### Marketing trends

Usage of 5.25 inch, one side drives in Western countries will continue to drop rapidly. In the U.S., the remaining captive shipments by Digital Equipment are expected to end this year, as newer types of drives are substituted. Newer drives will also displace the majority of one side 5.25 inch flexible disk drive production by non-U.S. manufacturers in Western countries, and 1991 worldwide shipments drives are forecasted to decline to 120,000 units.

The most significant reason for the abandonment of 5.25 inch, one side drives in Western countries was IBM's action in the early 1980s in offering two sided 5.25 inch drives with its personal computers. The success of IBM's personal computer family made the industry hungry for compatibility. And, while 5.25 inch one side drives were offered with the original IBM personal computer model, two sided drives dominated shipments on subsequent models, until replaced by 3.5 inch drives.

By 1990, it is probable that most remaining production of drives in this group will be located in the Eastern Bloc. Eastern Bloc countries have concentrated on establishing production of full size 5.25 inch for their emerging personal computer industry, but a gradual transition to half high drives will occur, as it already has in Western countries.

Microfloppy drives will directly displace 5.25 inch one side drives which otherwise would have been used in portable and desktop computers. While the widespread use of 5.25 inch diskette media provides considerable momentum for the format, microflopies have already built up shipment momentum in the portable and "small-footprint" desktop computer markets, at the expense of 5.25 inch drives.

#### Technical trends

The industry has not invested heavily in development programs for this product group, and most of the work undertaken has been intended to result in smaller, cheaper floppy drives. Well publicized programs by Alps Electric, Tandon and Shugart resulted in mechanism-only versions of 5.25 inch one side drives priced as low as \$40 for very large quantities.

More significant to the entire industry, however, were the half high drives, just 1.625 inches (41 millimeters) in height. Although designed

for both one side and two sided models, the one side versions have kept this product group going longer than would otherwise have been likely.

Significant changes in technology for this group during the next few years are not expected. 5.25 inch one side drives offer neither the capacity potential of two sided 5.25 inch drives nor the smaller physical volume potential of 3.5 inch drives -- and will probably not see any further development.

#### Forecasting assumptions

1. Shipments of 5.25 inch one side drives will decline, except in Eastern Bloc countries, due to competition from microfloppies and 5.25 inch two sided drives.

TABLE 13  
FLEXIBLE DISK DRIVES, 5.25 INCH, ONE SIDE  
REVENUE SUMMARY

	-----DISK DRIVE REVENUES, BY SHIPMENT DESTINATION (\$M)-----									
	1987		1988		1989		1990		1991	
	Revenues									
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
-----										
U.S. Manufacturers										
-----										
IBM Captive	--	--	--	--	--	--	--	--	--	--
Other U.S. Captive	15.0	28.0	7.0	13.0	--	--	--	--	--	--
TOTAL U.S. CAPTIVE	15.0	28.0	7.0	13.0	--	--	--	--	--	--
PCM	--	--	--	--	--	--	--	--	--	--
OEM	1.2	1.2	.7	.7	--	--	--	--	--	--
TOTAL U.S. NON-CAPTIVE	1.2	1.2	.7	.7	--	--	--	--	--	--
TOTAL U.S. REVENUES	16.2	29.2	7.7	13.7	--	--	--	--	--	--
Non-U.S. Manufacturers										
-----										
Captive	--	36.1	--	27.0	--	23.0	--	19.8	--	16.0
PCM	--	--	--	--	--	--	--	--	--	--
OEM	51.4	77.5	38.5	52.1	21.8	29.1	10.9	14.0	3.9	4.9
TOTAL NON-U.S. REVENUES	51.4	113.6	38.5	79.1	21.8	52.1	10.9	33.8	3.9	20.9
Worldwide Recap										
-----										
TOTAL WORLDWIDE REVENUES	67.6	142.8	46.2	92.8	21.8	52.1	10.9	33.8	3.9	20.9
OEM Average Price (\$000)	.058	.057	.060	.060	.058	.058	.056	.056	.054	.054
-----										

TABLE 14  
FLEXIBLE DISK DRIVES, 5.25 INCH, ONE SIDE  
UNIT SHIPMENT SUMMARY

	-----DISK DRIVE UNIT SHIPMENTS, BY SHIPMENT DESTINATION (000)-----									
	1987		-----Forecast-----							
	---Shipments---		1988		1989		1990		1991	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
	----	----	----	----	----	----	----	----	----	----
U.S. Manufacturers										
-----										
IBM Captive	--	--	--	--	--	--	--	--	--	--
Other U.S. Captive	30.0	56.0	14.0	26.0	--	--	--	--	--	--
TOTAL U.S. CAPTIVE	30.0	56.0	14.0	26.0	--	--	--	--	--	--
PCM	--	--	--	--	--	--	--	--	--	--
OEM	8.0	8.0	6.0	6.0	--	--	--	--	--	--
TOTAL U.S. NON-CAPTIVE	8.0	8.0	6.0	6.0	--	--	--	--	--	--
TOTAL U.S. SHIPMENTS	38.0	64.0	20.0	32.0	--	--	--	--	--	--
Non-U.S. Manufacturers										
-----										
Captive	--	73.0	--	53.0	--	45.0	--	38.0	--	30.0
PCM	--	--	--	--	--	--	--	--	--	--
OEM	903.1	1,365.4	648.6	867.0	375.0	500.0	195.0	250.0	72.0	90.0
TOTAL NON-U.S. SHIPMENTS	903.1	1,438.4	648.6	920.0	375.0	545.0	195.0	288.0	72.0	120.0
Worldwide Recap										
-----										
TOTAL WORLDWIDE SHIPMENTS	941.1	1,502.4	668.6	952.0	375.0	545.0	195.0	288.0	72.0	120.0
Cumulative Shipments										
-----										
IBM	--	--	--	--	--	--	--	--	--	--
Non-IBM	15,149.0	20,566.0	15,817.6	21,518.0	16,192.6	22,063.0	16,387.6	22,351.0	16,459.6	22,471.0
WORLDWIDE TOTAL	15,149.0	20,566.0	15,817.6	21,518.0	16,192.6	22,063.0	16,387.6	22,351.0	16,459.6	22,471.0

TABLE 15  
FLEXIBLE DISK DRIVES, 5.25 INCH, ONE SIDE  
WORLDWIDE SHIPMENTS (000)  
DRIVE HEIGHT ANALYSIS

	1987		Forecast		Forecast		Forecast		Forecast	
	Units	%	Units	%	Units	%	Units	%	Units	%
U.S. MANUFACTURERS										
Captive Total	56.0		26.0		--		--		--	
Full Size	56.0	100.0	26.0	100.0	--	--	--	--	--	--
OEM Total	8.0		6.0		--		--		--	
Half High	8.0	100.0	6.0	100.0	--	--	--	--	--	--
Total U.S.	64.0		32.0		--		--		--	
Full Size	56.0	87.6	26.0	81.4	--	--	--	--	--	--
Half High	8.0	12.4	6.0	18.6	--	--	--	--	--	--
NON-U.S. MANUFACTURERS										
Captive Total	73.0		53.0		45.0		38.0		30.0	
Full Size	51.0	70.0	25.0	47.2	15.0	33.3	5.0	13.2	--	--
Half High	22.0	30.0	28.0	52.8	30.0	66.7	33.0	86.8	30.0	100.0
OEM Total	1,365.4		867.0		500.0		250.0		90.0	
Full Size	4.0	.3	1.0	.1	--	--	--	--	--	--
Half High	1,361.4	99.7	866.0	99.9	500.0	100.0	250.0	100.0	90.0	100.0
Total Non-U.S.	1,438.4		920.0		545.0		288.0		120.0	
Full Size	55.0	3.8	26.0	2.8	15.0	2.8	5.0	1.7	--	--
Half High	1,383.4	96.2	894.0	97.2	530.0	97.2	283.0	98.3	120.0	100.0
WORLDWIDE RECAP										
Total Worldwide Shipments	1,502.4		952.0		545.0		288.0		120.0	
	-21.4%		-36.6%		-42.7%		-47.1%		-58.3%	
Full Size	111.0	7.4	52.0	5.5	15.0	2.8	5.0	1.7	--	--
	-33.9%		-53.1%		-71.1%		-66.6%		--	
Half High	1,391.4	92.6	900.0	94.5	530.0	97.2	283.0	98.3	120.0	100.0
	-20.1%		-35.3%		-41.1%		-46.6%		-57.5%	

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



TABLE 16  
FLEXIBLE DISK DRIVES, 5.25 INCH, ONE SIDE  
WORLDWIDE SHIPMENTS (000)  
TRACK DENSITY ANALYSIS

	1987		1988		1989		Forecast		1990		1991	
	Units	%	Units	%	Units	%	Units	%	Units	%	Units	%
<b>U.S. MANUFACTURERS</b>												
Captive Total	56.0		26.0		--		--		--		--	
96 TPI	56.0	100.0	26.0	100.0	--	--	--	--	--	--	--	--
OEM Total	8.0		6.0		--		--		--		--	
48 TPI	8.0	100.0	6.0	100.0	--	--	--	--	--	--	--	--
Total U.S.	64.0		32.0		--		--		--		--	
48 TPI	8.0	12.5	6.0	18.8	--	--	--	--	--	--	--	--
96 TPI	56.0	87.5	26.0	81.2	--	--	--	--	--	--	--	--
<b>NON-U.S. MANUFACTURERS</b>												
Captive Total	73.0		53.0		45.0		38.0		30.0		30.0	
48 TPI	71.0	97.4	50.0	94.4	40.0	89.0	30.0	79.0	20.0	66.8		
96 TPI	2.0	2.6	3.0	5.6	5.0	11.0	8.0	21.0	10.0	33.2		
OEM Total	1,365.4		867.0		500.0		250.0		90.0		90.0	
48 TPI	1,356.4	99.4	864.0	99.8	500.0	100.0	250.0	100.0	90.0	100.0		
96 TPI	9.0	.6	3.0	.2	--	--	--	--	--	--		
Total Non-U.S.	1,438.4		920.0		545.0		288.0		120.0		120.0	
48 TPI	1,427.4	99.3	914.0	99.4	540.0	99.2	280.0	97.3	110.0	91.8		
96 TPI	11.0	.7	6.0	.6	5.0	.8	8.0	2.7	10.0	8.2		
<b>WORLDWIDE RECAP</b>												
Total Worldwide Shipments	1,502.4		952.0		545.0		288.0		120.0		120.0	
	-21.4%		-36.6%		-42.7%		-47.1%		-58.3%			
48 TPI	1,435.4	95.6	920.0	96.7	540.0	99.2	280.0	97.3	110.0	91.8		
	-20.9%		-35.9%		-41.3%		-48.1%		-60.7%			
96 TPI	67.0	4.4	32.0	3.3	5.0	.8	8.0	2.7	10.0	8.2		
	-29.4%		-52.2%		-84.3%		+60.0%		+25.0%			

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

TABLE 17  
FLEXIBLE DISK DRIVES, 5.25 INCH, ONE SIDE  
APPLICATIONS SUMMARY  
Percentage of Worldwide Shipments

APPLICATION	1987 Estimate		1991 Projection	
	Units (000)	%	Units (000)	%
MAINFRAME/SUPERMINI General purpose	5.6	.4	--	--
MINICOMPUTERS AND MULTI-USER MICROS Business and professional, including networks	33.7	2.2	1.2	1.0
PERSONAL COMPUTERS Business and professional, single user	613.1	40.8	13.2	11.0
OFFICE SYSTEMS AND WORKSTATIONS Dedicated application	--	--	--	--
NON-OFFICE SYSTEMS AND WORKSTATIONS Technical, distribution, medical, other specialized	--	--	--	--
CONSUMER AND HOBBY COMPUTERS	850.0	56.6	105.6	88.0
OTHER APPLICATIONS	--	--	--	--
Total	1,502.4	100.0	120.0	100.0

TABLE 18  
FLEXIBLE DISK DRIVES, 5.25 INCH, ONE SIDE  
MARKET SHARE SUMMARY  
Worldwide Shipments of Non-Captive Disk Drives

Drive Manufacturers	1987 Net Shipments			
	To United States Destinations		Worldwide	
	Units (000)	%	Units (000)	%
Alps Electric	680.0	74.7	850.0	61.9
Chinon	20.0	2.2	90.0	6.6
Mitsumi Electric	--	--	80.0	5.8
Oceanic	24.1	2.6	63.9	4.7
Other U.S.	8.0	0.9	8.0	0.6
Other Non-U.S.	179.0	19.6	281.5	20.4
TOTAL	911.1	100.0	1,373.4	100.0



FLEXIBLE DISK DRIVES, 5.25 INCH, TWO SIDESCoverage

Examples of flexible disk drives in this group include:

48 tracks per inch

Alps Electric	DFC 222, DFE 222A
Asia Commercial	FD-104
Canon	MD 5201
Chinon	FZ-502
Copal	F-5002
Ergo	DS-6
Flexdisc	FF 650
Fujitsu	M2551A
Goldstar Telecommunication	GSF 548
Ho Shin	HD-551
ISOT	ES 5321
Magyar Optikai Movek	MF 54D
Mantec	MTL-FD128
Matsushita Communication Ind.	JA-455
Mitsubishi Electric	MF501A
Mitsumi	D 503V
Multidigit	DF0511
NEC	FD 1054
Oceanic	OB-1
Oriental Precision	OFD 546
Peripheral Data Systems	BD-120
Ricoh	RF5050
Roctec	RF 502B
Samsung Electronics	SFD-500K
Seiko Epson	SD-621L
Teac	FD-55BR
Tecmate	MT-502
Toshiba	ND-04DT-A
Weltec Digital	WT 36
Y-E Data	YD-580

96 tracks per inch, 1.0 megabyte

Alps Electric	DFE 422A
Asia Commercial	FD-106
Copal	F-5014
Fujitsu	M2552K
Ho Shin	HD-552
ISOT	ES 5323
Magyar Optikai Movek	MF 58D
Matsushita Communication Ind.	JA-465
Mitsubishi Electric	MF503B
NEC	FD 1057

96 tracks per inch, 1.0 megabyte (continued)

Oriental Precision	OFD 596
Teac	FD-55FR
Toshiba	ND-06D/DT
Y-E Data	YD-480

96 tracks per inch, 1.6 megabytes

Alps Electric	DFE 642A, DFE 682A
Asia Commercial	FD-107
Canon	MD-5501
Chinon	FZ-506
Copal	F-5016, F-5018
Flexdisc	FF 950
Fujitsu	M2553A, M2554A
Goldstar Telecommunication	GSF 596
Hitachi	HFD 516C
Ho Shin	HD-553
Matsushita Communication Ind.	JU-475
Mitsubishi Electric	MF504B
Mitsumi	D 509V
Multidigit	DF1611
NEC	FD 1157D
Ricoh	RF5160
Roctec	RF512B
Samsung Electronics	SFD-560K
Seiko Epson	SD-680L
Teac	FD-55GR, FD-55GFR
Tecmate	MT-504
Toshiba	ND-08DE
Weltec Digital	M 16-A
Y-E Data	YD-380, YD-380B

96 tracks per inch, 2.0 megabytes

Multidigit	DF 2011
------------	---------

96 or more tracks per inch, 3.3 megabytes

Eastman Kodak	Kodak 3.3
Y-E Data	YE-801

Two sided 5.25 inch floppy drives became a reality in 1978. The size of these drives was the same as the original full size Shugart one sided SA 400 introduced in 1976 -- 3.25 inches high, 5.75 inches wide, and 8.0 inches deep.

The first two thirds high drives were offered by BASF, also in 1978, followed by a handful of others, with sales mostly in Europe. However, during the early 1980's most manufacturers of 5.25 inch drives introduced half high models (1.625 inches high), with an enthusiastic reaction from system manufacturers.

The original 48 TPI drives were joined by 96 TPI drives from Tandon, Micro Peripherals and Micropolis in 1980. However, a more influential development occurred in 1982, when 1.6 megabyte 5.25 inch drives were first shipped by Y-E Data, designed to a standard coordinated by Nippon Telephone and Telegraph.

These drives match the capacity and file organization of two sided 8 inch drives by using a minimum of 77 tracks (at 96 TPI) per side at 9600 BPI. Initial shipments were used mostly on systems sold in the Japanese domestic market, with little outside impact.

IBM's 1984 introduction of the PC AT, using Y-E Data's 1.6 megabyte drive, stamped the market into rapid worldwide usage of the 1.6 megabyte 5.25 inch format. The 2.0 megabyte drive using slightly higher linear densities did not provide enough improvement to generate wide interest.

Drivetec's half high drive using an embedded servo technique -- with 192 TPI, and capacity of 3.3 megabytes -- was a technical success and a commercial failure. The company closed down in early 1985 after spending all of its money, but before closing in 1983 had licensed Eastman Kodak to make the drive. Eastman started production of a drive compatible with Drivetec's unit in 1984, later challenged by other 3.3 megabyte formats from Matsushita Communication Industrial and Y-E Data. Usage of 3.3 megabyte drives has been held down due to lack of industry standards and the movement to 3.5 inch microfloppies.

Market status

DISK/TREND estimate of total market size:

<u>Worldwide sales (\$M)</u>	<u>1987</u>	<u>1988</u>	<u>1989</u>	<u>1990</u>	<u>1991</u>
U.S. manufacturers	15.9	.2	.2	--	--
All manufacturers	1,266.0	1,193.5	1,072.2	904.3	735.7

The decline in unit shipments anticipated for this product group in 1987 and 1988 has been delayed by the confused state of the personal computer market. Two sided 5.25 inch floppy drives were used predominantly with IBM XT and AT personal computers, plus the clones offered by numerous manufacturers. IBM has moved on to the PS/2 personal computer family, using 3.5 inch microfloppies, but the older IBM standards have been tough to kill.

Despite abandonment by IBM, the PC AT standard has continued its momentum and has actually contributed to increased sales of two sided 5.25 inch drives. Worldwide unit shipments were 14,729,700 drives in 1987, up 2.5%, and are expected to reach 15,250,000 drives in 1988, up 3.5%. The last volume production by U.S. manufacturers ended in 1987, with the withdrawal of Tandon from direct floppy drive manufacturing.

Worldwide revenues are another story, however. Total revenues for this product group peaked in 1984, and despite increased unit shipments and movement to higher capacity drives, revenues have declined in recent years. The reason is well known: Average unit prices for OEM drives continue to decline, from \$114 in 1984 to \$64 in 1988.

Considering the major shift in dollar/yen exchange rates which occurred during the last two years, it appeared during 1986 that OEM price levels for drives in this group would stabilize for several years. However, the decline has continued, as major Japanese producers concentrate

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on aggressive cost reduction programs, including product redesign and plant relocation.

Major changes in product mix are still occurring. 48 TPI drives, with one half megabyte capacity, peaked for the last time in 1986, with 9.9 million units shipped worldwide. 1988 shipments of 48 TPI drives are estimated at barely over 8 million units, reflecting reduced emphasis by clone makers on PC XT compatible systems. 1.0 megabyte drives peaked in 1984 with almost 1.8 million units and have fallen continuously to a level estimated to be below 300,000 drives in 1988, with most remaining usage in the Japanese language word processor market.

Unexpected strength in the market for PC AT compatible systems provided a major boost for 1.6 megabyte drives during 1987. Worldwide unit shipments were 6,082,500 drives, up 56.9%, with a further 13.6% increase forecasted for 1988. IBM's selection of 1.6 megabyte drives for the PC AT provided the key stimulus for expansion of the 1.6 megabyte drive market, and extensive usage of the same drives by PC clone producers has continued the trend.

IBM's movement to half high drives for all of its major personal computers also helped to depress shipments of older full size drives. 99.7% of 1987 worldwide unit shipments are expected to be half high drives, with the only remaining full size drives used in captive shipments in the Eastern Bloc.

Personal computer systems dominate applications for drives in this product group as the result of IBM's influence in using 5.25 inch two sided drives with the PC XT and PC AT. 80.3% of 1987 shipments were used with personal computers, and 7.6% were used with dedicated application office systems and workstations.

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Matsushita Communication Industrial's 2.8 million OEM drives provided 20.7% of the 1987 worldwide non-captive shipments. Teac's 1987 total was slightly higher than the previous year, but dropped to second place, with 17.5%. Mitsubishi Electric held 9.1% and Y-E Data was tied with Fujitsu at 7.5% -- all with shipments of at least one million drives.

#### Marketing trends

Despite continuing strength for PC AT clone markets, 1989 total shipments of two sided 5.25 inch drives are forecasted to be down a million units from the 1988 peak. 1991 shipments are forecasted at 10,791,000 drives, an average annual decline of 10.8% during 1989-91.

Total revenue for this product group will decline at a more rapid pace than the shipment decline, averaging -14.8% annually during 1989-91. The revenue loss will be even greater if average unit prices should decline at the same rate experienced in the last few years. However, it is believed that little effort will be expended in the future to redesign drives in this group for lower cost, now that shipments have peaked -- since drive manufacturers will be concentrating on 3.5 inch models.

It is obvious that the PC AT standard will remain in contention for years, considering IBM's failure to stampede the industry with the PS/2 and its microchannel bus, the counterattack by the "gang of nine" with the proposed EISA bus, the momentum of software development for PC AT systems, and the continuing support for PC AT standards by many users and clone makers. The current DISK/TREND forecasts assume that PS/2 and the microchannel will eventually prevail as the dominant industry standard, but that the PC AT standard will enjoy wide support and continuing sales for many years.

As a result, the many PC AT clones using 1.6 megabyte drives are expected to stay in production, to take advantage of existing market momentum. For this reason, 1.6 megabyte drives are expected to grow from 1987's 41% of the total for all 5.25 inch two sided drives to 70% of the 1991 total. 1.6 megabyte drives are expected to maintain a sustained shipment peak of about 7.5 million drives per year during the 1989-91 period, despite market weakness for this product group overall. 1.0 megabyte drives will be down to less than 1% of the total by 1991, with 48 TPI 500 kilobyte drives accounting for less than 30% of the total.

During the forecast period covered by this report, production of floppy drives in Eastern Bloc countries will start to reach significant levels. One result of this development will be growth in older product configurations, since most of the Eastern Bloc manufacturing organizations making floppy drives will be several years behind the West in product design. One manifestation of this activity is expected to be renewed growth in total shipments of full size floppy drives.

High capacity flexible disk drives over 5 megabytes are covered in a different product group, starting with last year's DISK/TREND Report. However, there are several 3.3 megabyte drives still included in this product group. A few years ago it seemed possible that additional development of higher capacity 5.25 inch drives might lead to new major products for the industry, with attention focused on drives with double the capacity of the 1.6 megabyte models then becoming a standard.

However, with the decision by IBM to utilize 3.5 inch drives with one and two megabyte capacities, most of the potential market for a double capacity version of the 1.6 megabyte 5.25 inch drive seems to have evaporated. At this time, the principal market opportunity for the currently

offered 3.3 megabyte drives appears to be in specialized applications such as Japanese language word processors.

#### Technical trends

It is considered unlikely that drive manufacturers will devote their resources to further product development for most of the products in this group, considering the outlook for declining production and the obvious need to place development priorities in other product areas.

The one possible product area which may still receive attention is in the 3.3 megabyte capacity range. The early 5.25 inch drives at this capacity level used embedded servo techniques for head positioning to achieve double the normal TPI, requiring preformatted diskettes. A variation of the pioneering drive introduced by Drivetec in 1982 is still being offered by Eastman Kodak, and a more recently designed 192 TPI drive was introduced by Matsushita Communication Industrial in 1986.

Another approach has been followed by Y-E Data, which introduced a 3.3 megabyte drive without embedded servo in early 1987. This drive employs the standard 96 TPI, with standard track positioning, and doubles the linear density, at 19,740 BPI.

The principal advantage of this method is the ability to maintain full read and write compatibility with both 1.0 and 1.6 megabyte diskettes, even though a special diskette is required for usage at 3.3 megabytes. This drive has been designed for 180 RPM, in order to hold the transfer rate to the standard level, making it possible to use stock single chip controllers, but doubling the latency.

Forecasting assumptions

1. IBM's efforts to make PS/2 and the microchannel bus into dominant industry standards will eventually prevail, forcing continually increasing usage of 3.5 inch microfloppy drives on new systems. However, the existing momentum of the PC AT format will decline only slowly, insuring a flat market for 1.6 megabyte 5.25 inch drives for several years.
2. The growth rate for personal computers which, resumed in 1986, will be maintained.
3. The dollar/yen exchange rate will stay in the current range, and the major Japanese floppy disk drive producers will maintain prices at approximately the current levels or slightly lower.

TABLE 19  
FLEXIBLE DISK DRIVES, 5.25 INCH, TWO SIDES  
REVENUE SUMMARY

	-----DISK DRIVE REVENUES, BY SHIPMENT DESTINATION (\$M)-----									
	1987		-----Forecast-----							
	Revenues		1988		1989		1990		1991	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
-----										
U.S. Manufacturers										
-----										
IBM Captive	--	--	--	--	--	--	--	--	--	--
Other U.S. Captive	7.0	10.5	--	--	--	--	--	--	--	--
TOTAL U.S. CAPTIVE	7.0	10.5	--	--	--	--	--	--	--	--
PCM	--	--	--	--	--	--	--	--	--	--
OEM	3.9	5.4	.2	.2	--	.2	--	--	--	--
TOTAL U.S. NON-CAPTIVE	3.9	5.4	.2	.2	--	.2	--	--	--	--
TOTAL U.S. REVENUES	10.9	15.9	.2	.2	--	.2	--	--	--	--
Non-U.S. Manufacturers										
-----										
Captive	36.7	335.6	30.8	274.4	22.8	214.7	13.8	149.7	5.3	84.6
PCM	--	--	--	--	--	--	--	--	--	--
OEM	417.8	914.5	384.0	918.9	327.2	857.3	268.3	754.6	213.8	651.1
TOTAL NON-U.S. REVENUES	454.5	1,250.1	414.8	1,193.3	350.0	1,072.0	282.1	904.3	219.1	735.7
Worldwide Recap										
-----										
TOTAL WORLDWIDE REVENUES	465.4	1,266.0	415.0	1,193.5	350.0	1,072.2	282.1	904.3	219.1	735.7
OEM Average Price (\$000)	.068	.067	.064	.064	.063	.064	.063	.063	.062	.062
-----										

TABLE 20  
FLEXIBLE DISK DRIVES, 5.25 INCH, TWO SIDES  
UNIT SHIPMENT SUMMARY

	-----DISK DRIVE UNIT SHIPMENTS, BY SHIPMENT DESTINATION (000)-----									
	1987		-----Forecast-----							
	---Shipments---		-----1988-----		-----1989-----		-----1990-----		-----1991-----	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
	----	----	----	----	----	----	----	----	----	----
U.S. Manufacturers										
-----										
IBM Captive	--	--	--	--	--	--	--	--	--	--
Other U.S. Captive	40.0	60.0	--	--	--	--	--	--	--	--
TOTAL U.S. CAPTIVE	40.0	60.0	--	--	--	--	--	--	--	--
PCM	--	--	--	--	--	--	--	--	--	--
OEM	68.3	93.3	1.0	1.0	.2	1.0	--	--	--	--
TOTAL U.S. NON-CAPTIVE	68.3	93.3	1.0	1.0	.2	1.0	--	--	--	--
TOTAL U.S. SHIPMENTS	108.3	153.3	1.0	1.0	.2	1.0	--	--	--	--
Non-U.S. Manufacturers										
-----										
Captive	114.0	1,035.0	108.0	945.5	80.0	748.0	50.0	525.0	20.0	292.0
PCM	--	--	--	--	--	--	--	--	--	--
OEM	6,129.4	13,541.4	5,998.6	14,303.5	5,157.0	13,471.0	4,279.0	11,999.0	3,452.0	10,499.0
TOTAL NON-U.S. SHIPMENTS	6,243.4	14,576.4	6,106.6	15,249.0	5,237.0	14,219.0	4,329.0	12,524.0	3,472.0	10,791.0
Worldwide Recap										
-----										
TOTAL WORLDWIDE SHIPMENTS	6,351.7	14,729.7	6,107.6	15,250.0	5,237.2	14,220.0	4,329.0	12,524.0	3,472.0	10,791.0
Cumulative Shipments										
-----										
IBM	427.5	475.0	427.5	475.0	427.5	475.0	427.5	475.0	427.5	475.0
Non-IBM	28,738.9	57,869.9	34,846.5	73,119.9	40,083.7	87,339.9	44,412.7	99,863.9	47,884.7	10,654.9
WORLDWIDE TOTAL	29,166.4	58,344.9	35,274.0	73,594.9	40,511.2	87,814.9	44,840.2	100,338.9	48,312.2	11,129.9

TABLE 21  
FLEXIBLE DISK DRIVES, 5.25 INCH, TWO SIDES  
WORLDWIDE SHIPMENTS (000)  
DRIVE HEIGHT ANALYSIS

	1987		Forecast									
	Units	%	Units	%	Units	%	Units	%	Units	%	Units	%
U.S. MANUFACTURERS												
Captive Total	60.0		--		--		--		--		--	
Full Size	--	--	--	--	--	--	--	--	--	--	--	--
Half High	60.0	100.0	--	--	--	--	--	--	--	--	--	--
OEM Total	93.3		1.0		1.0		--		--		--	
Full Size	20.0	21.4	--	--	--	--	--	--	--	--	--	--
Half High	73.3	78.6	1.0	100.0	1.0	100.0	--	--	--	--	--	--
Total U.S.	153.3		1.0		1.0		--		--		--	
Full Size	20.0	13.0	--	--	--	--	--	--	--	--	--	--
Half High	133.3	87.0	1.0	100.0	1.0	100.0	--	--	--	--	--	--
NON-U.S. MANUFACTURERS												
Captive Total	1,035.0		945.5		748.0		525.0		292.0			
Full Size	20.0	1.9	24.0	2.5	40.0	5.3	60.0	11.4	80.0	27.4		
Half High	1,015.0	98.1	921.5	97.5	708.0	94.7	465.0	88.6	212.0	72.6		
OEM Total	13,541.4		14,303.5		13,471.0		11,999.0		10,499.0			
Full Size	2.0	--	--	--	--	--	--	--	--	--	--	--
Half High	13,539.4	100.0	14,303.5	100.0	13,471.0	100.0	11,999.0	100.0	10,499.0	100.0		
Total Non-U.S.	14,576.4		15,249.0		14,219.0		12,524.0		10,791.0			
Full Size	22.0	.2	24.0	.2	40.0	.3	60.0	.5	80.0	.7		
Half High	14,554.4	99.8	15,225.0	99.8	14,179.0	99.7	12,464.0	99.5	10,711.0	99.3		
WORLDWIDE RECAP												
Total Worldwide Shipments	14,729.7		15,250.0		14,220.0		12,524.0		10,791.0			
	+2.5%		+3.5%		-6.7%		-11.9%		-13.8%			
Full Size	42.0	.3	24.0	.2	40.0	.3	60.0	.5	80.0	.7		
	-93.7%		-42.8%		+66.6%		+50.0%		+33.3%			
Half High	14,687.7	99.7	15,226.0	99.8	14,180.0	99.7	12,464.0	99.5	10,711.0	99.3		
	+7.2%		+3.6%		-6.8%		-12.1%		-14.0%			

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



TABLE 22  
FLEXIBLE DISK DRIVES, 5.25 INCH, TWO SIDES  
WORLDWIDE SHIPMENTS (000)  
TRACK DENSITY ANALYSIS

	1987		Forecast							
	Units	%	Units	%	Units	%	Units	%	Units	%
<b>U.S. MANUFACTURERS</b>										
Captive Total	60.0		--		--		--		--	
48 TPI	30.0	50.1	--	--	--	--	--	--	--	--
96 TPI 1.6 MB	30.0	49.9	--	--	--	--	--	--	--	--
OEM Total	93.3		1.0		1.0		--		--	
48 TPI	85.0	91.2	--	--	--	--	--	--	--	--
96 TPI 1.0 MB	1.3	1.4	--	--	--	--	--	--	--	--
96 TPI 1.6 MB	7.0	7.4	1.0	100.0	1.0	100.0	--	--	--	--
Total U.S.	153.3		1.0		1.0		--		--	
48 TPI	115.0	75.1	--	--	--	--	--	--	--	--
96 TPI 1.0 MB	1.3	.8	--	--	--	--	--	--	--	--
96 TPI 1.6 MB	37.0	24.1	1.0	100.0	1.0	100.0	--	--	--	--
<b>NON-U.S. MANUFACTURERS</b>										
Captive Total	1,035.0		945.5		748.0		525.0		292.0	
48 TPI	87.0	8.4	79.5	8.4	80.0	10.7	85.0	16.2	90.0	30.8
96 TPI 1.0 MB	1.0	.1	5.0	.5	8.0	1.1	10.0	1.9	12.0	4.1
96 TPI 1.6 MB	947.0	91.5	861.0	91.1	660.0	88.2	430.0	81.9	190.0	65.1
OEM Total	13,541.4		14,303.5		13,471.0		11,999.0		10,499.0	
48 TPI	8,076.6	59.7	7,972.5	55.8	6,458.0	48.0	4,710.0	39.4	3,065.0	29.2
96 TPI 1.0 MB	366.3	2.7	282.0	2.0	225.0	1.7	158.0	1.3	78.0	.7
96 TPI 1.6 MB	5,098.5	37.6	6,049.0	42.2	6,788.0	50.3	7,131.0	59.3	7,356.0	70.1
Total Non-U.S.	14,576.4		15,249.0		14,219.0		12,524.0		10,791.0	
48 TPI	8,163.6	56.1	8,052.0	52.9	6,538.0	46.1	4,795.0	38.4	3,155.0	29.2
96 TPI 1.0 MB	367.3	2.5	287.0	1.9	233.0	1.6	168.0	1.3	90.0	.8
96 TPI 1.6 MB	6,045.5	41.4	6,910.0	45.2	7,448.0	52.3	7,561.0	60.3	7,546.0	70.0
<b>WORLDWIDE RECAP</b>										
Total Worldwide Shipments	14,729.7		15,250.0		14,220.0		12,524.0		10,791.0	
	+2.5%		+3.5%		-6.7%		-11.9%		-13.8%	
48 TPI	8,278.6	56.3	8,052.0	52.9	6,538.0	46.1	4,795.0	38.4	3,155.0	29.2
	-16.6%		-2.7%		-18.8%		-26.6%		-34.2%	
96 TPI 1.0 MB	368.6	2.5	287.0	1.9	233.0	1.6	168.0	1.3	90.0	.8
	-36.1%		-22.1%		-18.8%		-27.8%		-46.4%	
96 TPI 1.6 MB	6,082.5	41.2	6,911.0	45.2	7,449.0	52.3	7,561.0	60.3	7,546.0	70.0
	+56.9%		+13.6%		+7.7%		+1.5%		-.1%	

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

2. Track densities greater than 96 TPI are grouped with 96 TPI 1.6 MB totals in this table.

TABLE 23  
FLEXIBLE DISK DRIVES, 5.25 INCH, TWO SIDES  
APPLICATIONS SUMMARY  
Percentage of Worldwide Shipments

APPLICATION -----	1987 Estimate -----		1991 Projection -----	
	Units (000) -----	% -----	Units (000) -----	% -----
MAINFRAME/SUPERMINI General purpose	--	--	43.2	.4
MINICOMPUTERS AND MULTI-USER MICROS Business and professional, including networks	964.8	6.6	561.1	5.2
PERSONAL COMPUTERS Business and professional, single user	11,832.3	80.3	8,794.6	81.5
OFFICE SYSTEMS AND WORKSTATIONS Dedicated application	1,123.9	7.6	474.8	4.4
NON-OFFICE SYSTEMS AND WORKSTATIONS Technical, distribution, medical, other specialized	645.2	4.4	539.6	5.0
CONSUMER AND HOBBY COMPUTERS	73.6	.5	215.8	2.0
OTHER APPLICATIONS	89.9	.6	161.9	1.5
Total	14,729.7	100.0	10,791.0	100.0

TABLE 24  
FLEXIBLE DISK DRIVES, 5.25 INCH, TWO SIDES  
MARKET SHARE SUMMARY  
Worldwide Shipments of Non-Captive Disk Drives

Drive Manufacturers	1987 Net Shipments			
	To United States Destinations		Worldwide	
	Units (000)	%	Units (000)	%
Matsushita Commun. Ind.	1,015.0	16.4	2,818.0	20.7
Teac	669.0	10.8	2,391.0	17.5
Mitsubishi Electric	957.0	15.4	1,234.0	9.1
Y-E Data	493.0	8.0	1,024.0	7.5
Fujitsu	1,024.0	16.5	1,024.0	7.5
Alps Electric	510.0	8.2	860.0	6.3
Toshiba	455.0	7.3	809.0	5.9
Chinon	240.0	3.9	680.0	5.0
Mitsumi Electric	135.0	2.2	540.0	4.0
NEC	98.0	1.6	511.0	3.7
Canon	205.0	3.3	490.0	3.6
Seiko Epson	125.0	2.0	340.0	2.5
Other U.S.	68.3	1.1	93.3	0.7
Other Non-U.S.	203.4	3.3	820.4	6.0
TOTAL	6,197.7	100.0	13,634.7	100.0



FLEXIBLE DISK DRIVES, MICROFLOPPIESCoverage

Examples of flexible disk drives in this group include:

3.5" disk diameter, one side, 67.5 TPI

Mitsumi Electric	D 351
------------------	-------

3.5" disk diameter, one side, 135 TPI

Brother	FB 100
Canon	MD3301
Matsushita Communication Ind.	JU-252
Matsushita Electronic Comp.	EME-112
Mitsumi Electric	D 355T
Teac	FD-35EN
Tecmate	MT-301

3.5" disk diameter, two sides, 67.5 TPI

Brother	FB 220
Y-E Data	YD-625B

3.5" disk diameter, two sides, 135 TPI, 1.0 megabyte

Alps Electric	DFL 413, DFP 423A
Brother	FB 600V
Canon	MD 3402
Chinon	F-354E
Citizen	OSDC
Copal	F-3534
Fujitsu	M2532K
Genisco Memory Products	EDR-350
Hyundai Electronics	HMF-311
Matsushita Communication Ind.	JU-363, JU-253A
Matsushita Electronic Comp.	EME-212
Mitsubishi Electric	MF353C
Mitsumi Electric	D357T
NEC	FD 1035, FD 1037A
Sankyo Seiki	FDU-380
Seiko Epson	SMD-280H, SMD-280L
Sony	MP-F11W
Teac	FD-235F, FD-135FN
Tecmate	MT-302
Teco	VF 3540, VF 3640
Toshiba	ND-352SH/TH
Y-E Data	YD-645B, YD-645C

3.5" disk diameter, two sides, 135 TPI, 1.6 megabytes

Alps Electric	DFP 683A
Brother	FB 700
Chinon	F-356
Citizen	OTDB
Copal	F-3536, F-3538
Fujitsu	M2533K, M2534K
Hyundai	HMF-321, HMF-331
Matsushita Communication Ind.	JU-255
Mitsubishi Electric	MF354C
NEC	FD 1135C, FD 1137C
Sankyo Seiki	FDU-480
Teac	FD-235G
Toshiba	ND-355S/T
Y-E Data	YD-665B, YD-686

3.5" disk diameter, two sides, 135 TPI, 2.0 megabytes

Alps Electric	DFP 723
Brother	FB 800
Chinon	F-357L
Citizen	OSDA, OTDA
Copal	F-3537
Fujitsu	M2537K
Goldstar Telecommunication	GFS-313
Hyundai Electronics	HMF-341
Matsushita Communication Ind.	JU-257
Mitsubishi Electric	MF355C
Mitsumi Electric	D359T
NEC	FD 1137H
Sankyo Seiki	FDU-580
Seiko Epson	SMD-240
Sony	MP-F73W-00D, MP-F17W
Teac	FD-35HFN, FD-235HF
Tecmate	NPH-304
Teco	VF 3660
Toshiba	ND-356S/T
Y-E Data	YD-701

3.5" disk diameter, two sides, 135 TPI, 4.0 megabytes

Teac	FD-235J
Toshiba	PD-211
Y-E Data	YD-740

3.0" disk diameter, one side

Matsushita Electronic Comp.	EME-156
-----------------------------	---------

3.0" disk diameter, two sides

Matsushita Electronic Comp.	EME-232
-----------------------------	---------

2.0" disk diameter, one side, 254 TPI, 1.0 megabyte

Matsushita Communication Ind.	JU-202
Sony	PDD-100

All microfloppy drives with capacities less than 5 megabytes and disk diameters of 3.5 inches or less are included in this product group. The separate types of products include: (1) 3.5 inch drives, both one and two sided versions, which are now manufactured by 23 companies, (2) the 3.0 inch drive, which is currently offered only by Matsushita Electronic Components, the company which originally introduced the format in cooperation with Hitachi, which has since discontinued production, and (3) 2.0 inch drives, currently offered only by Sony and Matsushita Communication Industrial, using separate, non-interchangeable formats.

All 3.5 inch drives are derived from the Sony microfloppy first shipped in 1982, with modifications to achieve logical file organization similar to the larger diskette drives preceding it. Drives with capacities of one megabyte or less use 6,250 bytes per track, the same track capacity as "double density" 5.25 inch diskettes, and also use 40 or 80 tracks per side to maintain file compatibility with 5.25 inch diskettes.

1.6 and 2.0 megabyte 3.5 inch drives were announced in 1985, and are intended for use with the high density media originally proposed by Sony, and operate at up to 17,434 BPI, using the 135 TPI standard of today's production drives. All of the current 1.6 and 2.0 megabyte drives claim "backward compatibility," the ability to read and write on lower capacity diskettes. Since the adoption of 2.0 megabyte drives by IBM in April, 1987, for the PS/2 systems, most major manufacturers of microfloppy drives have announced similar drives. Most manufacturers are also making the transition from the earlier 41.3 millimeter high drives ("half high", in

5.25 inch drive terms) to the 25.4 millimeter (one inch) high drives pioneered by Citizen in 1984.

While the 3.0 inch microfloppy format has lost all of its original adherents except Matsushita Electronic Components, the newly emerging 2.0 inch drives could have a brighter future with very small systems. Initial shipments are being used with "notebook" portable computers, with other possible applications in home computers, electronic typewriters and games. However, there are competing interchange standards, and it is not yet clear how many other manufacturers will join the fray.

#### Market status

DISK/TREND estimate of total market size:

<u>Worldwide sales (\$M)</u>	<u>1987</u>	<u>1988</u>	<u>1989</u>	<u>1990</u>	<u>1991</u>
U.S. manufacturers	--	--	--	--	--
All manufacturers	958.0	1,230.4	1,495.1	1,692.4	1,779.2

In 1988, microfloppy drives have finally become the industry leader, passing up 5.25 inch drives by an estimated lead of almost one million units. 1987 worldwide unit shipments grew by 99% to 12.3 million drives, and 1988's estimated 39% growth will boost the total to 17.1 million drives. Total revenue for the product group also increased 96.7% and 28.3% in the same two years. The last U.S. production of microfloppy drives occurred in 1984, and all drives in this product group are now manufactured by Japanese companies, except for recently initiated production programs in Taiwan.

Despite continuing momentum for two sided 5.25 inch drives, 3.5 inch microfloppies have found adequate stimulus for growth from IBM's PS/2 personal computer family, Apple's Macintosh and extensive usage with other

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U.S., Japanese and European computers. In addition, the laptop portable market is achieving excellent growth, with most using 3.5 inch floppies. One by-product of this growth is increased use of 3.5 inch drives with PC AT compatible office computers to provide interchange with portables.

After early standards confusion, the 3.5 inch diskette introduced by Sony has become the industry standard. OEM shipments of Matsushita 3.0 inch drives were slightly more than 700,000 units in 1987, driven by strong demand in the European home computer market, but this total was less than 6% of worldwide microfloppy drive shipments.

3.0 inch drives have never significantly penetrated the U.S. market, and after an early lead have been passed up in the Japan domestic market by 3.5 inch drives, now used by many system manufacturers, including Fujitsu, NEC and IBM. In this edition of the DISK/TREND Report, 3.0 inch drives are shown in the disk diameter breakdown tables as "<3.5 inches", a subgroup which also includes the 2.0 inch drives now starting to ship.

Within the 3.5 inch format, a complete reversal in the rankings of one side and two sided drives has occurred since 1984. In 1984, one side 3.5 inch drives held over 60% of all microfloppy unit shipments, but in 1987 two sided drives accounted for over 95.6% of shipments. Almost all new systems introduced in the last few years using microflopies have adopted two sided 3.5 inch models.

Most 3.5 inch drives shipped in the last year have used the standard 135 TPI, with 80 tracks per side. 67.5 TPI drives, with 40 tracks per side, have a minor role, with fewer producers each year. The 2.0 megabyte models now offered by almost all major floppy drive manufacturers have become the industry's fastest growing products, now that IBM has adopted 2.0 megabyte drives for high end PS/2 models.

## **1988 DISK/TREND REPORT**

More than 90% of microfloppy drives are sold through OEM distribution channels, and Sony, the originator of the format, remains the clear leader in non-captive shipments. In 1987, Sony shipped 27.5% of the worldwide non-captive total, with 3,102,000 drives. Alps Electric held second place with 13.3% and Matsushita Communication Industrial had 9.3%.

#### Marketing trends

Two sided 3.5 inch drives have become the largest selling microfloppy format, and the outlook is for excellent growth. Worldwide 1991 unit shipments are forecasted to reach 27.2 million drives, 95.6% of microfloppy drives and 67.6% of all floppy drives. 1991 worldwide shipments for the microfloppy drive product group in total are forecasted at 28.4 million drives, an average 18.5% annual increase for the 1989-91 period.

Until 1987, shipment gains for microfloppy drives occurred with limited participation by IBM, but with enthusiastic support by Hewlett-Packard, Apple Computer, and several manufacturers of portable computers and consumer computer systems. IBM used 3.5 inch two sided drives starting in 1984 in the JX system in Asia, and in early 1986 introduced the Convertible briefcase portable, using similar drives.

But the biggest endorsement of all for 3.5 inch drives came with IBM's PS/2. Despite a surprisingly high level of continuing support for the PC AT by users and clone makers, clumsy handling of licensing policies by IBM, and a strong counterattack on the IBM microchannel by independent personal computer manufacturers, it is assumed in DISK/TREND forecasts that the PS/2 will eventually become the predominant personal computer standard, and with it the 3.5 inch microfloppy.

1.0 megabyte models were the leaders for several years in 3.5 inch drive shipments, but higher capacity versions, mostly 2.0 megabyte drives are expected to assume leadership by 1989. Another major emerging micro-floppy trend is the movement to one inch high 3.5 inch drives. In the early 1980's there was no standard for the critical height dimension for 3.5 inch drives. Following Sony's original introduction of drives with two inch height in 1982, many other manufacturers settled on 1.625 inches (41.3 millimeters -- the same as 5.25 inch half high drives). While 1.625 inches became widely used, many of the same manufacturers also offered drives with 28, 30 or 32 millimeter heights.

Amidst all the confusion, Citizen Watch entered the microfloppy business with one inch high drives in 1984, with little immediate following. However, during the last three years, all significant producers of 3.5 inch drives have also added one inch high drives. One inch has already become the winner:

Two sided 3.5 inch  
worldwide captive & OEM  
unit shipments (000)

	<u>1987</u>	<u>1988</u>	<u>1989</u>	<u>1990</u>	<u>1991</u>
<u>1.625 inches (41.3 mm)</u>					
1 megabyte	4,585.0	2,989.0	1,340.0	241.0	24.0
1.6/2.0 megabytes	1,149.0	1,396.0	2,248.0	1,266.0	227.0
Total 1.625 inches	5,734.0	4,385.0	3,588.0	1,507.0	251.0
	50.7%	27.0%	17.6%	6.2%	.9%
<u>1 inch (25.4 mm)</u>					
1 megabyte	4,245.0	6,926.0	8,048.0	8,845.0	8,234.0
1.6/2.0 megabytes	1,336.3	4,908.0	8,750.0	14,042.0	18,745.0
Total 1 inch	5,581.3	11,834.0	16,798.0	22,887.0	26,979.0
	49.3%	73.0%	82.4%	93.8%	99.1%

This edition of DISK/TREND Report does not include separate forecasts for 4 megabyte 3.5 inch drives or for 2.0 inch drives. Sales of 4 megabyte drives are included in the two sided 3.5 inch microfloppy totals, and sales of 2.0 inch drives are included in the <3.5 inch totals.

There are two competing media standards (barium ferrite vs. cobalt modified oxide) in the 4 megabyte 3.5 inch market, with no reconciliation in sight. Several manufacturers now claim full read/write backward compatibility to 1 and 2 megabyte diskettes, and it is probable that limited system usage will start in 1989. However, it is likely that only an adoption by IBM or Apple Computer could create serious movement toward status as a de facto standard -- and it's probably too early to expect such a development.

A similar situation applies to 2.0 inch microfloppies, with incompatible products offered by Sony and Matsushita Communication Industrial. Although early usage with "notebook" computers and electronic typewriters may get the format started in the market, 2.0 inch drives will probably remain specialty products unless a major system manufacturer adopts them.

The share of microfloppy drives used with single user business and professional personal computers increased in 1987, to 80.7%, but is expected to decline slightly in future years. The proportion used with consumer and hobby computers is expected to grow from 5.6% in 1987 to 17.0% in 1991, mostly in lower capacity configurations. Microfloppy usage with dedicated application office systems and workstations is destined to drop to an estimated 6.5% in 1991, as personal computers take over additional assignments in the office.

### Technical trends

With the announcement of full backward compatibility by the sponsors of both products competing for the envisioned 4 megabyte standard, the remaining hurdles appear to be more political than technical. Development of special heads has made it possible for 4 megabyte drives to read and write 1 and 2 megabyte diskettes, so the next critical step would appear to be a favorable glance by IBM or Apple. But whether the PC giants will bother with the 4 megabyte proposals or jump directly to higher capacity floppy drives is unclear.

There is no question of media compatibility with 2.0 inch diskettes, either with each other or with other floppy formats. Sony's drive is a digital modification of the video floppy drive now used with still-frame cameras, which results in unique file organization and controller requirements. Matsushita Communication Industrial's drive is a miniaturized version of existing 3.5 inch drives, maintaining the same file organization and controller requirements. Although the Sony drive has a modest head start in the market, it could be more expensive for system integrators to utilize.

### Forecasting assumptions

1. One inch high 3.5 inch drives will become the dominant floppy drive configuration by 1988 and 2.0 megabyte capacities will assume leadership by 1989.
2. IBM will continue worldwide usage of 3.5 inch floppy drives with all newly introduced personal computers.
3. A positive growth rate for personal computers will be maintained.
4. The dollar/yen exchange rate will stay in the current range, and the major Japanese floppy disk drive producers will maintain prices at approximately the current levels or slightly lower.

TABLE 25  
FLEXIBLE DISK DRIVES, MICROFLOPPIES  
REVENUE SUMMARY

	DISK DRIVE REVENUES, BY SHIPMENT DESTINATION (\$M)									
	1987		Forecast							
	Revenues		1988		1989		1990		1991	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
-----										
U.S. Manufacturers										
-----										
IBM Captive	--	--	--	--	--	--	--	--	--	--
Other U.S. Captive	--	--	--	--	--	--	--	--	--	--
TOTAL U.S. CAPTIVE	--	--	--	--	--	--	--	--	--	--
PCM	--	--	--	--	--	--	--	--	--	--
OEM	--	--	--	--	--	--	--	--	--	--
TOTAL U.S. NON-CAPTIVE	--	--	--	--	--	--	--	--	--	--
TOTAL U.S. REVENUES	--	--	--	--	--	--	--	--	--	--
Non-U.S. Manufacturers										
-----										
Captive	16.2	216.5	27.6	267.8	42.4	344.6	57.9	419.0	75.4	452.8
PCM	--	--	--	--	--	--	--	--	--	--
OEM	403.5	741.5	524.6	962.2	650.8	1,150.5	814.3	1,273.4	939.3	1,326.4
TOTAL NON-U.S. REVENUES	419.7	958.0	552.2	1,230.0	693.2	1,495.1	872.2	1,692.4	1,014.7	1,779.2
Worldwide Recap										
-----										
TOTAL WORLDWIDE REVENUES	419.7	958.0	552.2	1,230.0	693.2	1,495.1	872.2	1,692.4	1,014.7	1,779.2
OEM Average Price (\$000)	.069	.066	.064	.061	.060	.059	.055	.055	.051	.051

TABLE 26  
FLEXIBLE DISK DRIVES, MICROFLOPPIES  
UNIT SHIPMENT SUMMARY

	DISK DRIVE UNIT SHIPMENTS, BY SHIPMENT DESTINATION (000)									
	1987		Forecast							
	Shipments		1988		1989		1990		1991	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM Captive	--	--	--	--	--	--	--	--	--	--
Other U.S. Captive	--	--	--	--	--	--	--	--	--	--
TOTAL U.S. CAPTIVE	--	--	--	--	--	--	--	--	--	--
PCM	--	--	--	--	--	--	--	--	--	--
OEM	--	--	--	--	--	--	--	--	--	--
TOTAL U.S. NON-CAPTIVE	--	--	--	--	--	--	--	--	--	--
TOTAL U.S. SHIPMENTS	--	--	--	--	--	--	--	--	--	--
Non-U.S. Manufacturers										
Captive	72.0	1,042.0	134.0	1,380.0	211.0	1,780.0	290.0	2,196.0	385.0	2,408.0
PCM	--	--	--	--	--	--	--	--	--	--
OEM	5,881.1	11,295.3	8,257.0	15,770.0	10,807.0	19,537.0	14,729.0	23,214.0	18,300.0	26,077.0
TOTAL NON-U.S. SHIPMENTS	5,953.1	12,337.3	8,391.0	17,150.0	11,018.0	21,317.0	15,019.0	25,410.0	18,685.0	28,485.0
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	5,953.1	12,337.3	8,391.0	17,150.0	11,018.0	21,317.0	15,019.0	25,410.0	18,685.0	28,485.0
Cumulative Shipments										
IBM	--	--	--	--	--	--	--	--	--	--
Non-IBM	10,446.8	24,243.0	18,837.8	41,393.0	29,855.8	62,710.0	44,874.8	88,120.0	63,559.8	16,605.0
WORLDWIDE TOTAL	10,446.8	24,243.0	18,837.8	41,393.0	29,855.8	62,710.0	44,874.8	88,120.0	63,559.8	16,605.0

TABLE 27  
FLEXIBLE DISK DRIVES, MICROFLOPPIES  
WORLDWIDE REVENUES (\$M)  
BREAKDOWN BY DISK DIAMETER

	1987 Revenues			1988			Forecast 1989			1990			1991	
	<3.5"	3.5" SS	3.5" DS	<3.5"	3.5" SS	3.5" DS	<3.5"	3.5" SS	3.5" DS	<3.5"	3.5" SS	3.5" DS	<3.5"	3.5" DS
U.S. MANUFACTURERS														
IBM Captive	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Other U.S. Captive	--	--	--	--	--	--	--	--	--	--	--	--	--	--
OEM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
TOTAL U.S. REVENUES	--	--	--	--	--	--	--	--	--	--	--	--	--	--
NON-U.S. MANUFACTURERS														
Captive	7.5	14.0	195.0	10.5	4.7	252.6	17.9	.8	325.9	27.5	--	391.5	38.6	414.2
OEM	40.9	13.2	687.4	36.5	9.6	916.1	34.4	8.4	1,107.7	38.4	3.6	1,231.4	45.3	1,281.1
TOTAL NON-U.S. REVENUES	48.4	27.2	882.4	47.0	14.3	1,168.7	52.3	9.2	1,433.6	65.9	3.6	1,622.9	83.9	1,695.3
WORLDWIDE RECAP														
Captive	7.5	14.0	195.0	10.5	4.7	252.6	17.9	.8	325.9	27.5	--	391.5	38.6	414.2
	--	-40.9%	+104.4%	+40.0%	-66.4%	+29.5%	+70.5%	-83.0%	+29.0%	+53.6%	--	+20.1%	+40.4%	+5.8%
OEM	40.9	13.2	687.4	36.5	9.6	916.1	34.4	8.4	1,107.7	38.4	3.6	1,231.4	45.3	1,281.1
	+31.9%	-60.4%	+126.4%	-10.8%	-27.3%	+33.3%	-5.8%	-12.5%	+20.9%	+11.6%	-57.1%	+11.2%	+18.0%	+4.0%
Total Revenues	48.4	27.2	882.4	47.0	14.3	1,168.7	52.3	9.2	1,433.6	65.9	3.6	1,622.9	83.9	1,695.3
	+56.1%	-52.3%	+121.2%	-2.9%	-47.4%	+32.4%	+11.3%	-35.7%	+22.7%	+26.0%	-60.9%	+13.2%	+27.3%	+4.5%
ANNUAL SHARE, BY DIAMETER	5.1%	2.8%	92.1%	3.8%	1.2%	95.0%	3.5%	.6%	95.9%	3.9%	.2%	95.9%	4.7%	95.3%



TABLE 28  
FLEXIBLE DISK DRIVES, MICROFLOPPIES  
WORLDWIDE SHIPMENTS (000)  
BREAKDOWN BY DISK DIAMETER

	1987 Shipments			1988			Forecast 1989			1990			1991	
	<3.5"	3.5" SS	3.5" DS	<3.5"	3.5" SS	3.5" DS	<3.5"	3.5" SS	3.5" DS	<3.5"	3.5" SS	3.5" DS	<3.5"	3.5" DS
U.S. MANUFACTURERS														
IBM Captive	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Other U.S. Captive	--	--	--	--	--	--	--	--	--	--	--	--	--	--
OEM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
TOTAL U.S. SHIPMENTS	--	--	--	--	--	--	--	--	--	--	--	--	--	--
NON-U.S. MANUFACTURERS														
Captive	50.0	66.0	926.0	70.0	23.0	1,287.0	119.0	2.0	1,659.0	190.0	--	2,006.0	276.0	2,132.0
OEM	676.0	230.0	10,389.3	650.0	188.0	14,932.0	630.0	180.0	18,727.0	745.0	81.0	22,388.0	979.0	25,098.0
TOTAL NON-U.S. SHIPMENTS	726.0	296.0	11,315.3	720.0	211.0	16,219.0	749.0	182.0	20,386.0	935.0	81.0	24,394.0	1,255.0	27,230.0
WORLDWIDE RECAP														
Captive	50.0	66.0	926.0	70.0	23.0	1,287.0	119.0	2.0	1,659.0	190.0	--	2,006.0	276.0	2,132.0
	--	-36.5%	+166.1%	+40.0%	-65.2%	+39.0%	+70.0%	-91.3%	+28.9%	+59.7%	--	+20.9%	+45.3%	+6.3%
OEM	676.0	230.0	10,389.3	650.0	188.0	14,932.0	630.0	180.0	18,727.0	745.0	81.0	22,388.0	979.0	25,098.0
	-4.8%	-55.9%	+130.1%	-3.8%	-18.3%	+43.7%	-3.1%	-4.3%	+25.4%	+18.3%	-55.0%	+19.5%	+31.4%	+12.1%
Total Shipments	726.0	296.0	11,315.3	720.0	211.0	16,219.0	749.0	182.0	20,386.0	935.0	81.0	24,394.0	1,255.0	27,230.0
	+2.3%	-52.7%	+132.7%	-.8%	-28.7%	+43.3%	+4.0%	-13.7%	+25.7%	+24.8%	-55.5%	+19.7%	+34.2%	+11.6%
ANNUAL SHARE, BY DIAMETER	5.9%	2.4%	91.7%	4.2%	1.2%	94.6%	3.5%	.9%	95.6%	3.7%	.3%	96.0%	4.4%	95.6%

TABLE 29  
FLEXIBLE DISK DRIVES, MICROFLOPPIES  
APPLICATIONS SUMMARY  
Percentage of Worldwide Shipments

APPLICATION -----	1987 Estimate		1991 Projection	
	Units (000) -----	% -----	Units (000) -----	% -----
MAINFRAME/SUPERMINI General purpose	--	--	--	--
MINICOMPUTERS AND MULTI-USER MICROS Business and professional, including networks	62.9	.5	341.8	1.2
PERSONAL COMPUTERS Business and professional, single user	9,950.0	80.7	20,822.5	73.1
OFFICE SYSTEMS AND WORKSTATIONS Dedicated application	1,103.0	8.9	1,851.5	6.5
NON-OFFICE SYSTEMS AND WORKSTATIONS Technical, distribution, medical, other specialized	434.3	3.5	370.3	1.3
CONSUMER AND HOBBY COMPUTERS	694.6	5.6	4,842.5	17.0
OTHER APPLICATIONS	92.5	.8	256.4	.9
Total	12,337.3	100.0	28,485.0	100.0

TABLE 30  
FLEXIBLE DISK DRIVES, MICROFLOPPIES  
MARKET SHARE SUMMARY  
Worldwide Shipments of Non-Captive Disk Drives

Drive Manufacturers	1987 Net Shipments			
	To United States Destinations		Worldwide	
	Units (000)	%	Units (000)	%
Sony	2,846.0	48.4	3,102.0	27.5
Alps Electric	1,440.0	24.5	1,500.0	13.3
Matsushita Commun. Ind.	139.1	2.4	1,047.0	9.3
Mitsubishi Electric	758.0	12.9	935.0	8.3
Matsushita Elect. Comp.	--	--	917.0	8.1
Toshiba	213.0	3.6	863.0	7.6
NEC	83.0	1.4	625.3	5.5
Seiko Epson	60.0	1.0	617.0	5.5
Citizen	127.0	2.2	449.0	4.0
Teac	20.0	0.3	335.0	3.0
Y-E Data	24.0	0.4	289.0	2.6
Chinon	90.0	1.5	220.0	1.9
Sankyo Seiki	--	--	215.0	1.9
Other U.S.	--	--	--	--
Other Non-U.S.	81.0	1.4	181.0	1.5
	-----	-----	-----	-----
TOTAL	5,881.1	100.0	11,295.3	100.0



FLEXIBLE DISK DRIVES, CAPACITY OVER 5 MEGABYTESCoverage

Examples of flexible disk drives included in this group are:

8 inch Bernoulli principle drives

Iomega	Alpha-10H, A120H
--------	------------------

5.25 inch Bernoulli principle drives

Iomega	Beta-20, B120, B144
--------	---------------------

8 inch flexible disk drives

Hitachi	FDD 641
---------	---------

5.25 inch flexible disk drives

Eastman Kodak	Kodak 6.6, Kodak 12
Hitachi	FDD 541
Konica	KT-510
Qume	HF-12, HF-24

3.5 inch flexible disk drives

Brier Technology	BR 3020
Insite Peripherals	I325
Matsushita Communication Ind.	JU-3511

All types of floppy drives with capacities over 5 megabytes have been consolidated into this section of the report. The functional and physical characteristics of these products are varied, and will be individually discussed below. Unfortunately, there has been no industry agreement on media interchange standards, and none of the high capacity floppy drives announced to date is capable of interchanging diskettes with high capacity drives of other manufacturers, except for limited backward compatibility with lower capacity standard floppy drives.

Iomega's Bernoulli principle drives: Iomega's drives use the Bernoulli effect to control head/disk spacing. These are high performance drives,

using flexible disks in a removable rigid cartridge, and a sophisticated internal air flow system to maintain the proper position of the disk relative to the recording head. A voice coil rotary head positioning system, in conjunction with an embedded servo, provides average seek times in the range of 32-40 milliseconds.

Iomega announced the 8 inch Alpha-10 in May, 1981, and deliveries of production drives, with 10 megabytes formatted capacity, started in September, 1982. The original drive was replaced by a half high 8 inch model in 1984, also with 10 megabyte capacity, and a 21 megabyte version was added in 1985. A 5 megabyte full size 5.25 inch drive was introduced in 1983, followed by a 21 megabyte half high model in 1986, with a new 44 megabyte version scheduled for delivery in first quarter, 1989.

Other flexible disk drives: For several years the technology required for production of higher capacity floppy drives using conventional recording techniques has been available, and several differing approaches have been offered. Hitachi was the first to offer drives in this group, starting with a 9.6 megabyte 8 inch drive in 1984, followed in 1985 by a 6.5 megabyte 5.25 inch drive. Both of these drives have been used only in limited applications, and only in Japan.

Building on the technology used in its earlier 3.3 megabyte 5.25 inch drive licensed from Drivetec, Eastman Kodak started shipments of a 6.6 megabyte 5.25 inch drive in the second half of 1986, followed by a more advanced 12 megabyte embedded servo drive in the second half of 1987. Primary responsibility for manufacturing this drive was turned over to Data Technology, a firm in which Eastman Kodak had an investment, and has since been merged into Qume. Qume added a 24 megabyte version in 1988, by doubling the track density to 666 TPI.

## **1988 DISK/TREND REPORT**

Konica has introduced a 10 megabyte 5.25 inch drive, with deliveries starting in late 1987. These drives also use embedded servo head positioning methods, but use diskettes in conventional diskette flexible plastic jackets instead of the rigid cartridge used in Kodak's and Qume's higher capacity drives, thus making it possible to provide for reading standard 1.6 megabyte diskettes.

The newest developments in high capacity floppies involve 3.5 inch drives announced by Brier Technology, Insite Peripherals, NEC and Matsushita Communication Industrial. With usage of 3.5 inch microfloppies on major personal computer systems from IBM and Apple, it is expected that most new activity in the high capacity marketplace will involve 3.5 inch drives.

NEC was the first to deliver its 9.4 megabyte (formatted) drive, in August, 1988, with NEC systems in the domestic Japanese market. The drive uses embedded servo, records on metal powder media and reads 1.0 and 2.0 megabyte diskettes.

Brier Technology has announced 21 and 43 megabyte (formatted) 3.5 inch drives using a unique "dual level" or "buried" recording system in which embedded servo information occupies the same position as data tracks without reducing track capacity. The first version of the 21 megabyte Brier drive is now promised for delivery in first quarter, 1989.

Insite Peripherals has achieved quick fame in the industry by announcing "floptical" technology, a combination of optical tracking methods with conventional magnetic recording. Insite uses a servo pattern burned onto the surface of standard 3.5 inch diskettes with a laser to achieve high track density (1,250 TPI), resulting in a capacity of 20.8 megabytes for the firm's initial drive, promised for first quarter, 1989.

Matsushita Communication Industrial recently announced a 16 megabyte 3.5 inch drive using diskettes with an iron metallic recording surface, for delivery in second quarter, 1989. MCI's drive writes its own servo information, with track density four times the 135 TPI density which is standard with open-loop drives.

#### Market status

DISK/TREND estimate of total market size:

<u>Worldwide sales (\$M)</u>	<u>1987</u>	<u>1988</u>	<u>1989</u>	<u>1990</u>	<u>1991</u>
U.S. manufacturers	66.4	69.3	88.4	110.5	135.0
All manufacturers	67.3	76.6	108.1	136.5	174.5

Worldwide unit shipments for this product group were down slightly in 1987, at 111,200 drives, most of which were of the Bernoulli type produced by Iomega. The decline was due primarily to Iomega's difficulties in converting promptly from 8 inch to 5.25 inch drives, as the shipment rate for 8 inch drives dropped. Sales of other 5.25 inch drives were still too small in 1987 to make any significant difference in the totals. The current market situation for Bernoulli drives and other types is analyzed separately below.

Iomega's Bernoulli principle drives: The capacity, performance, and pricing of Iomega's drives has traditionally placed them in competition with small Winchester disks and removable rigid disk cartridge drives, rather than with most flexible disk drives available in the past. Iomega has attracted great interest in the industry, but orders for OEM drives from system manufacturers were initially slow in coming. The firm achieved much better success through its program to sell Bernoulli Box subsystems in the personal computer add-on market.



During 1983-85, an 8 inch subsystem sold through dealers to IBM PC users was the key to the firm's growth to over \$100 million in annual sales. During 1986, however, sales grew only modestly and profits were down, due to the lower prices necessary to meet competition from small hard disks and approaching saturation of the 8 inch Bernoulli Box market. Success of a 21 megabyte half high 5.25 inch drive introduced in 1986 was delayed by technical problems, but the product started to take off in 1987 and is expected to provide two thirds of Iomega's unit shipments in 1988.

The company followed a policy of offering this drive only in the OEM market with sales mostly to personal computer manufacturers and subsystem builders, in an attempt to diversify its distribution channels. The product was not offered to Iomega's own distribution structure under the Iomega name until September, 1987.

Iomega's main difficulty in selling to major system manufacturers on an OEM basis has been lack of credible alternate sources for the company's drives. The products are unique, and system manufacturers, as always, are reluctant to take a chance on a sole-source product. Attempts to establish token alternate sources in Japan and the U.S. have been abortive. Further development of alternate sources for drives and media would provide a major boost in establishing shipments of Iomega's drives to conventional system manufacturers.

Other flexible disk drives: Although announcements of 3.5 inch high capacity floppy drives have received extensive press coverage, most of the non-Bernoulli high capacity drives currently being produced are 5.25 inch drives previously introduced by Konica, Eastman Kodak, and Qume (previously Data Technology). Worldwide shipments of 5.25 inch drives in this product group are expected to exceed 35,000 units in 1988. Most of these

have capacities of about 10 megabytes (formatted), but the new Qume 20 megabyte model is also now in production.

The newer 10 megabyte 5.25 inch drives have average head positioning times in the 65 to 75 millisecond range, much faster than conventional floppy drives, but also much slower than the Bernoulli drives. Latencies are much the same story: The 10 megabyte 5.25 inch drives, with 50 millisecond latency, are twice as fast as conventional floppies, but less than half as fast as the Bernoulli drives.

Given these comparisons, the future of the new high capacity drives will probably be found as backup devices used with Winchester disk drives and in applications such as data logging, in which access time is not a factor. Cartridge tape drives are the established competitor in these applications, and the new floppies could have a friendly reception by end users and system OEMs, both of whom usually respond favorably to faster performance and easier system integration.

The eventual market role for the new 5.25 inch drives will probably be determined by whether the manufacturers are able to achieve enough market penetration before high capacity 3.5 inch drives become generally available, and whether prices can be held low enough to be attractive compared to Bernoulli drives, removable hard disk drives, high capacity 3.5 inch floppy drives, erasable optical disk drives and tape cartridge drives.

#### Marketing trends

3.5 inch drives are expected to establish a serious challenge next year to 5.25 inch drives, which in 1988 will provide an estimated 70.8% of worldwide unit shipments. The 5.25 inch share is forecasted to drop to

slightly less than 50% in 1989, declining to 7.5% in 1991. 3.5 inch drives are expected to provide 92.5% of 1991 shipments, totaling 694,000 units.

Because of the large latent demand believed to exist for improved system backup devices, combined with availability of existing high capacity drives and new 3.5 inch models to come, rapid growth is expected for this product group. Once high capacity 3.5 inch drives are in production from multiple vendors, it is believed that the window for 5.25 inch drives will start to close.

Although 3.5 inch drives are expected to prevail in the high capacity floppy drive market, there will be many challenges along the way. The most important of these is the current lack of any consensus in the industry on just what formats should be used. As a result, the high capacity 3.5 inch drives active in the market during the next few years will include models with various embedded servo head positioning techniques, at least one with optical tracking methods, and possibly a Bernoulli principle drive.

As usual, the customers will be put off by all of the ensuing bickering over standards and will find it easy to delay purchases. For these reasons, current DISK/TREND forecasts could be conservative if any of the competing 3.5 inch products quickly becomes a mainstream de facto standard -- but the industry's history argues against the probability of a quick consensus, unless an extremely large system manufacturer makes an early choice among the contenders. Acceptance of high capacity 3.5 inch drives would also be greatly improved if backward compatibility with today's standard microflops, in both read and write modes, could be offered.

Iomega's Bernoulli drives, currently the main products in this group, are expected to undergo major changes in product mix and market acceptance during the forecast period of this report. 8 inch drives will continue to decline, and are expected to be out of production by 1991. Today's 21 megabyte 5.25 inch Bernoulli drives, as well as the new 44 megabyte model, are expected to top out in unit shipments in 1989, under pressure from newer 3.5 inch drives.

### Technology trends

The major product development challenges in this product group during the remainder of the 1990's will be to increase capacity and lower product cost. If high capacity floppy drives are to achieve prominence in data storage markets, they must offer sufficient capacity to be attractive for most small system backup requirements and they must provide aggressive price competition to tape cartridge drives, removable hard disk drives and erasable optical disk drives.

Since the 3.5 inch form factor for data storage products in this class is clearly destined to prevail, the development task will be to produce drives which offer capacities of 20 megabytes and more. It is expected that such drives will all use head positioning servo methods, but several approaches are anticipated.

Brier Technology, the first company to announce a specific high capacity 3.5 inch floppy drive, will use a "dual servo" technique, in order to avoid wasting valuable capacity in each data track for servo information. Other firms are known to be developing drives using conventional embedded (interspersed) servo technology. Insite Peripherals' optical tracking method is perhaps the most innovative approach, with obvious

potential for greater capacity and low manufacturing costs -- if the first hurdle of establishing quantity production can be accomplished smoothly. None of the above product designs will provide for media interchange except among drives of the same type, and perhaps in a few cases with 3.5 inch 1.0 and 2.0 megabyte drives.

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

#### Forecasting assumptions

1. Production of 3.5 inch high capacity drives from multiple vendors will start in the first half of 1989.
2. No major system OEM, such as IBM or Apple Computer, will adopt a product in this group for system usage through 1991.
3. Shipments of 5.25 inch Bernoulli drives will be greater than 8 inch models in 1988, but will peak in 1989.

TABLE 31  
FLEXIBLE DISK DRIVES, OVER 5 MEGABYTES  
REVENUE SUMMARY

	-----DISK DRIVE REVENUES, BY SHIPMENT DESTINATION (\$M)-----									
	1987		1988		1989		1990		1991	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers	-----									
IBM Captive	--	--	--	--	--	--	--	--	--	--
Other U.S. Captive	--	--	--	--	--	--	--	--	--	--
TOTAL U.S. CAPTIVE	--	--	--	--	--	--	--	--	--	--
PCM	38.2	45.9	41.1	51.4	45.7	57.7	45.3	58.5	41.5	54.5
OEM	13.9	20.5	11.2	17.9	22.5	30.7	41.4	52.0	59.9	80.5
TOTAL U.S. NON-CAPTIVE	52.1	66.4	52.3	69.3	68.2	88.4	86.7	110.5	101.4	135.0
TOTAL U.S. REVENUES	52.1	66.4	52.3	69.3	68.2	88.4	86.7	110.5	101.4	135.0
Non-U.S. Manufacturers	-----									
Captive	--	--	3.0	6.0	--	13.2	2.1	14.4	4.5	16.3
PCM	--	--	--	--	--	--	--	--	--	--
OEM	.4	.9	.7	1.3	1.8	6.5	4.3	11.6	8.4	23.2
TOTAL NON-U.S. REVENUES	.4	.9	3.7	7.3	1.8	19.7	6.4	26.0	12.9	39.5
Worldwide Recap	-----									
TOTAL WORLDWIDE REVENUES	52.5	67.3	56.0	76.6	70.0	108.1	93.1	136.5	114.3	174.5
OEM Average Price (\$000)	.464	.461	.449	.442	.365	.365	.261	.264	.199	.198
	-----									

TABLE 32  
FLEXIBLE DISK DRIVES, OVER 5 MEGABYTES  
UNIT SHIPMENT SUMMARY

	-----DISK DRIVE UNIT SHIPMENTS, BY SHIPMENT DESTINATION (000)-----									
	1987		-----Forecast-----							
	---Shipments---		---1988---		---1989---		---1990---		---1991---	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
-----										
U.S. Manufacturers										
-----										
IBM Captive	--	--	--	--	--	--	--	--	--	--
Other U.S. Captive	--	--	--	--	--	--	--	--	--	--
TOTAL U.S. CAPTIVE	--	--	--	--	--	--	--	--	--	--
PCM	54.0	64.8	60.0	75.0	80.0	101.0	100.0	129.0	127.0	167.0
OEM	30.0	44.2	24.9	40.3	61.0	80.0	158.0	193.0	300.0	402.0
TOTAL U.S. NON-CAPTIVE	84.0	109.0	84.9	115.3	141.0	181.0	258.0	322.0	427.0	569.0
TOTAL U.S. SHIPMENTS	84.0	109.0	84.9	115.3	141.0	181.0	258.0	322.0	427.0	569.0
Non-U.S. Manufacturers										
-----										
Captive	--	--	5.0	10.0	--	27.0	7.0	40.0	18.0	61.0
PCM	--	--	--	--	--	--	--	--	--	--
OEM	.8	2.2	1.6	3.1	5.5	22.0	17.0	48.0	43.0	121.0
TOTAL NON-U.S. SHIPMENTS	.8	2.2	6.6	13.1	5.5	49.0	24.0	88.0	61.0	182.0
Worldwide Recap										
-----										
TOTAL WORLDWIDE SHIPMENTS	84.8	111.2	91.5	128.4	146.5	230.0	282.0	410.0	488.0	751.0
Cumulative Shipments										
-----										
IBM	--	--	--	--	--	--	--	--	--	--
Non-IBM	325.6	371.9	417.1	500.3	563.6	730.3	845.6	1,140.3	1,333.6	1,891.3
WORLDWIDE TOTAL	325.6	371.9	417.1	500.3	563.6	730.3	845.6	1,140.3	1,333.6	1,891.3

TABLE 33  
FLEXIBLE DISK DRIVES, OVER 5 MEGABYTES  
WORLDWIDE REVENUES (\$M)  
BREAKDOWN BY DISK DIAMETER

	1987 Revenues		1988		Forecast			1990			1991	
	5.25"	8"	5.25"	8"	3.5"	5.25"	8"	3.5"	5.25"	8"	3.5"	5.25"
U.S. MANUFACTURERS												
PCM	5.0	40.9	31.5	19.9	17.5	32.3	7.9	34.0	21.5	3.0	43.5	11.0
OEM	16.6	3.9	14.2	3.7	8.3	20.9	1.5	33.4	18.1	.5	66.7	13.8
TOTAL U.S. REVENUES	21.6	44.8	45.7	23.6	25.8	53.2	9.4	67.4	39.6	3.5	110.2	24.8
NON-U.S. MANUFACTURERS												
Captive	--	--	6.0	--	6.0	7.2	--	9.6	4.8	--	14.5	1.8
OEM	.7	.2	1.0	.3	4.9	1.4	.2	10.4	1.2	--	22.8	.4
TOTAL NON-U.S. REVENUES	.7	.2	7.0	.3	10.9	8.6	.2	20.0	6.0	--	37.3	2.2
WORLDWIDE RECAP												
Captive	--	--	6.0	--	6.0	7.2	--	9.6	4.8	--	14.5	1.8
	--	--	--	--	--	+20.0%	--	+60.0%	-33.3%	--	+51.0%	-62.5%
PCM	5.0	40.9	31.5	19.9	17.5	32.3	7.9	34.0	21.5	3.0	43.5	11.0
	--	-42.2%	+530.0%	-51.3%	--	+2.5%	-60.3%	+94.3%	-33.4%	-62.0%	+27.9%	-48.8%
OEM	17.3	4.1	15.2	4.0	13.2	22.3	1.7	43.8	19.3	.5	89.5	14.2
	+408.8%	-83.3%	-12.1%	-2.4%	--	+46.7%	-57.5%	+231.8%	-13.5%	-70.6%	+104.3%	-26.4%
Total Revenues	22.3	45.0	52.7	23.9	36.7	61.8	9.6	87.4	45.6	3.5	147.5	27.0
	+486.8%	-52.8%	+136.3%	-46.9%	--	+17.3%	-59.8%	+138.1%	-26.2%	-63.5%	+68.8%	-40.8%
ANNUAL SHARE, BY DIAMETER	33.1%	66.9%	68.9%	31.1%	34.1%	57.2%	8.7%	64.1%	33.4%	2.5%	84.6%	15.4%



TABLE 34  
 FLEXIBLE DISK DRIVES, OVER 5 MEGABYTES  
 WORLDWIDE SHIPMENTS (000)  
 BREAKDOWN BY DISK DIAMETER

	1987 Shipments		1988		Forecast			1990			1991	
	5.25"	8"	5.25"	8"	3.5"	5.25"	8"	3.5"	5.25"	8"	3.5"	5.25"
U.S. MANUFACTURERS												
PCM	6.4	58.4	45.0	30.0	35.0	53.0	13.0	85.0	39.0	5.0	145.0	22.0
OEM	37.7	6.5	33.4	6.9	32.0	45.0	3.0	152.0	40.0	1.0	371.0	31.0
TOTAL U.S. SHIPMENTS	44.1	64.9	78.4	36.9	67.0	98.0	16.0	237.0	79.0	6.0	516.0	53.0
NON-U.S. MANUFACTURERS												
Captive	--	--	10.0	--	15.0	12.0	--	32.0	8.0	--	58.0	3.0
OEM	1.6	.6	2.4	.7	18.0	3.5	.5	45.0	3.0	--	120.0	1.0
TOTAL NON-U.S. SHIPMENTS	1.6	.6	12.4	.7	33.0	15.5	.5	77.0	11.0	--	178.0	4.0
WORLDWIDE RECAP												
Captive	--	--	10.0	--	15.0	12.0	--	32.0	8.0	--	58.0	3.0
	--	--	--	--	--	+20.0%	--	+113.3%	-33.3%	--	+81.3%	-62.5%
PCM	6.4	58.4	45.0	30.0	35.0	53.0	13.0	85.0	39.0	5.0	145.0	22.0
	+700.0%	-27.7%	+603.1%	-48.6%	--	+17.8%	-56.7%	+142.9%	-26.4%	-61.5%	+70.6%	-43.6%
OEM	39.3	7.1	35.8	7.6	50.0	48.5	3.5	197.0	43.0	1.0	491.0	32.0
	+495.5%	-71.9%	-8.9%	+7.0%	--	+35.5%	-53.9%	+294.0%	-11.3%	-71.4%	+149.2%	-25.6%
Total Shipments	45.7	65.5	90.8	37.6	100.0	113.5	16.5	314.0	90.0	6.0	694.0	57.0
	+517.6%	-38.3%	+98.7%	-42.6%	--	+25.0%	-56.1%	+214.0%	-20.7%	-63.6%	+121.0%	-36.7%
ANNUAL SHARE, BY DIAMETER	41.2%	58.8%	70.8%	29.2%	43.6%	49.3%	7.1%	76.7%	22.0%	1.3%	92.5%	7.5%

TABLE 35  
FLEXIBLE DISK DRIVES, OVER 5 MEGABYTES  
APPLICATIONS SUMMARY  
Percentage of Worldwide Shipments

APPLICATION	1987 Estimate		1991 Projection	
	Units (000)	%	Units (000)	%
MAINFRAME/SUPERMINI General purpose	--	--	--	--
MINICOMPUTERS AND MULTI-USER MICROS Business and professional, including networks	1.8	1.6	52.6	7.0
PERSONAL COMPUTERS Business and professional, single user	82.0	73.7	593.3	79.0
OFFICE SYSTEMS AND WORKSTATIONS Dedicated application	1.2	1.1	30.0	4.0
NON-OFFICE SYSTEMS AND WORKSTATIONS Technical, distribution, medical, other specialized	26.1	23.5	75.1	10.0
CONSUMER AND HOBBY COMPUTERS	--	--	--	--
OTHER APPLICATIONS	.1	.1	--	--
Total	111.2	100.0	751.0	100.0



FLEXIBLE DISK DRIVES, SPIRAL TRACKCoverage

Examples of flexible disk drives included in this group are:

Spiral track drives

Mitsumi Electric

D 281, D 284, D 286

The flexible disk drives in this group are analyzed separately, because the drives included are significantly different from those in other DISK/TREND product groups. Currently, the only products still active in this group are members of the Mitsumi "Quick Disk" family. Specific shipment and revenue forecasts for products in this group were included in the DISK/TREND Report for the first time in the 1985 edition.

Each of the Mitsumi Quick Disk drives records in a single spiral track on flexible disks 72 millimeters in diameter. The drives' physical size, interfaces and media are not compatible with other floppy formats.

Several manufacturers preceded Mitsumi Electric in the spiral track floppy drive marketplace, but all have since withdrawn their products. Olivetti offered a similar drive, starting in 1977, but phased it out several years ago. Olivetti's drive was used as a program loader and data storage medium on a variety of word processing and data processing equipment, but has been replaced with standard floppy drives. The drive was unsuccessful as an OEM product. Sankyo Seiki's first spiral track drive was introduced in 1980, and Tokyo Electric drives were introduced in 1982. The Mitsumi Quick Disk, became available in early 1984, and Ricoh's drive followed in the Spring of 1986.

All of these drives were, like Olivetti's, intended to develop the market for very small, low priced serial recording devices in applications

such as electronic typewriters, POS terminals, personal computers, and for other specialized systems. Most early shipments by Japanese manufacturers were in connection with electronic typewriters.

Mitsumi's Quick Disk has been the most ambitious product in this group. The target market is low cost home computers, where the intent is to provide a very low cost serial recording device which will be usable in quickly loading programs and user files into main system memory. Current drives have 64 kilobytes capacity, but higher capacity versions are feasible. The drive is designed to sell for less than \$30 to system manufacturers, and several successful home computers intended for the Japanese market have already appeared with Quick Disk drives. Maxell offers the media, providing a credible source.

#### Market status

DISK/TREND estimate of total market size:

<u>Worldwide sales (\$M)</u>	<u>1987</u>	<u>1988</u>	<u>1989</u>	<u>1990</u>	<u>1991</u>
U.S. manufacturers	--	--	--	--	--
All manufacturers	32.6	20.2	12.0	5.9	2.7

During 1985 the three companies participating at that time in the spiral track flexible disk drive market shipped a total of only 25,000 units, but the huge success in the Japan domestic market of certain game-oriented home computers drove the 1986 shipment level to over 1.3 million drives, most of which were the Mitsumi Quick Disk. 1987 shipments declined to 1.1 million drives, with a further drop to 720,000 expected in 1988. Because of the very low average unit price for drives of this type, the total revenues produced remain comparatively small.

## **1988 DISK/TREND REPORT**

### Marketing trends

The outlook for spiral track drives is considered questionable. In the early primary applications with word processing and electronic typewriters, spiral track drives have already been largely replaced by conventional floppy drives, initially 5.25 inch, and currently 3.5 inch drives -- with 2.0 inch drives now starting to appear.

The much larger current market with game-oriented home computers will probably also be impacted by alternate storage devices, such as 3.5 inch floppy drives, 2.0 inch floppy drives and IC cards. Current DISK/TREND forecasts indicate a decline in unit shipments and revenues to nominal levels by 1991.

Small size and low cost have not been enough to make a permanent place in the industry for spiral track floppy drives. Without the random access capability of other floppy drive formats, spiral track drives cannot be used conveniently with most of the applications stimulating the industry's growth, and lack of interchange standards have limited interest by system manufacturers.

### Forecasting assumptions

1. The market for home computers will enjoy continued growth in the Japanese domestic market, but with declining usage of spiral track floppy drives.
2. No major new applications for spiral track drives will be developed.

TABLE 36  
FLEXIBLE DISK DRIVES, SPIRAL TRACK  
REVENUE SUMMARY

	-----DISK DRIVE REVENUES, BY SHIPMENT DESTINATION (\$M)-----									
	1987		1988		1989		1990		1991	
	Revenues									
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
-----										
U.S. Manufacturers										
-----										
IBM Captive	--	--	--	--	--	--	--	--	--	--
Other U.S. Captive	--	--	--	--	--	--	--	--	--	--
TOTAL U.S. CAPTIVE	--	--	--	--	--	--	--	--	--	--
PCM	--	--	--	--	--	--	--	--	--	--
OEM	--	--	--	--	--	--	--	--	--	--
TOTAL U.S. NON-CAPTIVE	--	--	--	--	--	--	--	--	--	--
TOTAL U.S. REVENUES	--	--	--	--	--	--	--	--	--	--
Non-U.S. Manufacturers										
-----										
Captive	--	--	--	--	--	--	--	--	--	--
PCM	--	--	--	--	--	--	--	--	--	--
OEM	--	32.6	--	20.2	--	12.0	--	5.9	--	2.7
TOTAL NON-U.S. REVENUES	--	32.6	--	20.2	--	12.0	--	5.9	--	2.7
Worldwide Recap										
-----										
TOTAL WORLDWIDE REVENUES	--	32.6	--	20.2	--	12.0	--	5.9	--	2.7
OEM Average Price (\$000)	--	.028	--	.028	--	.028	--	.028	--	.028
-----										

TABLE 37  
FLEXIBLE DISK DRIVES, SPIRAL TRACK  
UNIT SHIPMENT SUMMARY

	-----DISK DRIVE UNIT SHIPMENTS, BY SHIPMENT DESTINATION (000)-----									
	1987		1988		1989		1990		1991	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM Captive	--	--	--	--	--	--	--	--	--	--
Other U.S. Captive	--	--	--	--	--	--	--	--	--	--
TOTAL U.S. CAPTIVE	--	--	--	--	--	--	--	--	--	--
PCM	--	--	--	--	--	--	--	--	--	--
OEM	--	--	--	--	--	--	--	--	--	--
TOTAL U.S. NON-CAPTIVE	--	--	--	--	--	--	--	--	--	--
TOTAL U.S. SHIPMENTS	--	--	--	--	--	--	--	--	--	--
Non-U.S. Manufacturers										
Captive	--	--	--	--	--	--	--	--	--	--
PCM	--	--	--	--	--	--	--	--	--	--
OEM	--	1,157.2	--	720.0	--	430.0	--	210.0	--	95.0
TOTAL NON-U.S. SHIPMENTS	--	1,157.2	--	720.0	--	430.0	--	210.0	--	95.0
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	--	1,157.2	--	720.0	--	430.0	--	210.0	--	95.0
Cumulative Shipments										
IBM	--	--	--	--	--	--	--	--	--	--
Non-IBM	--	2,538.0	--	3,258.0	--	3,688.0	--	3,898.0	--	3,993.0
WORLDWIDE TOTAL	--	2,538.0	--	3,258.0	--	3,688.0	--	3,898.0	--	3,993.0



TABLE 38  
FLEXIBLE DISK DRIVES, SPIRAL TRACK  
APPLICATIONS SUMMARY  
Percentage of Worldwide Shipments

APPLICATION -----	1987 Estimate -----		1991 Projection -----	
	Units (000) -----	% -----	Units (000) -----	% -----
MAINFRAME/SUPERMINI General purpose	--	--	--	--
MINICOMPUTERS AND MULTI-USER MICROS Business and professional, including networks	--	--	--	--
PERSONAL COMPUTERS Business and professional, single user	--	--	--	--
OFFICE SYSTEMS AND WORKSTATIONS Dedicated application	--	--	--	--
NON-OFFICE SYSTEMS AND WORKSTATIONS Technical, distribution, medical, other specialized	--	--	--	--
CONSUMER AND HOBBY COMPUTERS	1,157.0	100.0	95.0	100.0
OTHER APPLICATIONS	--	--	--	--
Total	----- 1,157.2	----- 100.0	----- 95.0	----- 100.0



## FLEXIBLE DISK DRIVE SPECIFICATIONS

### Coverage

The product specification section of this report includes most flexible disk drives intended for computer data storage which are now in production or announced, arranged alphabetically by manufacturer. Most of the listed drives are still in production.

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

### Capacities

Capacities are listed as "U" for unformatted or "F" for formatted. All capacities are per spindle. For DISK/TREND purposes, one spindle consists of the disk drive mechanism required to utilize a single flexible disk. Drives which use a single head positioning mechanism with two diskettes are considered to be two spindles.

### OEM prices

The 500 unit price is usually given for most OEM flexible disk drives sold in the United States, except where larger quantity prices are indicated. Since these prices may be changed by manufacturers without notice, please use them with the appropriate caution.

Generic type

Media intended for use with individual drives is identified by recording format -- for example, 5.25"--2/80 means 5.25 inch media suitable for two sided 80 track recording. For 5.25 inch and 3.5 inch drives which require media intended for higher than normal recording densities, the identification HD has been added to the media listing. Individual drives may require media with a variety of special characteristics.

Accuracy

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

DISK/TREND product groups

In most cases the product groups used for individual drives are clear, but a few arbitrary decisions have been made. The IBM magazine drive has been included in the 8 inch group, since the magazine mechanism uses a single drive.

1988 DISK/TREND product groups for flexible disk drives

<u>Group number</u>	<u>Drives included</u>
13.	8 inch drives
14.	5.25 inch drives, one side
15.	5.25 inch drives, two sides
16.	Microfloppy drives, one and two sides
17.	High capacity flexible disk drives, over 5 megabytes
18.	Spiral track drives

MANUFACTURER	ALPS ELECTRIC	ALPS ELECTRIC	ALPS ELECTRIC	ALPS ELECTRIC	ALPS ELECTRIC
DRIVE					
	DFE 422A	DFE 642A	DFE 682A	DFL 413	DFL 713
DISK/TREND GROUP	15	15	15	16	16
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	5.25" -- 2/80	5.25" - 2/80 HD	5.25" - 2/80 HD	3.5" -- 2/80	3.5" -- 2/80 HD
Nominal disk diameter	5.25"	5.25"	5.25"	3.5"	3.5"
Recording medium	Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: 1.0	U: 1.6	U: 1.0/1.6	U: 1.0	U: 2.0
Capacity per track (Bytes)	U: 6,250	U: 10,416	U: 6,250/10,416	U: 6,250	U: 12,500
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80	77	80/77	80	80
Track density (TPI)	96	96	96	135	135
Maximum linear density (BPI)	5922	9646	5922/9646	8717	17434
Rotational speed (RPM)	300	360	300/360	300	300
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING:Track to track(msec)	3	3	3	6	6
Settling time (msec)	15	15	15	15	15
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	100	83.3	100/83.3	100	100
Data transfer rate (KBytes/sec)	31.25	62.5	31.25/62.5	31.25	62.5
SIZE (Inches: H x W x D)	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0	1.625 x 4.0 x 5.5	1.625 x 4.0 x 5.5
FIRST CUSTOMER SHIPMENT	1987	1987	1987	4/85	1986
U.S. OEM PRICE FOR 500 UNITS	--	--	--	--	--
COMMENTS					

## 1988 DISK/TREND REPORT

MANUFACTURER	ALPS ELECTRIC	ALPS ELECTRIC	ALPS ELECTRIC	ASIA COMMERCIAL	ASIA COMMERCIAL
DRIVE	DFP 423A DFP 423D DFP 423E DFP 423F	DFP 683A DFP 683D	DFP 723A DFP 723D	FD-103	FD-148
DISK/TREND GROUP	16	16	16	14	14
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	3.5" -- 2/80	3.5" -- 2/80 HD	3.5" -- 2/80 HD	5.25" -- 1/40	5.25" - 1/40
Nominal disk diameter	3.5"	3.5"	3.5"	5.25"	5.25"
Recording medium	Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	Oxide Coated	Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: 1.0	U: 1.0/1.6	U: 1.0/2.0	U: .125/.250	U: .250
Capacity per track (Bytes)	U: 6,250	U: 6,250/10,416	U: 6,250/12,500	U: 3,125/6,250	U: 6,250
Data surfaces per spindle	2	2	2	1	1
Tracks per surface	80	80/77	80	40	40
Track density (TPI)	135	135	135	48	48
Maximum linear density (BPI)	8717	8717/14528	8717/17434	2768/5536	5536
Rotational speed (RPM)	300	300/360	300	300	300
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor
POSITIONING:Track to track(msec)	3	3	3	6	6
Settling time (msec)	15	15	15	20	20
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	100	100/83.3	100	100	100
Data transfer rate (KBytes/sec)	31.25	31.25/62.5	31.25/62.5	15.63/31.25	31.25
SIZE (Inches: H x W x D)	1.0 x 4.0 x 5.9	1.0 x 4.0 x 5.9	1.0 x 4.0 x 5.9	1.625 x 5.75 x 8.25	1.625 x 5.75 x 8.25
FIRST CUSTOMER SHIPMENT	1987	1987	1987	2Q85	1988
U.S. OEM PRICE FOR 500 UNITS	--	--	--	--	--
COMMENTS				For Apple IIC and Apple IIE	For Commodore

MANUFACTURER	ASIA COMMERCIAL	ASIA COMMERCIAL	ASIA COMMERCIAL	BRIER TECHNOLOGY	BRIER TECHNOLOGY
DRIVE	FD-104 FD-109	FD-106	FD-107	BR 3050	BR 3225
DISK/TREND GROUP	15	15	15	16	16
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	5.25" -- 2/40	5.25" -- 2/80	5.25" - 2/80 HD	3.5"- 2/1021 HD	3.5" - 2/516 HD
Nominal disk diameter	5.25"	5.25"	5.25"	3.5"	3.5"
Recording medium	Oxide Coated	Oxide Coated	High Density Oxide Coated	Barium Ferrite	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: .250/.5	U: .8/1.6	U: 1.6	F: 43.2	F: 21.4
Capacity per track (Bytes)	U: 3,125/6,250	U: 5,208/10,416	U: 10,416	**	**
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	40	80	80	1021	516
Track density (TPI)	48	96	96	1555	777
Maximum linear density (BPI)	2938/5876	4823/9646	9646	26000*	26000*
Rotational speed (RPM)	300	360	300	720	720
PERFORMANCE					
Actuator type	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Linear, Voice Coil	Linear, Voice Coil
POSITIONING:Track to track(msec)	6	3	3	10	15
Settling time (msec)	15	18	18	--	--
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	100	83.3	100	41.6	41.6
Data transfer rate (KBytes/sec)	15.63/31.25	31.25/62.5	62.5	1250	1250
SIZE (Inches: H x W x D)	1.625 x 5.75 x 8.25	1.625 x 5.75 x 8.25	1.625 x 5.75 x 8.25	1.625 x 4.0 x 5.75	1.625 x 4.0 x 5.75
FIRST CUSTOMER SHIPMENT	1Q86	3Q87	1988	4Q89	3Q89
U.S. OEM PRICE FOR 500 UNITS	--	--	--	\$485 (5000)	\$390 (5000)
COMMENTS	For IBM PC XT  FD-109 is externally mounted	For IBM AT	For IBM PS/2	Dual level embedded servo  29 msec average head positioning  *RLL Code **Varies by zone	Dual level embedded servo. 35 msec average head position. *RLL Code. **Varies by zone. Reads 1.0 and 2.0 MB diskettes.

## 1988 DISK/TREND REPORT

MANUFACTURER	BRIER TECHNOLOGY	BROTHER	BROTHER	BROTHER	BROTHER
DRIVE					
	BR 3020	FB 015	FB 100	FB 220	FB 600V
DISK/TREND GROUP	17	16	16	16	16
MARKET	OEM	OEM	Captive, OEM	Captive, OEM	Captive, OEM
MEDIA: Generic type	3.5" - 2/516 HD	3.5" -- 1/80	3.5" -- 1/40	3.5" -- 2/80	3.5" -- 2/80
Nominal disk diameter	3.5"	3.5	3.5"	3.5"	3.5"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: 21.4	U: .320	F: .1024	F: .2048	U: 1.0
Capacity per track (Bytes)	**	U: 4,000	F: 2,560	F: 2,560	U: 6,250
Data surfaces per spindle	2	1	1	2	2
Tracks per surface	516	80	40	40	80
Track density (TPI)	777	135	67.5	67.5	135
Maximum linear density (BPI)	26000*	8187	4064	4064	8717
Rotational speed (RPM)	720	300	300	300	300
PERFORMANCE					
Actuator type	Linear, Voice Coil	Lead Screw, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING:Track to track(msec)	15	20	60	60	6
Settling time (msec)	--	10	20	20	15
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	41.6	100	100	100	100
Data transfer rate (KBytes/sec)	1250	250	15.63	15.63	31.25
SIZE (Inches: H x W x D)	1.625 x 4.0 x 5.75	25.4 x 103.3 x 170	2.16 x 5.1 x 6.5	2.16 x 5.1 x 6.5	1.0 x 4.0 x 5.9
FIRST CUSTOMER SHIPMENT	1Q89	10/87	1984	1986	2Q86
U.S. OEM PRICE FOR 500 UNITS	\$350 (5000)	\$80	--	--	--
COMMENTS	Dual level embedded servo 35 msec average head positioning *RLL Code **Varies by zone				



MANUFACTURER	BROTHER	BROTHER	BROTHER	BROTHER	CANON
DRIVE					
	FB 620V	FB 700V	FB 710V	FB 800V	MD 5201
DISK/TREND GROUP	16	16	16	16	15
MARKET	Captive, OEM	Captive, OEM	Captive, OEM	Captive, OEM	OEM
MEDIA: Generic type	3.5" -- 2/80	3.5" -- 2/80	3.5" -- 2/80	3.5" -- 2/80	5.25" -- 2/80
Nominal disk diameter	3.5"	3.5"	3.5"	3.5"	5.25"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: 1.0	U: 1.0/1.67	U: 1.0/1.67	U: 1.0/2.0	U: .250/.5
Capacity per track (Bytes)	U: 6,250	U: 6,250/10,416	U: 6,250/10,416	U: 6,250/12,500	U: 3,125/6,250
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80	80	80	80	40
Track density (TPI)	135	135	135	135	48
Maximum linear density (BPI)	8717	8717/14528	8717/14528	8717/17434	2938/5876
Rotational speed (RPM)	300	360	300/360	300	300
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING:Track to track(msec)	3	3	3	3	6
Settling time (msec)	15	15	15	15	15
Head load time(msec)	Continuous Contact 100	Continuous Contact 83	Continuous Contact 100/83	Continuous Contact 100	Continuous Contact 100
Average rotational delay (msec)	100				
Data transfer rate (KBytes/sec)	31.25	37.5/62.5	31.25/62.5	31.25/62.5	15.63/31.25
SIZE (Inches: H x W x D)	1.0 x 4.0 x 5.9	1.0 x 4.0 x 5.9	1.0 x 4.0 x 5.9	1.0 x 4.0 x 5.9	1.06 x 5.75 x 7.8
FIRST CUSTOMER SHIPMENT	2Q86	2Q86	2Q86	2Q86	7/86
U.S. OEM PRICE FOR 500 UNITS	--	--	--	--	--
COMMENTS					

## 1988 DISK/TREND REPORT

MANUFACTURER	CANON	CANON	CANON	CANON	CANON
DRIVE					
	MD 5501	MD 3301 MD 3302	MD 3401 MD 3402	MD 3411	MD 3511
DISK/TREND GROUP	15	16	16	16	16
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	5.25" -- 2/80	3.5" -- 1/80	3.5" -- 2/80	3.5" -- 2/80	3.5" -- 2/80
Nominal disk diameter	5.25"	3.5"	3.5"	3.5"	3.5"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: 1.0/1.6	U: .5	U: 1.0	U: 1.0	U: 1.0/1.6
Capacity per track (Bytes)	U: 6,250/10,416	U: 6,250	U: 6,250	U: 6,250	U: 6,250/10,420
Data surfaces per spindle	2	1	2	2	2
Tracks per surface	80/77	80	80	80	80
Track density (TPI)	96	135	135	135	135
Maximum linear density (BPI)	5922/9646	8187	8717	8717	8717/17434
Rotational speed (RPM)	360	300	300	300	300/360
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING:Track to track(msec)	3	3	3	3	3
Settling time (msec)	15	15	15	15	15
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	83.3	100	100	100	100/83.3
Data transfer rate (KBytes/sec)	31.25/62.5	31.25	31.25	250	250/500
SIZE (Inches: H x W x D)	1.06 x 5.75 x 7.8	1.0 x 4.0 x 5.8	1.0 x 4.0 x 5.8	1.0 x 4.0 x 5.89	1.0 x 4.0 x 5.89
FIRST CUSTOMER SHIPMENT	7/86	7/86	7/86	4Q88	4/88
U.S. OEM PRICE FOR 500 UNITS	--	--	--	--	--
COMMENTS		MD 3302 is low power version	MD 3402 is low power version		

MANUFACTURER	CANON	CHINON	CHINON	CHINON	CHINON
DRIVE	MD 3611	FZ-501A	FZ-502	FZ-506	F-354E F-354EI FB-354 FB-354I
DISK/TREND GROUP	16	14	15	15	16
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	3.5" -- 2/80	5.25" -- 1/40	5.25" -- 2/40	5.25" - 2/80 HD	3.5" -- 2/80
Nominal disk diameter	3.5"	5.25"	5.25"	5.25"	3.5"
Recording medium	High Density Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: 1.0/2.0	U: .125/.250	U: .250/.5	U: 1.0/1.6	U: .5/1.0
Capacity per track (Bytes)	U: 6,250/12,500	U: 3,125/6,250	U: 3,125/6,250	U: 6,250/10,416	U: 3,125/6,250
Data surfaces per spindle	2	1	2	2	2
Tracks per surface	80	40	40	80/77	80
Track density (TPI)	135	48	48	96	135
Maximum linear density (BPI)	8717/17434	2768/5536	2938/5876	5922/9870	4359/8717
Rotational speed (RPM)	300	300	300	300/360	300
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor
POSITIONING:Track to track(msec)	3	6	5	3	3
Settling time (msec)	15	20	20	15	15
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	100	100	100	100/83.3	100
Data transfer rate (KBytes/sec)	250/500	15.63/31.25	15.63/31.25	37.5/62.5	15.63/31.25
SIZE (Inches: H x W x D)	1.0 x 4.0 x 5.89	1.625 x 5.75 x 8.1	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0	1.26 x 4.0 x 6.1
FIRST CUSTOMER SHIPMENT	4/88	8/83	3/87	4/87	11/84
U.S. OEM PRICE FOR 500 UNITS	--	--	--	--	--
COMMENTS					F-354E1 in 5.25" frame

MANUFACTURER	CHINON	CHINON	CHINON	CHINON	CHINON
DRIVE	F-354L FX-354	F-354MC F-354MCU	F-356 FB-356	F-356L	FB-357
DISK/TREND GROUP	16	16	16	16	16
MARKET	OEM	OEM, PCM	OEM	OEM	OEM
MEDIA: Generic type	3.5" -- 2/80	3.5" -- 2/80	3.5" -- 2/80 HD	3.5" -- 2/80 HD	3.5" -- 2/80 HD
Nominal disk diameter	3.5"	3.5"	3.5"	3.5"	3.5"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: 1.0	U: .8	U: 1.0/1.6	U: 1.0/1.6	U: 2.0
Capacity per track (Bytes)	U: 6,250	Varies	U: 5,208/10,416	U: 6,250/10,416	U: 12,500
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80	80	77	80/77	80
Track density (TPI)	135	135	135	135	135
Maximum linear density (BPI)	8717	8850	8717/14184	8717/14184	17434
Rotational speed (RPM)	300	390-605	360	300/360	300
PERFORMANCE	Lead Screw, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Lead Screw, Stepping Motor	Stepping Motor
Actuator type					
POSITIONING:Track to track(msec)	3	12	3	3	3
Settling time (msec)	15	30	15	15	15
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	100	76.9/49.6	83.3	100/83.3	100
Data transfer rate (KBytes/sec)	31.25	61.2	31.25/62.5	31.25/62.5	62.5
SIZE (Inches: H x W x D)	1.0 x 4.0 x 5.75	1.7 x 4.1 x 7.0	1.26 x 4.0 x 6.1	1.0 x 4.0 x 5.75	1.26 x 4.0 x 6.1
FIRST CUSTOMER SHIPMENT	7/86	1985	7/85	3Q87	7/86
U.S. OEM PRICE FOR 500 UNITS	--	--	--	--	--
COMMENTS		Subsystem for Apple MacIntosh			

MANUFACTURER	CHINON	CITIZEN	CITIZEN	CITIZEN	CITIZEN
DRIVE	F-357L FX-357	OSDA	OSDB	OSDC	OSDD
DISK/TREND GROUP	16	16	16	16	16
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	3.5" -- 2/80 HD	3.5" -- 2/80 HD	3.5" -- 2/80 HD	3.5" -- 2/80	3.5" -- 2/80
Nominal disk diameter	3.5"	3.5"	3.5"	3.5"	3.5"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: 1.0/2.0	U: 1.0/2.0	U: 1.0/1.6	U: 1.0	U: 1.0
Capacity per track (Bytes)	U: 6,250/12,500	U: 6,250/12,500	U: 6,250/10,416	U: 6,250	U: 6,250
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80	80	80/77	80	80
Track density (TPI)	135	135	135	135	135
Maximum linear density (BPI)	8717/17434	8717/17434	8717/14184	8717	8717
Rotational speed (RPM)	300	300	300/360	300	300
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING:Track to track(msec)	3	3	3	3	6
Settling time (msec)	15	15	15	15	15
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	300	100	100/83.3	100	100
Data transfer rate (KBytes/sec)	31.25/62.5	31.25/62.5	31.25/62.5	31.25	31.25
SIZE (Inches: H x W x D)	1.0 x 4.0 x 5.75	1.0 x 4.0 x 5.9	1.0 x 4.0 x 5.9	1.0 x 4.0 x 5.9	1.0 x 4.0 x 5.9
FIRST CUSTOMER SHIPMENT	3Q87	4Q87	4Q87	4Q87	4Q87
U.S. OEM PRICE FOR 500 UNITS	--	--	--	--	--
COMMENTS		Front loading	Front loading	Front loading	Front loading

## 1988 DISK/TREND REPORT

MANUFACTURER	CITIZEN	CITIZEN	CITIZEN	CITIZEN	COPAL
DRIVE					
	OTDA	OTDB	OTDC	OTDD	F-5002
DISK/TREND GROUP	16	16	16	16	15
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	3.5" -- 2/80 HD	3.5" -- 2/80 HD	3.5" -- 2/80	3.5" -- 2/80	5.25" -- 2/40
Nominal disk diameter	3.5"	3.5"	3.5"	3.5"	5.25"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: 1.0/2.0	U: 1.0/1.6	U: 1.0	U: 1.0	U: .5
Capacity per track (Bytes)	U: 6,250/12,500	U: 6,250/10,416	U: 6,250	U: 6,250	U: 6,250
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80	80/77	80	80	40
Track density (TPI)	135	135	135	135	48
Maximum linear density (BPI)	8717/17434	8717/14184	8717	8717	5876
Rotational speed (RPM)	300	300/360	300	300	300
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Band, Stepping Motor
POSITIONING:Track to track(msec)	3	3	3	6	6
Settling time (msec)	15	15	15	15	15
Head load time(msec)	Continuous Contact 100	Continuous Contact 100/83.3	Continuous Contact 100	Continuous Contact 100	Continuous Contact 100
Average rotational delay (msec)	100	100/83.3	100	100	100
Data transfer rate (KBytes/sec)	31.25/62.5	31.25/62.5	31.25	31.25	31.25
SIZE (Inches: H x W x D)	1.0 x 4.1 x 5.16	1.0 x 4.1 x 5.16	1.0 x 4.1 x 5.16	1.0 x 4.1 x 5.16	1.625 x 5.75 x 8.0
FIRST CUSTOMER SHIPMENT	4Q87	4Q87	4Q87	4Q87	9/85
U.S. OEM PRICE FOR 500 UNITS	--	--	--	--	--
COMMENTS	Top loading	Top loading	Top loading	Top loading	

MANUFACTURER	COPAL	COPAL	COPAL	COPAL	COPAL
DRIVE					
	F-5014	F-5016	F-5018	F-3534	F-3536
DISK/TREND GROUP	15	15	15	16	16
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	5.25" -- 2/80	5.25" - 2/80 HD	5.25" - 2/80 HD	3.5" -- 2/80	3.5" -- 2/80 HD
Nominal disk diameter	5.25"	5.25"	5.25"	3.5"	3.5"
Recording medium	Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY			U: 1.0 or U: 1.6		
Total capacity (Mbytes)	U: 1.0	U: 1.6	U: 1.6	U: 1.0	U: 1.6
Capacity per track (Bytes)	U: 6,250	U: 10,416	U: 10,416	U: 6,250	U: 10,416
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80	77	80/77	80	77
Track density (TPI)	96	96	96	135	135
Maximum linear density (BPI)	5922	9646	9646	8717	14528
Rotational speed (RPM)	300	360	300/360	300	360
PERFORMANCE					
Actuator type	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING:Track to track(msec)	3	3	3	6/3	3
Settling time (msec)	15	15	15	15	15
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	100	83.3	100/83.3	100	83.3
Data transfer rate (KBytes/sec)	31.25	62.5	31.25/62.5	31.25	62.5
SIZE (Inches: H x W x D)	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0	1.0 x 4.0 x 5.9	1.0 x 4.0 x 5.9
FIRST CUSTOMER SHIPMENT	12/86	12/86	12/86	6/87	6/87
U.S. OEM PRICE FOR 500 UNITS	--	--	--	--	--
COMMENTS					

## 1988 DISK/TREND REPORT

MANUFACTURER	COPAL	COPAL	COPAL	DIGITAL EQUIPMENT CORPORATION	EASTMAN KODAK
DRIVE					
	F-3537	F-3538	F-3539	RX50	KODAK 3.3
DISK/TREND GROUP	16	16	16	14	15
MARKET	OEM	OEM	OEM	Captive	Captive, OEM
MEDIA: Generic type	3.5" -- 2/80 HD	3.5" -- 2/80 HD	3.5" -- 2/80 HD	5.25" -- 1/80	5.25" - Special
Nominal disk diameter	3.5"	3.5"	3.5"	5.25"	5.25"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY				Per Diskette: F: .409 Per Drive: F: .818	
Total capacity (Mbytes)	U: 2.0	U: 1.0/1.6	U: 1.0/2.0		U: 3.33
Capacity per track (Bytes)	U: 12,500	U: 6,250/10,416	U: 6,250/12,500	F: 5,120	U: 10,416
Data surfaces per spindle	2	2	2	1 per diskette 2 per drive	2
Tracks per surface	80	80/77	80	80	160
Track density (TPI)	135	135	135	96	192
Maximum linear density (BPI)	17434	8717/14528	8717/17434	5536	9908
Rotational speed (RPM)	300	300/360	300	300	360
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Cam, Stepping Motor	Lead Screw/Dual Stepping Motors
POSITIONING:Track to track(msec)	3	3	3	6	3
Settling time (msec)	15	15	15		15
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact		Continuous Contact
Average rotational delay (msec)	100	100/83.3	100	100	83.3
Data transfer rate (KBytes/sec)	62.5	31.25/62.5	31.25/62.5	31.25	62.5
SIZE (Inches: H x W x D)	1.0 x 4.0 x 5.9	1.0 x 4.0 x 5.9	1.0 x 4.0 x 5.9	3.25 x 5.75 x 8.5	1.625 x 5.75 x 8.5
FIRST CUSTOMER SHIPMENT	6/87	6/87	9/87	4Q82	1Q84
U.S. OEM PRICE FOR 500 UNITS	--	--	--	--	--
COMMENTS				Dual drive with single head positioning system	Embedded Servo



MANUFACTURER	EASTMAN KODAK	EASTMAN KODAK	ELCOMATIC	ELCOMATIC	ELCOMATIC
DRIVE					
	KODAK 6.6	KODAK 12	ACP 500 ACP 550	ACP 700 ACP 750	ACP 1500
DISK/TREND GROUP	17	17	13	13	13
MARKET	Captive, OEM	Captive, OEM	OEM	OEM	OEM
MEDIA: Generic type	5.25" - Special	5.25" Cartridge	8" -- 1/77	8" -- 2/77	8" -- Special
Nominal disk diameter	5.25"	5.25"	8"	8"	8"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: 6.6	U: 12.76	U: .401/.802	U: .8/1.6	U: 1.6/3.2
Capacity per track (Bytes)	U: 10,416	U: 23,868	U: 5,208/10,416	U: 5,208/10,416	U: 10,416
Data surfaces per spindle	2	2	1	2	2
Tracks per surface	320	301	77	77	154
Track density (TPI)	384	333	48	48	96
Maximum linear density (BPI)	9908	21925	3268/6536	3408/6816	3408/6816
Rotational speed (RPM)	360	600	360	360	360
PERFORMANCE					
Actuator type	Lead Screw/Dual Stepping Motors	Linear, Voice Coil	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor
POSITIONING:Track to track(msec)	3	25	3	3	1.5
Settling time (msec)	15	--	15	15	32
Head load time(msec)	Continuous Contact	Continuous Contact	35	35	35
Average rotational delay (msec)	83.3	50	83.3	83.3	83.3
Data transfer rate (KBytes/sec)	62.5	250	31.25/62.5	31.25/62.5	31.25/62.5
SIZE (Inches: H x W x D)	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0	4.35 x 8.55 x 12.0	4.35 x 8.55 x 12.0	4.35 x 8.55 x 12.0
FIRST CUSTOMER SHIPMENT	3Q86	4Q86	4Q81	4Q81	1983
U.S. OEM PRICE FOR 500 UNITS	--	--	--	--	--
COMMENTS	Embedded Servo	Embedded Servo SCSI interface 75 msec average positioning	ACP 500: AC ACP 550: DC	ACP 700: AC ACP 750: DC	

## 1988 DISK/TREND REPORT

MANUFACTURER	ERGO	FLEXDISC	FLEXDISC	FLEXDISC	FUJITSU
DRIVE					
	DS-6	FF 450	FF 650	FF 950	M2551A
DISK/TREND GROUP	15	14	15	15	15
MARKET	Captive, OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	5.25" -- 2/40	5.25" -- 1/40	5.25" -- 2/40	5.25" - 2/80 HD	5.25" -- 2/40
Nominal disk diameter	5.25"	5.25"	5.25"	5.25"	5.25"
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	High Density Oxide Coated	Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: .250/.5	U: .125/.250	U: .250/.5	U: .8/1.6	U: .250/.5
Capacity per track (Bytes)	U: 3,125/6,250	U: 3,125/6,250	U: 3,125/6,250	U: 5,208/10,416	U: 3,125/6,250
Data surfaces per spindle	2	1	2	2	2
Tracks per surface	40	40	40	77	40
Track density (TPI)	48	48	48	96	48
Maximum linear density (BPI)	2938/5876	2768/5536	2938/5876	4823/9646	2938/5876
Rotational speed (RPM)	300	300	300	360	300
PERFORMANCE					
Actuator type	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor
POSITIONING:Track to track(msec)	6	6	6	3	4
Settling time (msec)	15	15	15	15	15
Head load time(msec)	Continuous Contact 100	Continuous Contact 100	Continuous Contact 100	Continuous Contact 83.3	Continuous Contact 100
Average rotational delay (msec)	100	100	100	83.3	100
Data transfer rate (KBytes/sec)	15.63/31.25	15.63/31.25	15.63/31.25	31.25/62.5	15.63/31.25
SIZE (Inches: H x W x D)	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0
FIRST CUSTOMER SHIPMENT	1985	--	--	--	1/86
U.S. OEM PRICE FOR 500 UNITS	\$54	--	--	--	\$70
COMMENTS					

MANUFACTURER	FUJITSU	FUJITSU	FUJITSU	FUJITSU	FUJITSU
DRIVE					
	M2552K	M2553K	M2554K	M2532K	M2533K
DISK/TREND GROUP	15	15	15	16	16
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	5.25" -- 2/80	5.25" - 2/80 HD	5.25" - 2/80 HD	3.5" -- 2/80	3.5" -- 2/80 HD
Nominal disk diameter	5.25"	5.25"	5.25"	3.5"	3.5"
Recording medium	Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: .5/1.0	U: .8/1.6	U: 1.0/1.6	U: 1.0	U: 1.6
Capacity per track (Bytes)	U: 3,125/6,250	U: 5,208/10,416	U: 6,250/10,416	U: 6,250	U: 10,416
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80	77	80/77	80	77
Track density (TPI)	96	96	96	135	135
Maximum linear density (BPI)	2961/5922	4823/9646	5922/9646	8717	14528
Rotational speed (RPM)	300	360	300/360	300	360
PERFORMANCE					
Actuator type	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING:Track to track(msec)	3	3	3	3	3
Settling time (msec)	15	15	15	15	15
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	100	83.3	100/83.3	100	83.3
Data transfer rate (KBytes/sec)	15.63/31.25	31.25/62.5	31.25/62.5	31.25	62.5
SIZE (Inches: H x W x D)	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0	1.0 x 4.0 x 5.9	1.0 x 4.0 x 5.9
FIRST CUSTOMER SHIPMENT	1/86	1/86	1/86	4Q87	4Q87
U.S. OEM PRICE FOR 500 UNITS	\$78	\$95	\$100	\$75	--
COMMENTS					

## 1988 DISK/TREND REPORT

MANUFACTURER	FUJITSU	FUJITSU	GENISCO MEMORY PRODUCTS	GOLDSTAR TELE- COMMUNICATION	GOLDSTAR TELE- COMMUNICATION
DRIVE					
	M2534K	M2537K	EDR-350	GSF 548	GSF 596
DISK/TREND GROUP	16	16	16	15	15
MARKET	OEM	OEM	OEM	Captive, OEM	Captive, OEM
MEDIA: Generic type	3.5" -- 2/80 HD	3.5" -- 2/80 HD	3.5" -- 2/80	5.25" -- 2/40	5.25" -- 2/80
Nominal disk diameter	3.5"	3.5"	3.5"	5.25"	5.25"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: 1.0/1.6	U: 2.0	U: 1.0	U: .5	U: 1.6
Capacity per track (Bytes)	U: 6,250/10,416	U: 12,500	U: 6,250	U: 6,250	U: 10,416
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80/77	80	80	40	77
Track density (TPI)	135	135	135	48	96
Maximum linear density (BPI)	8717/14528	17434	8717	5870	9600
Rotational speed (RPM)	300/360	300	300	300	360
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor
POSITIONING:Track to track(msec)	3	3	6	5	3
Settling time (msec)	15	15	15	15	15
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	100/83.3	100	100	100	83.3
Data transfer rate (KBytes/sec)	31.25/62.5	62.5	31.25	31.25	62.5
SIZE (Inches: H x W x D)	1.0 x 4.0 x 5.9	1.0 x 4.0 x 5.9	3.75 x 5.75 x 7.37	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0
FIRST CUSTOMER SHIPMENT	4Q87	4Q87	1987	1983	3Q87
U.S. OEM PRICE FOR 500 UNITS	--	\$85	--	--	--
COMMENTS			Sold as militarized subsystem		GSF 596K is 1/3 high model

MANUFACTURER	GOLDSTAR TELE- COMMUNICATION	HITACHI	HITACHI	HITACHI	HITACHI
DRIVE					
	GSF 313	FDD 412 FDD 413B	HFD 516C	FDD 441	FDD 541
DISK/TREND GROUP	16	13	15	17	17
MARKET	OEM	Captive, OEM	OEM	OEM	OEM
MEDIA: Generic type	3.5" -- 2/80 HD	8" -- 2/77	5.25" - 2/80 HD	Maxell FD2-HD 8"	Maxell MD2-EH 5.25"
Nominal disk diameter	3.5"	8"	5.25"		
Recording medium	High Density Oxide Coated	Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: 1.0/2.0	U: .8/1.6	U: .8/1.6	U: 9.6	U: 6.5
Capacity per track (Bytes)	U: 6,250/12,500	U: 5,208/10,416	U: 5,208/10,416	U: 31,250	U: 31,250
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80	77	77	154	104
Track density (TPI)	135	48	96	96	125
Maximum linear density (BPI)	8717/17434	3408/6816	4823/9646	20560*	29560
Rotational speed (RPM)	300	360	360	360	720
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor
POSITIONING:Track to track(msec)	3	3	3	2	2
Settling time (msec)	15	35	15	15	37
Head load time(msec)	Continuous Contact	50	50	Continuous Contact	Continuous Contact
Average rotational delay (msec)	100	83.3	83.3	83.3	41.7
Data transfer rate (KBytes/sec)	31.25/62.5	31.25/62.5	31.25/62.5	187.5	375
SIZE (Inches: H x W x D)	1.0 x 4.0 x 6.06	2.24 x 8.54 x 13.0	1.625 x 5.75 x 8.0	2.24 x 8.54 x 12.9	1.625 x 5.75 x 8.6
FIRST CUSTOMER SHIPMENT	4Q88	2/82	4/83	2/84	1Q85
U.S. OEM PRICE FOR 500 UNITS	--	--	--	--	--
COMMENTS				*2,7 RLL Code	

## 1988 DISK/TREND REPORT

MANUFACTURER	HO SHIN	HO SHIN	HO SHIN	HO SHIN	HYUNDAI ELECTRONICS
DRIVE					
	HS-550	HS-551	HS-552	HS-553	HMF-311
DISK/TREND GROUP	14	15	15	15	16
MARKET	OEM	OEM	OEM	OEM	Captive, OEM
MEDIA: Generic type	5.25" -- 1/40	5.25" -- 2/40	5.25" -- 2/80	5.25" - 2/80 HD	3.5" -- 2/80
Nominal disk diameter	5.25"	5.25"	5.25"	5.25"	3.5"
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: .250	U: .5	U: 1.0	U: 1.6	U: 1.0
Capacity per track (Bytes)	U: 6,250	U: 6,250	U: 6,250	U: 10,416	U: 6,250
Data surfaces per spindle	1	2	2	2	2
Tracks per surface	40	40	80	77	80
Track density (TPI)	48	48	96	96	135
Maximum linear density (BPI)	5536	5876	5922	9646	8717
Rotational speed (RPM)	300	300	300	360	300
PERFORMANCE					
Actuator type	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING:Track to track(msec)	4	4	3	3	3
Settling time (msec)	15	15	15	15	20
Head load time(msec)	Continuous Contact 100	Continuous Contact 100	Continuous Contact 100	Continuous Contact 100	Continuous Contact 100
Average rotational delay (msec)	100	100	100	100	100
Data transfer rate (KBytes/sec)	31.25	31.25	31.25	31.25	31.25
SIZE (Inches: H x W x D)	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0	1.0 x 4.0 x 5.9
FIRST CUSTOMER SHIPMENT	12/87	3/88	3Q88	3Q88	3Q88
U.S. OEM PRICE FOR 500 UNITS	\$48	\$54	\$56	\$61	--
COMMENTS	For use with Apple II	For use with IBM PC XT	For use with IBM PC XT	For use with IBM PC AT	

MANUFACTURER	HYUNDAI ELECTRONICS	HYUNDAI ELECTRONICS	HYUNDAI ELECTRONICS	IBM	IBM
DRIVE					
	HMF-321	HMF-331	HMF-341	3684	3694
DISK/TREND GROUP	16	16	16	13	13
MARKET	Captive, OEM	Captive, OEM	Captive, OEM	Captive	Captive
MEDIA: Generic type	3.5" -- 2/80 HD	3.5" -- 2/80 HD	3.5" -- 2/80 HD	8" -- 2/77	8" -- 2/77
Nominal disk diameter	3.5"	3.5"	3.5"	8"	8"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	Oxide Coated	Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: 1.6	U: 1.0/1.6	U: 1.0/2.0	F: .985088	F: .568320
Capacity per track (Bytes)	U: 10,416	U: 6,250/10,416	U: 6,250/12,500	F: 6,656	F: 3,840
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	77	80/77	80	74/3	74/3
Track density (TPI)	135	135	135	48	48
Maximum linear density (BPI)	14528	8717/14528	8717/17434	6816	3408
Rotational speed (RPM)	360	300/360	300	360	360
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Band, Stepping Motor
POSITIONING:Track to track(msec)	3	3	3	5	5
Settling time (msec)	20	20	20	35	35
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	--	
Average rotational delay (msec)	83	100/83	100	83.3	83.3
Data transfer rate (KBytes/sec)	62.5	31.25/62.5	31.25/62.5	360	31.25
SIZE (Inches: H x W x D)	1.0 x 4.0 x 5.9	1.0 x 4.0 x 5.9	1.0 x 4.0 x 5.9	--	--
FIRST CUSTOMER SHIPMENT	3Q88	3Q88	3Q88	--	--
U.S. OEM PRICE FOR 500 UNITS	--	--	--	--	--
COMMENTS				Point of sale terminal	3600 finance communication controller

## MANUFACTURER

## DRIVE

## DISK/TREND GROUP

## MARKET

MEDIA: Generic type

Nominal disk diameter

Recording medium

## CAPACITY/RECORDING DENSITY

Total capacity (Mbytes)

Capacity per track (Bytes)

Data surfaces per spindle

Tracks per surface

Track density (TPI)

Maximum linear density (BPI)

Rotational speed (RPM)

## PERFORMANCE

Actuator type

POSITIONING: Track to track (msec)

Settling time (msec)

Head load time (msec)

Average rotational delay (msec)

Data transfer rate (KBytes/sec)

SIZE (Inches: H x W x D)

FIRST CUSTOMER SHIPMENT

U.S. OEM PRICE FOR 500 UNITS

## COMMENTS

IBM	IBM	IBM	IBM	IBM
4701-1	4701-2	4956 4965	4964	5231
13	13	13	13	13
Captive	Captive	Captive	Captive	Captive
8" -- 2/77	8" -- 2/77	8" -- 2/77	8" -- 2/77	8" -- 1/77
8"	8"	8"	8"	8"
Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
F: .568320	F: .985088	F: .985088 or F: 1.136640 or F: 1.212416	F: .492544 or F: .568320 or F: .606208	F: .242944
F: 3,840	F: 6,656	F: 6,656/7,680/ 8,192	F: 3,328/3,840/ 4,096	F: 3,328
2	2	2	2	1
74/3	74/3	74/3	74/3	74/3
48	48	48	48	48
3408	6816	3408/6816	3408	3268
360	360	360	360	360
Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Lead Screw, Stepping Motor
5	5	5	5	50
35	35	35	35	20
				80
83.3	83.3	83.3	83.3	83.3
31.25	62.5	31.25/62.5	31.25	31.25
--	--	--	--	--
1982	1982	8/81	11/76	--
--	--	--	--	--
4701 finance communication controller	4701 finance communication controller	Similar drive included with 4952 and 4954 models C and XXD  Series/1	Similar drive included with some 4962 models  Series/1	5230 data collection system



MANUFACTURER	IBM	IBM	IBM	IBM	IBM
DRIVE	5360-BXX 5360-DXX 5362-XXX	5360-X2X 5381-XXX 5832-XXX (Magazine Drive)	5525-02X 5525-03X 5525-04X	5525-05X (Magazine Drive)	8101-A20 8101-A23/25
DISK/TREND GROUP	13	13	13	13	13
MARKET	Captive	Captive	Captive	Captive	Captive
MEDIA: Generic type	8" -- 2/77	8" -- 2/77	8" -- 2/77	8" -- 2/77	8" -- 2/77
Nominal disk diameter	8"	8"	8"	8"	8"
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: 1.212416	F: .985088 or F: 1.212416	F: 1.212416	F: 1.212416	F: .492544 or F: .985088
Capacity per track (Bytes)	F: 8,192	F: 6,656/8,192	F: 8,192	F: 8,192	F: 3,328/6,656
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	74/3	74/3	74/3	74/3	74/3
Track density (TPI)	48	48	48	48	48
Maximum linear density (BPI)	6816	3408/6816	6816	6816	3408/6816
Rotational speed (RPM)	360	360	360	720	360
PERFORMANCE					
Actuator type	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor
POSITIONING: Track to track(msec)	5	5	5	5	5
Settling time (msec)	35	35	35	35	35
Head load time(msec)	--				
Average rotational delay (msec)	83.3	41.7	83.3	41.7	83.3
Data transfer rate (KBytes/sec)	62.5	31.25/62.5	62.5	125	31.25/62.5
SIZE (Inches: H x W x D)	--	--	--	--	--
FIRST CUSTOMER SHIPMENT	--	1/79 (S/34)	2/80	11/80	1980
U.S. OEM PRICE FOR 500 UNITS	--	--	--	--	--
COMMENTS	System/36	Capacity is 2 10-diskette magazines and 3 diskettes  System/36 & /38	5520 administrative system	5520 administrative system	8100 system

## 1988 DISK/TREND REPORT

MANUFACTURER	IBM	INSITE PERIPHERALS	IOMEGA	IOMEGA	IOMEGA
DRIVE	8130 Series 8150 Series	1325	A110H Bernoulli Box	A120H Bernoulli Box	Alpha-10H
DISK/TREND GROUP	13	17	17	17	17
MARKET	Captive	OEM	PCM	PCM	PCM, OEM
MEDIA: Generic type	8" -- 2/77	3.5" -- Special	Alpha-10 Cartridge 8"	Alpha-20 Cartridge 8"	Alpha-10 Cartridge 8"
Nominal disk diameter	8"	3.5"			
Recording medium	Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY	F: .492544 or F: .985088	F: 20.8	F: 10.0	F: 21.4	F: 10.027 or 10.497
Total capacity (Mbytes)	F: 3,328/6,656	F: 13,824	F: 32,768	F: 32,768	F: 32,768 or 34,304
Capacity per track (Bytes)	2	2	1	1	1
Data surfaces per spindle	74/3	755	306	654	306
Tracks per surface	48	1250	300	641	300
Track density (TPI)	3408/6816	24145 BPI* 16100 FCI	24000 BPI 18000 FCI	24000 BPI 18000 FCI	24000 BPI 18000 FCI
Maximum linear density (BPI)	360	720	1500	1500	1500
Rotational speed (RPM)					
PERFORMANCE	Band, Stepping Motor	Crs:Step. Motor Fine:Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Actuator type	5	1	10 (including settling)	10 (including settling)	10 (including settling)
POSITIONING:Track to track(msec)	35	15	--	--	--
Settling time (msec)		Continuous Contact 41.6	Continuous Contact 20	Continuous Contact 20	Continuous Contact 20
Head load time(msec)	83.3				
Average rotational delay (msec)	31.25/62.5	200	1130	1130	1130
Data transfer rate (KBytes/sec)	--	1.625 x 4.0 x 5.9	6.32 x 12.5 x 15.25	6.32 x 12.5 x 15.25	2.32 x 8.54 x 12.0
SIZE (Inches: H x W x D)	1980	1Q89	8/85	10/85	4Q84
FIRST CUSTOMER SHIPMENT	--	\$250 (5000)	\$1,299 (List)	\$1,799 (List)	See below
U.S. OEM PRICE FOR 500 UNITS	8100 system	*2,7 RLL Code  65 msec average positioning time  Optical servo track system  SCSI interface	Subsystem for IBM PC  A210H is 2 drive version priced at \$1,999	Subsystem for IBM PC  A220H is 2 drive version priced at \$2,299	1st drive \$840 2nd drive \$464
COMMENTS					

MANUFACTURER	IOmega	IOmega	IOmega	IOmega	ISOT
DRIVE	Alpha-20H	B120/B220 Bernoulli Box II	B144/B244 Bernoulli Box II/44	Beta-20	ES 5082
DISK/TREND GROUP	17	17	17	17	13
MARKET	PCM, OEM	PCM	PCM	OEM	Captive, OEM
MEDIA: Generic type	Alpha-20 Cartridge	Bernoulli II Cartridge	Bernoulli II Cartridge	Beta-20 Cartridge	8" -- 1/77
Nominal disk diameter	8"	5.25"	5.25"	5.25"	8"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	Barium Ferrite	High Density Oxide Coated	Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: 21.4	F: 21.4	F: 44.5	F: 21.4	U: .4/.8
Capacity per track (Bytes)	F: 32,768	F: 16,128	F: 20,480	F: 16,128	U: 5,208/10,416
Data surfaces per spindle	1	2	2	2	1
Tracks per surface	654	677	1088	677	77
Track density (TPI)	641	570	1095	570	48
Maximum linear density (BPI)	24000 BPI 18000 FCI	23511 BPI* 17633 FCI	28541 BPI* 21405 FCI	23511 BPI* 17633 FCI	3268/6536
Rotational speed (RPM)	1500	1845.7	2027	1845.7	360
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil	Lead Screw, Stepping Motor
POSITIONING:Track to track(msec)	10 (including settling)	6.2 (including settling)	3.7	6.2 (including settling)	10
Settling time (msec)	--	--	--	--	25
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	40
Average rotational delay (msec)	20	16.25	14.8	16.25	83.3
Data transfer rate (KBytes/sec)	1130	666	692.5	666	31.25/62.5
SIZE (Inches: H x W x D)	2.32 x 8.54 x 12.0	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8	5.2 x 10.3 x 16.1
FIRST CUSTOMER SHIPMENT	3Q85	9/87	2/89	3Q86	1983
U.S. OEM PRICE FOR 500 UNITS	See below	\$1,100 (List)	\$1,399 (List)	See below	--
COMMENTS	1st drive \$900 2nd drive \$550	2nd drive \$900  External Single \$1,450 Dual \$2,350  40 msec average positioning time *1,8 RLL Code	2nd drive \$1099  External Single \$1,799 Dual \$2,799  32 msec average positioning time *1,8 RLL Code	1000 quantity: 1st drive \$995 2nd drive \$723  38 msec average positioning time SCSI interface *1,8 RLL Code	

## 1988 DISK/TREND REPORT

MANUFACTURER	ISOT	ISOT	ISOT	ISOT	ISOT
DRIVE					
	ES 5083	ES 5088M	ISOT 5050E	ES 5321	ES 5323
DISK/TREND GROUP	13	14	14	15	15
MARKET	Captive, OEM	Captive, OEM	Captive, OEM	Captive, OEM	Captive, OEM
MEDIA: Generic type	8" -- 2/77	5.25" -- 1/40	5.25" -- 1/40	5.25" -- 2/40	5.25" -- 2/80
Nominal disk diameter	8"	5.25"	5.25"	5.25"	5.25"
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: .8/1.6	U: .125/.250	U: .250	U: .250/.5	U: .5/1.0
Capacity per track (Bytes)	U: 5,208/10,416	U: 3,125/6,250	U: 6,250	U: 3,125/6,250	U: 3,125/6,250
Data surfaces per spindle	2	1	1	2	2
Tracks per surface	77	40	40	40	80
Track density (TPI)	48	48	48	48	96
Maximum linear density (BPI)	3408/6816	2768/5536	5536	2938/5876	2961/5922
Rotational speed (RPM)	360	300	300	300	300
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Cam, Stepping Motor	Cam, Stepping Motor	Cam, Stepping Motor	Band, Stepping Motor
POSITIONING: Track to track (msec)	10	40	40	25	5
Settling time (msec)	20	10	10	15	15
Head load time (msec)	35	50	50	Continuous Contact 100	Continuous Contact 100
Average rotational delay (msec)	83.3	100	100	100	100
Data transfer rate (KBytes/sec)	31.25/62.5	15.63/31.25	31.25	15.63/31.25	15.63/31.25
SIZE (Inches: H x W x D)	5.2 x 10.3 x 16.1	3.25 x 5.75 x 8.0	3.25 x 5.75 x 8.0	3.25 x 5.75 x 8.0	1.625 x 5.75 x 8.0
FIRST CUSTOMER SHIPMENT	1983	1982	1984	1984	1985
U.S. OEM PRICE FOR 500 UNITS	--	--	--	--	--
COMMENTS		Apple II compatible			

MANUFACTURER	KONICA	KOVO (ZBROJOVKA BRNO)	LUNG HWA	MAGYAR OPTIKAI MUVEK	MAGYAR OPTIKAI MUVEK
DRIVE					
	KT-510	CONSUL 7113	LDD-103SSA	Momflex 6400	MF 54S
DISK/TREND GROUP	17	13	14	13	14
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	5.25" -- 2/350	Diskette 1	5.25" -- 1/40	8" -- 1/77	5.25" -- 1/40
Nominal disk diameter	5.25"	8"	5.25"	8"	5.25"
Recording medium	High Density Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: 10.76	U: .4	U: .250	U: .4/.8	U: .250
Capacity per track (Bytes)	F: 15,360	U: 5,208	U: 6,250	U: 5,208/10,416	U: 6,250
Data surfaces per spindle	2	1	1	1	1
Tracks per surface	350	77	40	77	40
Track density (TPI)	480	48	48	48	48
Maximum linear density (BPI)	17827	3268	5536	3268/6536	5536
Rotational speed (RPM)	600	360	300	360	300
PERFORMANCE					
Actuator type	Linear, Voice Coil	Lead Screw, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor
POSITIONING:Track to track(msec)	20	8	6	4	3
Settling time (msec)	--	15	15	15	15
Head load time(msec)	Continuous Contact	35	Continuous Contact	35	35
Average rotational delay (msec)	50	83.3	100	83.3	100
Data transfer rate (KBytes/sec)	200	31.25	31.25	31.25/62.5	31.25
SIZE (Inches: H x W x D)	1.625 x 5.75 x 8.0	5.9 x 8.8 x 14.5	1.9 x 5.8 x 8.1	4.4 x 8.5 x 13.9	1.625 x 5.75 x 8.3
FIRST CUSTOMER SHIPMENT	11/87	1980	1987	1980	1987
U.S. OEM PRICE FOR 500 UNITS	--	--	--	--	--
COMMENTS	Embedded Servo  75 msec average positioning time  SCSI, with 1200 KB/second transfer rate				

## 1988 DISK/TREND REPORT

## MANUFACTURER

## DRIVE

## DISK/TREND GROUP

## MARKET

MEDIA: Generic type

Nominal disk diameter

Recording medium

## CAPACITY/RECORDING DENSITY

Total capacity (Mbytes)

Capacity per track (Bytes)

Data surfaces per spindle

Tracks per surface

Track density (TPI)

Maximum linear density (BPI)

Rotational speed (RPM)

## PERFORMANCE

Actuator type

POSITIONING:Track to track(msec)

Settling time (msec)

Head load time(msec)

Average rotational delay (msec)

Data transfer rate (KBytes/sec)

SIZE (Inches: H x W x D)

FIRST CUSTOMER SHIPMENT

U.S. OEM PRICE FOR 500 UNITS

COMMENTS

MAGYAR OPTIKAI MUVEK	MAGYAR OPTIKAI MUVEK	MAGYAR OPTIKAI MUVEK	MANTEC TECHNOLOGY	MANTEC TECHNOLOGY
MF 58S	MF 54D	MF 58D	MTL-FD102E/C	MTL-FD128
14	15	15	14	15
OEM	OEM	OEM	OEM	OEM
5.25" -- 1/80	5.25" -- 2/40	5.25" -- 2/80	5.25" -- 1/40	5.25" -- 2/40
5.25"	5.25"	5.25"	5.25"	5.25"
Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
U: .5	U: .5	U: 1.0	U: .125/.250	U: .5
U: 6,250	U: 6,250	U: 6,250	U: 3,125/6,250	U: 6,250
1	2	2	1	2
80	40	80	40	40
96	48	96	48	48
5576	5876	5922	2768/5536	5876
300	300	300	300	300
Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor
3	3	3	3	3
15	15	15	16	16
35	35	35	Continuous Contact 100	Continuous Contact 100
100	100	100	100	100
31.25	31.25	31.25	15.63/31.25	31.25
1.625 x 5.75 x 8.3	1.625 x 5.75 x 8.3	1.625 x 5.75 x 8.3	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0
1987	1987	1987	1987	1987
--	--	--	--	--
			For use with Apple IIC and Apple IIE	

MANUFACTURER	MATSUSHITA COMMUNICATION INDUSTRIAL	MATSUSHITA COMMUNICATION INDUSTRIAL	MATSUSHITA COMMUNICATION INDUSTRIAL	MATSUSHITA COMMUNICATION INDUSTRIAL	MATSUSHITA COMMUNICATION INDUSTRIAL
DRIVE	JA-751	JU-455 JA-551*	JU-465 JU-466 JA-561*	JU-475 JU-595*	JU-585*
DISK/TREND GROUP	13	15	15	15	15
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	8" -- 2/77	5.25" -- 2/40	5.25" -- 2/80	5.25" -- 2/80	5.25" -- 2/77
Nominal disk diameter	8"	5.25"	5.25"	5.25"	5.25"
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY				U: .5/1.0 or U: .8/1.6	
Total capacity (Mbytes)	U: .8/1.6	U: .5	U: 1.0	U: .8/1.6	U: 1.6
Capacity per track (Bytes)	U: 5,208/10,416	U: 6,250	U: 6,250	U: 6,250/10,416	U: 10,416
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	77	40	80	77/80	77
Track density (TPI)	48	48	96	96	96
Maximum linear density (BPI)	3408/6816	5876	5876	5922/9646	9870
Rotational speed (RPM)	360	300	300	300/360	360
PERFORMANCE					
Actuator type	Band, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING:Track to track(msec)	3	4	3	3	3
Settling time (msec)	25	15	15	15	15
Head load time(msec)	50	Continuous Contact 100	Continuous Contact 100	Continuous Contact 100/83.3	50
Average rotational delay (msec)	83.3				83.3
Data transfer rate (KBytes/sec)	31.25/62.5	31.25	31.25	31.25/62.5	62.5
SIZE (Inches: H x W x D)	2.2 x 8.6 x 12.1	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0
FIRST CUSTOMER SHIPMENT	1987	1982	1982	1983	1983
U.S. OEM PRICE FOR 500 UNITS	--	--	--	--	--
COMMENTS		*Sold only in Japan	*Sold only in Japan	*Sold only in Japan	*Sold only in Japan

MANUFACTURER	MATSUSHITA COMMUNICATION INDUSTRIAL	MATSUSHITA COMMUNICATION INDUSTRIAL	MATSUSHITA COMMUNICATION INDUSTRIAL	MATSUSHITA COMMUNICATION INDUSTRIAL	MATSUSHITA COMMUNICATION INDUSTRIAL
DRIVE	JU-202	JU-243A*	JU-252	JU-252A	JU-253
DISK/TREND GROUP	16	16	16	16	16
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	2.0" -- 2/80 HD	3.5" -- 2/80	3.5" -- 1/80	3.5" -- 1/80	3.5" -- 2/80
Nominal disk diameter	2.0"	3.5"	3.5"	3.5"	3.5"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: 1.0	U: 1.0	U: .5	U: .5	U: 1.0
Capacity per track (Bytes)	U: 6,250	U: 6,250	U: 6,250	U: 6,250	U: 6,250
Data surfaces per spindle	2	2	1	1	2
Tracks per surface	80	80	80	80	80
Track density (TPI)	254	135	135	135	135
Maximum linear density (BPI)	14000	8717	8186	8186	8717
Rotational speed (RPM)	300	300	300	300	300
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING:Track to track(msec)	6	6	3	6	3
Settling time (msec)	15	15	15	15	15
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	100	100	100	100	100
Data transfer rate (KBytes/sec)	31.25	31.25	31.25	31.25	31.25
SIZE (Inches: H x W x D)	.8 x 2.5 x 3.6	1.0 x 4.0 x 5.9	1.0 x 4.0 x 5.9	1.0 x 4.0 x 5.9	1.0 x 4.0 x 5.9
FIRST CUSTOMER SHIPMENT	1Q89	1987	1987	1986	1987
U.S. OEM PRICE FOR 500 UNITS	--	--	--	--	--
COMMENTS		*Sold only in Japan			



MANUFACTURER	MATSUSHITA COMMUNICATION INDUSTRIAL	MATSUSHITA COMMUNICATION INDUSTRIAL	MATSUSHITA COMMUNICATION INDUSTRIAL	MATSUSHITA COMMUNICATION INDUSTRIAL	MATSUSHITA COMMUNICATION INDUSTRIAL
DRIVE					
	JU-253A	JU-255	JU-255A	JU-257	JU-257A
DISK/TREND GROUP	16	16	16	16	16
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	3.5" -- 2/80	3.5" - 2/80 HD	3.5" -- 2/80 HD	3.5" -- 2/80 HD	3.5" -- 2/80 HD
Nominal disk diameter	3.5"	3.5"	3.5"	3.5"	3.5"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: 1.0	U: 1.0/1.6	U: 1.0/1.6	U: 1.0/2.0	U: 1.0/2.0
Capacity per track (Bytes)	U: 6,250	U: 6,250/10,416	U: 6,250/10,416	U: 6,250/12,500	U: 6,250/12,500
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80	80/77	80/77	80	80
Track density (TPI)	135	135	135	135	135
Maximum linear density (BPI)	8717	8717/14184	8717/14184	8717/17434	8717/17434
Rotational speed (RPM)	300	300/360	300/360	300	300
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING:Track to track(msec)	6	3	3	3	3
Settling time (msec)	15	15	15	15	15
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	100	100/83.3	100/83.3	100	100
Data transfer rate (KBytes/sec)	31.25	31.25/37.5/62.5	31.25/37.5/62.5	31.25/62.5	31.25/62.5
SIZE (Inches: H x W x D)	1.0 x 4.0 x 5.9	1.0 x 4.0 x 5.9	1.0 x 4.0 x 5.9	1.0 x 4.0 x 5.9	1.0 x 4.0 x 5.9
FIRST CUSTOMER SHIPMENT	1986	1987	1987	1987	1987
U.S. OEM PRICE FOR 500 UNITS	--	--	--	--	--
COMMENTS					5V (single)

## 1988 DISK/TREND REPORT

MANUFACTURER	MATSUSHITA COMMUNICATION INDUSTRIAL	MATSUSHITA COMMUNICATION INDUSTRIAL	MATSUSHITA COMMUNICATION INDUSTRIAL	MATSUSHITA ELECTRONIC COMPONENTS	MATSUSHITA ELECTRONIC COMPONENTS
DRIVE	JU-263A*	JU-363 JU-363A JU-364	JU-3511	EME-156	EME-232
DISK/TREND GROUP	16	16	17	16	16
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	3.5" -- 2/80	3.5" -- 2/80	3.5"-2/320 Met.	3.0" -- 1/40	3.0" -- 2/80
Nominal disk diameter	3.5"	3.5"	3.5"	3"	3"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	Iron Metallic	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: 1.0	U: .5/1.0	U: 16.0	U: .250	U: 1.0
Capacity per track (Bytes)	U: 6,250	U: 3,125/6,250	U: 25,000	U: 6,250	U: 6,250
Data surfaces per spindle	2	2	2	1	2
Tracks per surface	80	80	320	40	80
Track density (TPI)	135	135	542	100	200
Maximum linear density (BPI)	8717	4359/8717	35100	8946	9891
Rotational speed (RPM)	300	300	600	300	300
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING:Track to track(msec)	6	3	20	12	12
Settling time (msec)	15	15		15	15
Head load time(msec)	Continuous Contact 100	Continuous Contact 100	Continuous Contact 50	Continuous Contact 100	Continuous Contact 100
Average rotational delay (msec)	100	100	50	100	100
Data transfer rate (KBytes/sec)	31.25	15.63/31.25	2000 Max.	31.25	31.25
SIZE (Inches: H x W x D)	1.0 x 4.0 x 5.9	1.26 x 4.0 x 5.9	1.625 x 4.0 x 5.9	1.5 x 3.5 x 5.9	1.5 x 3.5 x 5.9
FIRST CUSTOMER SHIPMENT	1987	1984	2Q89	1987	1987
U.S. OEM PRICE FOR 500 UNITS	--	--	--	--	--
COMMENTS	*Sold only in Japan		Drive writes embedded servo  60 msec average head positioning  SCSI interface	Replaces EME-155	Replaces EME-231

MANUFACTURER	MATSUSHITA ELECTRONIC COMPONENTS	MATSUSHITA ELECTRONIC COMPONENTS	MILTOPE	MILTOPE	MILTOPE
DRIVE					
	EME-112	EME-212	DD 400	DD 450	DD 550
DISK/TREND GROUP	16	16	13	13	13
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	3.5" -- 1/80	3.5" -- 2/80	8" -- 1/77	8" -- 2/77	8" -- 2/77
Nominal disk diameter	3.5"	3.5"	8"	8"	8"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: .5	U: 1.0	U: .401/.802	U: .8/1.6	U: .8/1.6
Capacity per track (Bytes)	U: 6,250	U: 6,250	U: 5,208/10,416	U: 5,208/10,416	U: 5,208/10,416
Data surfaces per spindle	1	2	1	2	2
Tracks per surface	80	80	77	77	77
Track density (TPI)	135	135	48	48	48
Maximum linear density (BPI)	8187	8717	3268/6536	3408/6816	3408/6816
Rotational speed (RPM)	300	300	360	360	360
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Band, Stepping Motor
POSITIONING:Track to track(msec)	3	6	6	5	5
Settling time (msec)	15	15	10	10	10
Head load time(msec)	Continuous Contact	Continuous Contact	16	16	16
Average rotational delay (msec)	100	100	83.3	83.3	83.3
Data transfer rate (KBytes/sec)	31.25	31.25	31.25/62.5	31.25/62.5	31.25/62.5
SIZE (Inches: H x W x D)	1.0 x 3.8 x 5.9	1.0 x 3.8 x 5.9	5.44 x 8.44 x 18.0	5.44 x 8.44 x 18.0	5.44 x 8.44 x 18.0
FIRST CUSTOMER SHIPMENT	3/87	3/87	1977	1980	1982
U.S. OEM PRICE FOR 500 UNITS	--	--	\$4,950	\$5,400	\$4,000
COMMENTS			Sold as militarized subsystem	Sold as militarized subsystem	Sold as militarized subsystem

## 1988 DISK/TREND REPORT

MANUFACTURER	MITSUBISHI ELECTRIC CORPORATION	MITSUBISHI ELECTRIC CORPORATION	MITSUBISHI ELECTRIC CORPORATION	MITSUBISHI ELECTRIC CORPORATION	MITSUBISHI ELECTRIC CORPORATION
DRIVE					
	M2896-63	MF 501B	MF 501C	MF 503B	MF 504B
DISK/TREND GROUP	13	15	15	15	15
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	8" -- 2/77	5.25" -- 2/40	5.25" -- 2/40	5.25" -- 2/80	5.25" - 2/80 HD
Nominal disk diameter	8"	5.25"	5.25"	5.25"	5.25"
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: 1.6	U: .5	U: .5	U: 1.0	U: 1.0/1.6
Capacity per track (Bytes)	U: 10,416	U: 6,250	U: 6,250	U: 6,250	U: 6,250/10,416
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	77	40	40	80	80/77
Track density (TPI)	48	48	48	96	96
Maximum linear density (BPI)	6816	5877	5877	5922	5922/9870
Rotational speed (RPM)	360	300	300	300	300/360
PERFORMANCE					
Actuator type	Band, Stepping Motor	Band, Stepping Motor	Lead Screw, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor
POSITIONING:Track to track(msec)	3	6	6	3	3
Settling time (msec)	15	15	15	15	15
Head load time(msec)	35	Continuous Contact 100	Continuous Contact 100	Continuous Contact 100	Continuous Contact 100/83.3
Average rotational delay (msec)	83.3				
Data transfer rate (KBytes/sec)	62.5	31.25	31.25	31.25	31.25/62.5
SIZE (Inches: H x W x D)	2.25 x 8.55 x 12.4	1.625 x 5.75 x 7.7	1.625 x 5.75 x 7.7	1.625 x 5.75 x 7.7	1.625 x 5.75 x 7.7
FIRST CUSTOMER SHIPMENT	1982	4Q85	2Q88	2Q86	4Q85
U.S. OEM PRICE FOR 500 UNITS	--	--	--	--	--
COMMENTS					

MANUFACTURER	MITSUBISHI ELECTRIC CORPORATION	MITSUBISHI ELECTRIC CORPORATION	MITSUBISHI ELECTRIC CORPORATION	MITSUBISHI ELECTRIC CORPORATION	MITSUBISHI ELECTRIC CORPORATION
DRIVE					
	MF 504C	MF 353B	MF 353C	MF 354B	MF 354C
DISK/TREND GROUP	15	16	16	16	16
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	5.25" - 2/80 HD	3.5" -- 2/80	3.5" -- 2/80	3.5" -- 2/80 HD	3.5" - 2/80 HD
Nominal disk diameter	5.25"	3.5"	3.5"	3.5"	3.5"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: 1.0/1.6	U: 1.0	U: 1.0	U: 1.0/1.6	U: 1.0/1.6
Capacity per track (Bytes)	U: 6,250/10,416	U: 6,250	U: 6,250	U: 6,250/10,416	U: 6,250/10,416
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80/77	80	80	80/77	80/77
Track density (TPI)	96	135	135	135	135
Maximum linear density (BPI)	5922/9870	8717	8717	8717/14184	8717/14184
Rotational speed (RPM)	300/360	300	300	300/360	300/360
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING:Track to track(msec)	3	3	3	3	3
Settling time (msec)	15	15	15	15	15
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	100/83.3	100	100	100/83.3	100/83.3
Data transfer rate (KBytes/sec)	31.25/62.5	31.25	31.25	31.25/62.5	31.25/62.5
SIZE (Inches: H x W x D)	1.625 x 5.75 x 7.7	1.26 x 4.0 x 5.9	1.0 x 4.0 x 5.9	1.26 x 4.0 x 5.9	1.0 x 4.0 x 5.9
FIRST CUSTOMER SHIPMENT	--	4Q85	2Q87	4Q86	2Q87
U.S. OEM PRICE FOR 500 UNITS	--	--	--	--	--
COMMENTS					

## 1988 DISK/TREND REPORT

MANUFACTURER	MITSUBISHI ELECTRIC CORPORATION	MITSUBISHI ELECTRIC CORPORATION	MITSUMI ELECTRIC	MITSUMI ELECTRIC	MITSUMI ELECTRIC
DRIVE					
	MF 355B	MF 355C	D 503V	D 503V2	D 509V
DISK/TREND GROUP	16	16	15	15	15
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	3.5" -- 2/80 HD	3.5" -- 2/80 HD	5.25" -- 2/40	5.25" -- 2/40	5.25" - 2/80 HD
Nominal disk diameter	3.5"	3.5"	5.25"	5.25"	5.25"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	Oxide Coated	Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: 1.0/2.0	U: 1.0/2.0	U: .500	U: .500	U: 1.0/1.6
Capacity per track (Bytes)	U: 6,250/12,500	U: 6,250/12,500	U: 6,250	U: 6,250	U: 6,250/10,416
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80	80	40	40	80
Track density (TPI)	135	135	48	48	96
Maximum linear density (BPI)	8717/17434	8717/17434	5876	5876	5922/9646
Rotational speed (RPM)	300	300	300	300	360
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Band, Stepping Motor	Lead Screw, Stepping Motor	Band, Stepping Motor
POSITIONING:Track to track(msec)	3	3	6	6	3/5
Settling time (msec)	15	15	15	15	15
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	100	100	100	100	83.3
Data transfer rate (KBytes/sec)	31.25/62.5	31.25/62.5	31.25	31.25	37.5/62.5
SIZE (Inches: H x W x D)	1.26 x 4.0 x 5.9	1.0 x 4.0 x 5.9	1.625 x 5.75 x 7.4	1.625 x 5.75 x 7.4	1.625 x 5.75 x 7.4
FIRST CUSTOMER SHIPMENT	4Q86	2Q87	3/85	4Q88	1987
U.S. OEM PRICE FOR 500 UNITS	--	--	--	--	--
COMMENTS					

MANUFACTURER	MITSUMI ELECTRIC	MITSUMI ELECTRIC	MITSUMI ELECTRIC	MITSUMI ELECTRIC	MITSUMI ELECTRIC
DRIVE					
	D 509V2	D 351	D 355K	D 355T	D 355T2
DISK/TREND GROUP	15	16	16	16	16
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	5.25" - 2/80 HD	3.5" -- 1/40	3.5" -- 1/80	3.5" -- 1/80	3.5" -- 1/80
Nominal disk diameter	5.25"	3.5"	3.5"	3.5"	3.5"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: 1.0/1.6	U: .250	U: .500	U: .500	U: .5
Capacity per track (Bytes)	U: 6,250/10,416	U: 6,250	U: 6,250	U: 6,250	U: 6,250
Data surfaces per spindle	2	1	1	1	1
Tracks per surface	80	40	80	80	80
Track density (TPI)	96	67.5	135	135	135
Maximum linear density (BPI)	5922/9646	8125	8187	8187	8187
Rotational speed (RPM)	360	300	300	300	300
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING:Track to track(msec)	3/5	12	3	3	3
Settling time (msec)	15	15	15	15	15
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	83.3	100	100	100	100
Data transfer rate (KBytes/sec)	37.5/62.5	31.25	31.25	31.25	31.25
SIZE (Inches: H x W x D)	1.625 x 5.75 x 7.4	1.26 x 4.0 x 6.1	1.17 x 4.0 x 6.1	1.0 x 4.0 x 6.1	1.0 x 4.0 x 6.1
FIRST CUSTOMER SHIPMENT	4Q88	1/85	4/87	4/87	4Q88
U.S. OEM PRICE FOR 500 UNITS	--	--	--	--	--
COMMENTS					

# 1988 DISK/TREND REPORT

MANUFACTURER	MITSUMI ELECTRIC	MITSUMI ELECTRIC	MITSUMI ELECTRIC	MITSUMI ELECTRIC	MITSUMI ELECTRIC
DRIVE	D 357B D 357T	D 357K	D 357T2	D 359K	D 359T D 359T2
DISK/TREND GROUP	16	16	16	16	16
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	3.5" -- 2/80	3.5" -- 2/80	3.5" -- 2/80	3.5" -- 2/80 HD	3.5" -- 2/80 HD
Nominal disk diameter	3.5"	3.5"	3.5"	3.5"	3.5"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: 1.0	U: 1.0	U: 1.0	U: 2.0	U: 2.0
Capacity per track (Bytes)	U: 6,250	U: 6,250	U: 6,250	U: 12,500	U: 12,500
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80	80	80	80	80
Track density (TPI)	135	135	135	135	135
Maximum linear density (BPI)	8717	8717	8717	17434	17434
Rotational speed (RPM)	300	300	300	300	300
PERFORMANCE					
Actuator type	Band, Stepping Motor	Band, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING:Track to track(msec)	6	3	6	3	6
Settling time (msec)	15	15	15	15	15
Head load time(msec)	Continuous Contact 100	Continuous Contact 100	Continuous Contact 100	Continuous Contact 100	Continuous Contact 100
Average rotational delay (msec)	100	100	100	100	100
Data transfer rate (KBytes/sec)	31.25	31.25	31.25	62.5	62.5
SIZE (Inches: H x W x D)	1.0 x 4.0 x 6.1	1.17 x 4.0 x 6.1	1.0 x 4.0 x 6.1	1.17 x 4.0 x 6.1	1.0 x 4.0 x 6.1
FIRST CUSTOMER SHIPMENT	4/87	4/87	4Q88	1987	4Q88
U.S. OEM PRICE FOR 500 UNITS	--	--	--	--	--
COMMENTS		D 357P is in 5.25" form factor		D 359P is in 5.25" form factor	

## 1988 DISK/TREND REPORT



MANUFACTURER	MITSUMI ELECTRIC	MULTIDIGIT	MULTIDIGIT	MULTIDIGIT	MULTIDIGIT
DRIVE	D 281 D 284 D 286	DF0211	DF0511	DF1011	DF1611 DF1622
DISK/TREND GROUP	18	14	15	15	15
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	Maxell QD-2	5.25" -- 1/40	5.25" -- 2/40	5.25" -- 2/80	5.25" - 2/80 HD
Nominal disk diameter	72 mm	5.25"	5.25"	5.25"	5.25"
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: .064	U: .218	U: .5	U: 1.0	U: 1.6
Capacity per track (Bytes)	U: 64,000	U: 6,250	U: 6,250	U: 6,250	U: 10,416
Data surfaces per spindle	1	1	2	2	2
Tracks per surface	1	35	40	80	77
Track density (TPI)	59	48	48	96	96
Maximum linear density (BPI)	4410	5536	5877	5922	9646
Rotational speed (RPM)	423	300	300	300	360
PERFORMANCE					
Actuator type	N/A	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor
POSITIONING:Track to track(msec)	N/A	6	6	6	3
Settling time (msec)	N/A	15	25	15	15
Head load time(msec)	N/A	Continuous Contact	50	50	50
Average rotational delay (msec)	N/A	100	100	100	83.3
Data transfer rate (KBytes/sec)	12.63	31.25	31.25	31.25	62.5
SIZE (Inches: H x W x D)	1.73 x 4.6 x 4.1	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0
FIRST CUSTOMER SHIPMENT	2/86	1986	1985	1985	1986
U.S. OEM PRICE FOR 500 UNITS	--	--	--	--	--
COMMENTS	64,000 bytes in single spiral track  Front loading  QDM-02 is MSX subsystem				

## 1988 DISK/TREND REPORT

MANUFACTURER	MULTIDIGIT	NEC	NEC	NEC	NEC
DRIVE					
	DF2011	FD 1165	FD 1054	FD 1057	FD 1157C
DISK/TREND GROUP	15	13	15	15	15
MARKET	OEM	Captive, OEM	Captive, OEM	Captive, OEM	Captive, OEM
MEDIA: Generic type	5.25" - 2/80 HD	8" -- 2/77	5.25" -- 2/40	5.25" -- 2/80	5.25" - 2/80 HD
Nominal disk diameter	5.25"	8"	5.25"	5.25"	5.25"
Recording medium	High Density Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: 2.0	U: .8/1.6	U: .5	U: 1.0	U: 1.0/1.6
Capacity per track (Bytes)	U: 12,500	U: 5,208/10,416	U: 6,250	U: 6,250	U: 6,250/10,416
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80	77	40	80	80
Track density (TPI)	96	48	48	96	96
Maximum linear density (BPI)	11844	3408/6816	5876	5922	5922/9870
Rotational speed (RPM)	300	360	300	300	360
PERFORMANCE					
Actuator type	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor
POSITIONING:Track to track(msec)	3	3	6	3	3
Settling time (msec)	15	15	15	15	15
Head load time(msec)	50	50	35	35	35
Average rotational delay (msec)	100	83.3	100	100	83.3
Data transfer rate (KBytes/sec)	62.5	31.25/62.5	31.25	31.25	37.5/62.5
SIZE (Inches: H x W x D)	1.625 x 5.75 x 8.0	2.28 x 8.54 x 12.7	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0
FIRST CUSTOMER SHIPMENT	1986	4Q81	1987	1987	1987
U.S. OEM PRICE FOR 500 UNITS	--	\$280 (1000)	--	--	--
COMMENTS					

## 1988 DISK/TREND REPORT

MANUFACTURER	NEC	NEC	NEC	NEC	NEC
DRIVE					
	FD 1157D	FD 1035	FD 1036A	FD 1037A	FD 1135C
DISK/TREND GROUP	15	16	16	16	16
MARKET	Captive, OEM	Captive, OEM	Captive, OEM	Captive, OEM	Captive, OEM
MEDIA: Generic type	5.25" - 2/80 HD	3.5" -- 2/80	3.5" -- 2/80	3.5" -- 2/80 HD	3.5" -- 2/80 HD
Nominal disk diameter	5.25"	3.5"	3.5"	3.5"	3.5"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: 1.0/1.6	U: .5/1.0	U: .5/1.0	U: .5/1.0	U: 1.0/1.6
Capacity per track (Bytes)	U: 6,250/10,416	U: 3,125/6,250	U: 3,125/6,250	U: 3,125/6,250	U: 6,250/10,416
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80	80	80	80	80
Track density (TPI)	96	135	135	135	135
Maximum linear density (BPI)	5922/9870	4359/8717	4359/8717	4359/8717	8717/14528
Rotational speed (RPM)	360	300	300	300	300/360
PERFORMANCE					
Actuator type	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Linear, Stepping Motor	Band, Stepping Motor
POSITIONING:Track to track(msec)	3	3	3	3	3
Settling time (msec)	15	15	15	15	15
Head load time(msec)	35	35	Continuous Contact 100	Continuous Contact 100	35
Average rotational delay (msec)	83.3	100	100	100	100/83.3
Data transfer rate (KBytes/sec)	37.5/62.5	15.63/31.25	15.63/31.25	15.63/31.25	37.5/62.5
SIZE (Inches: H x W x D)	1.625 x 5.75 x 8.0	1.614 x 4.0 x 5.2	1.18 x 4.0 x 5.75	1.0 x 4.0 x 5.1	1.625 x 4.0 x 5.3
FIRST CUSTOMER SHIPMENT	1987	11/84	9/85	1987	11/85
U.S. OEM PRICE FOR 500 UNITS	--	\$105 (1000)	\$100 (1000)	--	--
COMMENTS	With VFO				

## 1988 DISK/TREND REPORT

MANUFACTURER	NEC	NEC	NEC	NEC	NEC
DRIVE					
	FD 1135D	FD 1136C	FD 1137C	FD 1137D	FD 1137H
DISK/TREND GROUP	16	16	16	16	16
MARKET	Captive, OEM	Captive, OEM	Captive, OEM	Captive, OEM	Captive, OEM
MEDIA: Generic type	3.5" -- 2/80 HD	3.5" -- 2/80 HD	3.5" -- 2/80 HD	3.5" -- 2/80 HD	3.5" -- 2/80 HD
Nominal disk diameter	3.5"	3.5"	3.5"	3.5"	3.5"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: 1.0/1.6	U: 1.0/1.6	U: 1.0/1.6	U: 1.0/1.6	U: 1.0/2.0
Capacity per track (Bytes)	U: 6,250/10,416	U: 6,250/10,416	U: 6,250/10,416	U: 6,250/10,416	U: 6,250/12,500
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80	80	80	80	80
Track density (TPI)	135	135	135	135	135
Maximum linear density (BPI)	8717/14528	8717/14528	8717/14528	8717/14528	8717/17434
Rotational speed (RPM)	300/360	300/360	300/360	300/360	300
PERFORMANCE					
Actuator type	Band, Stepping Motor	Band, Stepping Motor	Linear, Stepping Motor	Linear, Stepping Motor	Linear, Stepping Motor
POSITIONING:Track to track(msec)	3	3	3	3	3
Settling time (msec)	15	15	15	15	15
Head load time(msec)	35	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	100/83.3	100/83.3	100/83.3	100/83.3	100
Data transfer rate (KBytes/sec)	37.5/62.5	37.5/62.5	37.5/62.5	37.5/62.5	37.5/62.5
SIZE (Inches: H x W x D)	1.625 x 4.0 x 5.3	1.18 x 4.0 x 5.75	1.0 x 4.0 x 5.1	1.0 x 4.0 x 5.1	1.0 x 4.0 x 5.1
FIRST CUSTOMER SHIPMENT	1/86	6/86	1987	1987	1987
U.S. OEM PRICE FOR 500 UNITS	--	--	--	--	--
COMMENTS				With VFO	

## 1988 DISK/TREND REPORT

MANUFACTURER	NEC	OCEANIC	OCEANIC	OCEANIC	OCEANIC
DRIVE					
	FD 1331	OC-118 OC-118N	OH-2	Master 5A	OB-1
DISK/TREND GROUP	17	14	14	15	15
MARKET	Captive, OEM	OEM, PCM	OEM, PCM	PCM	OEM, PCM
MEDIA: Generic type	3.5"-2/240 Met.	5.25" -- 1/40	5.25" -- 1/40	5.25" -- 2/40	5.25" -- 2/40
Nominal disk diameter	3.5"	5.25"	5.25"	5.25"	5.25"
Recording medium	Metal Powder	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: 9.4	U: .174	U: .143	U: .5	U: .5
Capacity per track (Bytes)	F: 19,456	U: 4,833	U: 3,972	U: 6,250	U: 6,250
Data surfaces per spindle	2	1	1	2	2
Tracks per surface	240	36	36	40	40
Track density (TPI)	406	48	48	48	48
Maximum linear density (BPI)	36518	2768/5536	2768/5536	5536	5536
Rotational speed (RPM)	360	300	300	300	300
PERFORMANCE					
Actuator type	Linear, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor
POSITIONING:Track to track(msec)	3	6	4	5	4
Settling time (msec)	15	15	15	20	20
Head load time(msec)	Continuous Contact	35	35	Continuous Contact	Continuous Contact
Average rotational delay (msec)	83	100	100	100	100
Data transfer rate (KBytes/sec)	1250	15.63	15.63	31.25	31.25
SIZE (Inches: H x W x D)	1.26 x 4.0 x 5.75	1.57 x 5.67 x 7.95	1.65 x 5.75 x 7.05	1.57 x 5.67 x 7.95	1.57 x 5.67 x 7.95
FIRST CUSTOMER SHIPMENT	8/88	--	--	1988	9/86
U.S. OEM PRICE FOR 500 UNITS	--	\$86	\$55	--	\$62
COMMENTS	Embedded Servo  Reads 1.0 and 2.0 MB diskettes  ST412 interface	For Commodore	For Apple II	External mount for Amiga	

## 1988 DISK/TREND REPORT

MANUFACTURER	ORIENTAL PRECISION	ORIENTAL PRECISION	ORIENTAL PRECISION	PERIPHERAL DATA SYSTEMS	PERIPHERAL DATA SYSTEMS
DRIVE					
	OFD 543	OFD 546	OFD 596	MFDD-100	MFDD-110
DISK/TREND GROUP	14	15	15	14	14
MARKET	PCM	Captive	Captive	Captive, OEM	Captive, OEM
MEDIA: Generic type	5.25" -- 1/40	5.25" -- 2/40	5.25" -- 2/80	5.25" -- 1/40	5.25" -- 1/40
Nominal disk diameter	5.25"	5.25"	5.25"	5.25"	5.25"
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: .125/.250	U: .250/.5	U: .5/1.0	U: .109/.218	U: .125/.250
Capacity per track (Bytes)	U: 3,125/6,250	U: 3,125/6,250	U: 3,125/6,250	U: 3,125/6,250	U: 3,125/6,250
Data surfaces per spindle	1	2	2	1	1
Tracks per surface	40	40	80	35	40
Track density (TPI)	48	48	96	48	48
Maximum linear density (BPI)	2768/5536	2938/5876	2961/5922	2581/5162	2788/5576
Rotational speed (RPM)	300	300	300	300	300
PERFORMANCE					
Actuator type	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Cam, Stepping Motor	Band, Stepping Motor
POSITIONING:Track to track(msec)	6	6	6	18	5
Settling time (msec)	15	15	15	15	15
Head load time(msec)	50	50	50	Continuous Contact 100	Continuous Contact 100
Average rotational delay (msec)	100	100	100	100	100
Data transfer rate (KBytes/sec)	15.63/31.25	15.63/31.25	15.63/31.25	15.63/31.25	15.63/31.25
SIZE (Inches: H x W x D)	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0	3.93 x 6.1 x 8.62	2.2 x 5.86 x 9.68
FIRST CUSTOMER SHIPMENT	1983	1983	1983	1984	4Q86
U.S. OEM PRICE FOR 500 UNITS	--	--	--	--	--
COMMENTS	Licensed by TEAC  Apple compatible	Licensed by TEAC	Licensed by TEAC	Subsystem for Apple II system	Subsystem for Apple II system

MANUFACTURER	PERIPHERAL DATA SYSTEMS	PERIPHERAL DATA SYSTEMS	QUME	QUME	RICOH
DRIVE					
	BD-101	BD-120	HF12	HF24	RF8160
DISK/TREND GROUP	15	15	17	17	13
MARKET	Captive, OEM	Captive, OEM	OEM	OEM	Captive, OEM
MEDIA: Generic type	5.25" -- 2/40	5.25" -- 2/40	5.25" Cartridge	5.25" Cartridge	8" -- 2/77
Nominal disk diameter	5.25"	5.25"	5.25"	5.25"	8"
Recording medium	Oxide Coated	Oxide Coated	High Density Oxide Coated	Barium Ferrite	Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: .250/.5	U: .250/.5	F: 10.0	F: 20.2	U: .8/1.6
Capacity per track (Bytes)	U: 3,125/6,250	U: 3,125/6,250	F: 19,968	F: 19,968	U: 5,208/10,416
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	40	40	301	506	77
Track density (TPI)	48	48	333	666	48
Maximum linear density (BPI)	2938/5876	2938/5876	21640	24000	3408/6816
Rotational speed (RPM)	300	300	600	720	360
PERFORMANCE					
Actuator type	Band, Stepping Motor	Band, Stepping Motor	Voice Coil	Voice Coil	Band, Stepping Motor
POSITIONING:Track to track(msec)	5	5	25	25	3
Settling time (msec)	15	15	N/A	N/A	15
Head load time(msec)	Continuous Contact 100	Continuous Contact 100	Continuous Contact 50	Continuous Contact 42	50
Average rotational delay (msec)	100	100	50	42	83.3
Data transfer rate (KBytes/sec)	15.63/31.25	15.63/31.25	275	330	31.25/62.5
SIZE (Inches: H x W x D)	3.25 x 5.75 x 8.0	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0	2.2 x 8.5 x 12.6
FIRST CUSTOMER SHIPMENT	1986	1987	10/86	8/88	6/83
U.S. OEM PRICE FOR 500 UNITS	--	--	\$350	\$450	--
COMMENTS			Embedded Servo SCSI interface 65 msec average positioning	Embedded Servo SCSI interface 60 msec average positioning HF24 can read HF12 diskettes	

## 1988 DISK/TREND REPORT

MANUFACTURER	RICOH	RICOH	ROBOTRON	ROBOTRON	ROCTEC
DRIVE					
	RF5050	RF5160	K 5600.10	K 5600.20	RF501A
DISK/TREND GROUP	15	15	14	14	14
MARKET	OEM	Captive, OEM	Captive, OEM	Captive, OEM	OEM
MEDIA: Generic type	5.25" -- 2/40	5.25" - 2/80 HD	5.25" -- 1/40	5.25" -- 1/80	5.25" -- 1/40
Nominal disk diameter	5.25"	5.25"	5.25"	5.25"	5.25"
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: .250/.5	U: .8/1.6	U: .125/.250	U: .250/.5	U: .250
Capacity per track (Bytes)	U: 3,125/6,250	U: 5,208/10,416	U: 3,250/6,250	U: 3,250/6,250	U: 6,250
Data surfaces per spindle	2	2	1	1	1
Tracks per surface	40	77	40	80	40
Track density (TPI)	48	96	48	96	48
Maximum linear density (BPI)	2938/5876	4823/9646	2768/5536	2788/5576	5576
Rotational speed (RPM)	300	360	300	300	300
PERFORMANCE					
Actuator type	Band, Stepping Motor	Band, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Band, Stepping Motor
POSITIONING:Track to track(msec)	6	3	10	8	6
Settling time (msec)	15	15	12	10	20
Head load time(msec)	50	50	40	40	Continuous Contact 100
Average rotational delay (msec)	100	83.3	100	100	100
Data transfer rate (KBytes/sec)	15.63/31.25	31.25/62.5	15.63/31.25	15.63/31.25	31.25
SIZE (Inches: H x W x D)	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0	2.36 x 5.55 x 7.87	2.36 x 5.55 x 7.87	1.625 x 5.75 x 8.5
FIRST CUSTOMER SHIPMENT	3Q84	3Q84	1984	1984	4Q87
U.S. OEM PRICE FOR 500 UNITS	--	--	--	--	--
COMMENTS					For Apple II



MANUFACTURER	ROCTEC	ROCTEC	ROCTEC	SAMSUNG ELECTRONICS	SAMSUNG ELECTRONICS
DRIVE					
	RF501R	RF502B RF542BS	RF512B RF552BS	SFD-500K	SFD-500N
DISK/TREND GROUP	14	15	15	15	15
MARKET	OEM	OEM	OEM	Captive, OEM	Captive, OEM
MEDIA: Generic type	5.25" -- 1/40	5.25" -- 2/40	5.25" - 2/80 HD	5.25" -- 2/40	5.25" -- 2/80
Nominal disk diameter	5.25"	5.25"	5.25"	5.25"	5.25"
Recording medium	Oxide Coated	Oxide Coated	High Density Oxide Coated	Oxide Coated	Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: .250	U: .5	U: 1.6	U: .5	U: .5
Capacity per track (Bytes)	U: 6,250	U: 6,250	U: 10,416	U: 6,250	U: 6,250
Data surfaces per spindle	1	2	2	2	2
Tracks per surface	40	40	77	40	40
Track density (TPI)	48	48	96	48	48
Maximum linear density (BPI)	5576	5876	9646	5876	5876
Rotational speed (RPM)	300	300	360	300	300
PERFORMANCE					
Actuator type	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor
POSITIONING:Track to track(msec)	6	6	3	3	6
Settling time (msec)	20	20	20	15	15
Head load time(msec)	Continuous Contact 100	Continuous Contact 100	Continuous Contact 83.3	35 100	Continuous Contact 100
Average rotational delay (msec)	100	100	83.3	100	100
Data transfer rate (KBytes/sec)	31.25	31.25	62.5	31.25	31.25
SIZE (Inches: H x W x D)	2.67 x 5.8 x 10.0	1.625 x 5.75 x 8.2	1.625 x 5.75 x 8.2	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0
FIRST CUSTOMER SHIPMENT	3Q87	1Q87	3Q87	6/86	--
U.S. OEM PRICE FOR 500 UNITS	--	--	--	--	--
COMMENTS	External drive for Atari systems	RF542BS is external model	RF552BS is external model		

MANUFACTURER	SAMSUNG ELECTRONICS	SANKYO SEIKI	SANKYO SEIKI	SANKYO SEIKI	SANKYO SEIKI
DRIVE					
	SFD-560K	FDU-380	FDU-480	FDU-580	FDU-583
DISK/TREND GROUP	15	16	16	16	16
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	5.25" - 2/80 HD	3.5" -- 2/80	3.5" -- 2/80 HD	3.5" -- 2/80 HD	3.5" -- 2/80 HD
Nominal disk diameter	5.25"	3.5"	3.5"	3.5"	3.5"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: 1.6	U: 1.0	U: 1.0/1.6	U: 1.0/2.0	U: 2.0
Capacity per track (Bytes)	U: 10,416	U: 6,250	U: 6,250/10,416	U: 6,250/12,500	U: 12,500
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80/77	80	80/77	80	80
Track density (TPI)	96	135	135	135	135
Maximum linear density (BPI)	9870/9642	8717	8717/14184	8717/17434	17434
Rotational speed (RPM)	360	300	300/360	300	300
PERFORMANCE					
Actuator type	Band, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING:Track to track(msec)	3	3	3	3	3
Settling time (msec)	15	15	15	15	15
Head load time(msec)	35	Continuous Contact 100	Continuous Contact 100/83.3	Continuous Contact 100	Continuous Contact 100
Average rotational delay (msec)	83.3				
Data transfer rate (KBytes/sec)	62.5	31.25	31.25/62.5	31.25/62.5	62.5
SIZE (Inches: H x W x D)	1.625 x 5.75 x 8.0	1.0 x 4.0 x 5.1	1.0 x 4.0 x 5.1	1.0 x 4.0 x 5.1	1.0 x 4.0 x 5.1
FIRST CUSTOMER SHIPMENT	1986	12/86	2Q87	2Q87	3Q87
U.S. OEM PRICE FOR 500 UNITS	--	--	--	--	--
COMMENTS					

## 1988 DISK/TREND REPORT

MANUFACTURER	SEIKO EPSON	SEIKO EPSON	SEIKO EPSON	SEIKO EPSON	SEIKO EPSON
DRIVE					
	SD-621L	SD-680L	SMD-240	SMD-280H	SMD-280L
DISK/TREND GROUP	15	15	16	16	16
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	5.25" -- 2/40	5.25" - 2/80 HD	3.5" -- 2/80 HD	3.5" -- 2/80	3.5" -- 2/80
Nominal disk diameter	5.25"	5.25"	3.5"	3.5"	3.5"
Recording medium	Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: .5	U: 1.0/1.6	U: 1.0/2.0	U: 1.0	U: 1.0
Capacity per track (Bytes)	U: 6,250	U: 6,250/10,416	U: 6,250/12,500	U: 6,250	U: 6,250
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	40	80	80	80	80
Track density (TPI)	48	96	135	135	135
Maximum linear density (BPI)	5876	5922/9870	8717/17434	8717	8717
Rotational speed (RPM)	300	300/360	300	300	300
PERFORMANCE					
Actuator type	Rack & Pinion, Stepping Motor	Rack & Pinion, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING:Track to track(msec)	4	3	3	3	3
Settling time (msec)	15	15	15	15	15
Head load time(msec)	Continuous Contact	35	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	100	100/83.3	100	100	100
Data transfer rate (KBytes/sec)	31.25	37.5/62.5	31.25/62.5	31.25	31.25
SIZE (Inches: H x W x D)	1.625 x 5.75 x 7.7	1.625 x 5.75 x 7.7	1.0/1.1 x 4.0 x 5.87	1.1 x 4.0 x 5.87	1.0 x 4.0 x 5.87
FIRST CUSTOMER SHIPMENT	2Q86	3Q86	1Q86	1986	9/85
U.S. OEM PRICE FOR 500 UNITS	\$63 (1000)	\$74 (1000)	\$90 (1000)	\$75 (1000)	\$80 (1000)
COMMENTS					

## 1988 DISK/TREND REPORT

MANUFACTURER	SEIKO EPSON	SEIKO EPSON	SHUGART	SHUGART	SHUGART
DRIVE					
	SMD-440	SMD-480	801	848-1	848-2
DISK/TREND GROUP	16	16	13	13	13
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	3.5" -- 2/80 HD	3.5" -- 2/80	8" -- 1/77	8" -- 1/77	8" -- 2/77
Nominal disk diameter	3.5"	3.5"	8"	8"	8"
Recording medium	High Density Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: 2.0	U: 1.0	U: .401/.802	U: .401/.802	U: .8/1.6
Capacity per track (Bytes)	U: 12,500	U: 6,250	U: 5,208/10,416	U: 5,208/10,416	U: 5,208/10,416
Data surfaces per spindle	2	2	1	1	2
Tracks per surface	80	80	77	77	77
Track density (TPI)	135	135	48	48	48
Maximum linear density (BPI)	17434	8717	3268/6536	3268/6536	3406/6816
Rotational speed (RPM)	300	300	360	360	360
PERFORMANCE					
Actuator type	Rack & Pinion, Stepping Motor	Rack & Pinion, Stepping Motor	Lead Screw, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor
POSITIONING:Track to track(msec)	3	3	8	3	3
Settling time (msec)	15	15	8	15	15
Head load time(msec)	Continuous Contact 100	Continuous Contact 100	35	Continuous Contact 83.3	Continuous Contact 83.3
Average rotational delay (msec)	100	100	83.3	83.3	83.3
Data transfer rate (KBytes/sec)	62.5	31.25	31.25/62.5	31.25/62.5	31.25/62.5
SIZE (Inches: H x W x D)	1.0 x 4.0 x 5.87	1.0 x 4.0 x 5.87	4.62 x 8.55 x 14.25	2.3 x 8.55 x 13.125	2.3 x 8.55 x 13.125
FIRST CUSTOMER SHIPMENT	11/87	4Q86	9/75	4/81	4/81
U.S. OEM PRICE FOR 500 UNITS	--	\$65 (1000)	--	--	--
COMMENTS					

MANUFACTURER	SHUGART	SONY	SONY	SONY	SONY
DRIVE					
	851	MP-F11W	MP-F17W	MP-F52W	MP-F53W MP-F53W-00D
DISK/TREND GROUP	13	16	16	16	16
MARKET	OEM	Captive, OEM	Captive, OEM	Captive, OEM	Captive, OEM
MEDIA: Generic type	8" -- 2/77	3.5" -- 2/80 HD	3.5" -- 2/80 HD	3.5" -- 2/80	3.5" -- 2/80
Nominal disk diameter	8"	3.5"	3.5"	3.5"	3.5"
Recording medium	Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: .8/1.6	U: 1.0	U: 1.0/2.0	U: .5/1.0	U: .5/1.0
Capacity per track (Bytes)	U: 5,208/10,416	U: 6,250	U: 6,250/12,500	U: 3,125/6,250	U: 3,125/6,250
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	77	80	80	80	80
Track density (TPI)	48	135	135	135	135
Maximum linear density (BPI)	3408/6816	8717	8717/17434	4359/8717	4359/8717
Rotational speed (RPM)	360	300	300	600	300
PERFORMANCE					
Actuator type	Band, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING:Track to track(msec)	3	3	3	6	6
Settling time (msec)	15	15	15	15	15
Head load time(msec)	50	Continuous Contact 100	Continuous Contact 100	Continuous Contact 50	Continuous Contact 100
Average rotational delay (msec)	83.3				
Data transfer rate (KBytes/sec)	31.25/62.5	31.25	31.25/62.5	31.25/62.5	15.63/31.25
SIZE (Inches: H x W x D)	4.62 x 8.55 x 14.25	1.0 x 4.0 x 5.9	1.0 x 4.0 x 5.9	1.18 x 4.0 x 5.9	1.18 x 4.0 x 5.9
FIRST CUSTOMER SHIPMENT	6/77	2Q87	2Q87	2Q85	3Q85
U.S. OEM PRICE FOR 500 UNITS	--	\$93	\$120	\$93	\$93
COMMENTS					

# 1988 DISK/TREND REPORT

MANUFACTURER	SONY	SONY	SONY	TEAC	TEAC
DRIVE	MP-F63W-00D MP-F63W-01D	MP-F73W-00D MP-F73W-01D	PDD-100 PDD-150	FD-55BR	FD-55FR
DISK/TREND GROUP	16	16	16	15	15
MARKET	OEM	OEM	Captive, OEM	OEM	OEM
MEDIA: Generic type	3.5" -- 2/80	3.5" -- 2/80 HD	2.0" Data Disk	5.25" -- 2/40	5.25" -- 2/80
Nominal disk diameter	3.5"	3.5"	2.0"	5.25"	5.25"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	Metal Powder	Oxide Coated	Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: 1.0	U: 1.0/2.0	U: 1.0	U: .5	U: 1.0
Capacity per track (Bytes)	U: 6,250	U: 6,250/12,500	U: 20,000	U: 6,250	U: 6,250
Data surfaces per spindle	2	2	1	2	2
Tracks per surface	80	80	50	40	80
Track density (TPI)	135	135	254	48	96
Maximum linear density (BPI)	8717	8717/17434	51200	5876	5922
Rotational speed (RPM)	300	300	3600	300	300
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Stepping Motor	Band, Stepping Motor	Band, Stepping Motor
POSITIONING:Track to track(msec)	3	3	16	4/6	3
Settling time (msec)	15	15	12	10/15	15
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	50	50
Average rotational delay (msec)	100	100	8.3	100	100
Data transfer rate (KBytes/sec)	31.25	31.25/62.5	17.88	31.25	31.25
SIZE (Inches: H x W x D)	1.18 x 4.0 x 5.9	1.18 x 4.0 x 5.9	1.0 x 2.6 x 3.5	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0
FIRST CUSTOMER SHIPMENT	1Q86	1Q86	4Q87	1987	1987
U.S. OEM PRICE FOR 500 UNITS	\$100	\$120	--	\$55 (1000)	\$86 (1000)
COMMENTS			Data version of 2" still video disk		

MANUFACTURER	TEAC	TEAC	TEAC	TEAC	TEAC
DRIVE					
	FD-55GFR	FD-55GR	FD-235F	FD-235G	FD-235GF
DISK/TREND GROUP	15	15	16	16	16
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	5.25" - 2/80 HD	5.25" - 2/80 HD	3.5" -- 2/80	3.5" -- 2/80 HD	3.5" -- 2/80 HD
Nominal disk diameter	5.25"	5.25"	3.5"	3.5"	3.5"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: 1.0/1.6	U: 1.6	U: 1.0	U: 1.6	U: 1.0/1.6
Capacity per track (Bytes)	U: 6,250/10,416	U: 10,416	U: 6,250	U: 10,416	U: 6,250/10,416
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80/77	77	80	80	80
Track density (TPI)	96	96	135	135	135
Maximum linear density (BPI)	5922/9646	9646	8717	14528	8717/14528
Rotational speed (RPM)	300/360	360	300	360	300/360
PERFORMANCE					
Actuator type	Band, Stepping Motor	Band, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING:Track to track(msec)	3	3	3	3	3
Settling time (msec)	15	15	15	15	15
Head load time(msec)	50	50	Continuous Contact 100	Continuous Contact 83.3	Continuous Contact 100/83.3
Average rotational delay (msec)	100/83.3	83.3			
Data transfer rate (KBytes/sec)	31.25/62.5	62.5	31.25	62.5	31.25/62.5
SIZE (Inches: H x W x D)	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0	1.0 x 4.0 x 5.71	1.0 x 4.0 x 5.71	1.0 x 4.0 x 5.71
FIRST CUSTOMER SHIPMENT	1987	1987	2Q88	2Q88	2Q88
U.S. OEM PRICE FOR 500 UNITS	\$71 (1000)	\$86 (1000)	\$50 (1000)	--	--
COMMENTS	Dual speed				

## 1988 DISK/TREND REPORT

MANUFACTURER	TEAC	TEAC	TEAC	TEAC	TEAC
DRIVE					
	FD-235HF	FD-235J	FD-35EN	FD-35FN	FD-35FN-18
DISK/TREND GROUP	16	16	16	16	16
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	3.5" -- 2/80 HD	3.5" -- 2/80 BF	3.5" -- 1/80	3.5" -- 2/80	3.5" -- 2/80
Nominal disk diameter	3.5"	3.5"	3.5"	3.5"	3.5"
Recording medium	High Density Oxide Coated	Barium Ferrite	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: 1.0/2.0	U: 1.0/2.0/4.0	U: .5	U: 1.0	U: .5/1.0
Capacity per track (Bytes)	U: 6,250/12,500	U: 6,250/25,000	U: 6,250	U: 6,250	U: 3,125/6,250
Data surfaces per spindle	2	2	1	2	2
Tracks per surface	80	80	80	80	80
Track density (TPI)	135	135	135	135	135
Maximum linear density (BPI)	8717/17434	8717/34868	8187	8717	4359/8717
Rotational speed (RPM)	300	300	300	300	600
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor
POSITIONING:Track to track(msec)	3	3	3	3	1.5
Settling time (msec)	15	15	15	15	15
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	100	100	100	100	50
Data transfer rate (KBytes/sec)	31.25/62.5	31.25/62.5/125	31.25	31.25	15.63/31.25
SIZE (Inches: H x W x D)	1.0 x 4.0 x 5.71	1.0 x 4.0 x 5.71	1.57 x 4.0 x 5.3	1.57 x 4.0 x 5.3	1.57 x 4.0 x 5.3
FIRST CUSTOMER SHIPMENT	2Q88	1988	2Q84	2Q84	1986
U.S. OEM PRICE FOR 500 UNITS	\$61 (1000)	\$90 (1000)	\$68 (1000)	\$80 (1000)	\$80 (1000)
COMMENTS					

## 1988 DISK/TREND REPORT



MANUFACTURER	TEAC	TEAC	TEAC	TEAC	TEAC
DRIVE					
	FD-35FN-23	FD-35GFN	FD-35GN	FD-35HFN	FD-135FN
DISK/TREND GROUP	16	16	16	16	16
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	3.5" -- 2/80	3.5" -- 2/80 HD	3.5" -- 2/80 HD	3.5" -- 2/80 HD	3.5" -- 2/80
Nominal disk diameter	3.5"	3.5"	3.5"	3.5"	3.5"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: 1.0	U: 1.0/1.6	U: 1.6	U: 1.0/2.0	U: 1.0
Capacity per track (Bytes)	U: 6,250	U: 6,250/10,416	U: 10,416	U: 6,250/12,500	U: 6,250
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80	80/77	80	80	80
Track density (TPI)	135	135	135	135	135
Maximum linear density (BPI)	8717	14528/14184	14528	8717/17434	8717
Rotational speed (RPM)	300	300/360	360	300	300
PERFORMANCE					
Actuator type	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING:Track to track(msec)	3	3	3	3	3
Settling time (msec)	15	15	15	15	15
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	100	100/83.3	83.3	100	100
Data transfer rate (KBytes/sec)	31.25	31.25/62.5	62.5	31.25/62.5	31.25
SIZE (Inches: H x W x D)	1.625 x 5.75 x 8.0	1.57 x 4.0 x 5.3	1.57 x 4.0 x 5.3	1.57 x 4.0 x 5.3	1.0 x 4.0 x 5.9
FIRST CUSTOMER SHIPMENT	1986	1986	1986	1986	7/85
U.S. OEM PRICE FOR 500 UNITS	\$87 (1000)	--	--	\$95 (1000)	\$79 (1000)
COMMENTS	3.5" drive in 5.25" form factor				

## 1988 DISK/TREND REPORT

MANUFACTURER	TEAC	TEAC	TECMATE	TECMATE	TECMATE
DRIVE					
	FD-135HFN	FD-135JFN	MT-501A NPH-501A NPH-501AC	MT-502 NPH-502A	MT-504 NPH-504A
DISK/TREND GROUP	16	16	14	15	15
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	3.5" -- 2/80 HD	3.5" -- 2/80 BF	5.25" -- 1/40	5.25" -- 2/40	5.25" -- 2/80
Nominal disk diameter	3.5"	3.5"	5.25"	5.25"	5.25"
Recording medium	High Density Oxide Coated	Barium Ferrite	Oxide Coated	Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: 1.0/2.0	U: 4.0	U: .218	U: .500	U: 1.6
Capacity per track (Bytes)	U: 6,250/12,500	U: 25,000	U: 3,125	U: 6,250	U: 10,416
Data surfaces per spindle	2	2	1	2	2
Tracks per surface	80	80	35	40	80
Track density (TPI)	135	135	48	48	96
Maximum linear density (BPI)	8717/17434	34868	5162	5876	9646
Rotational speed (RPM)	300	300	300	300	360
PERFORMANCE					
Actuator type	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor
POSITIONING:Track to track(msec)	3	3	6	6	3
Settling time (msec)	15	15	15	10	10
Head load time(msec)	Continuous Contact 100	Continuous Contact 100	Continuous Contact 100	Continuous Contact 100	Continuous Contact 83.3
Average rotational delay (msec)	100	100	100	100	83.3
Data transfer rate (KBytes/sec)	31.25/62.5	125	31.25	31.25	62.5
SIZE (Inches: H x W x D)	1.0 x 4.0 x 5.9	1.0 x 4.0 x 5.9	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0
FIRST CUSTOMER SHIPMENT	1987	2Q88	1983	8/86	9/86
U.S. OEM PRICE FOR 500 UNITS	\$90 (1000)	\$150 (1000)	\$55	\$52	\$70
COMMENTS			Apple compatible		

## 1988 DISK/TREND REPORT

MANUFACTURER	TECMATE	TECMATE	TECMATE	TECMATE	TECMATE
DRIVE					
	MT-301 NPH-301	MT-302 NPH-302	NPH-304	NPH-312	NPH-314
DISK/TREND GROUP	16	16	16	16	16
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	3.5" -- 1/80	3.5" -- 2/80	3.5" -- 2/80 HD	3.5" -- 2/80	3.5" -- 2/80 HD
Nominal disk diameter	3.5"	3.5"	3.5"	3.5"	3.5"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: .5	U: 1.0	U: 1.0/2.0	U: 1.0	U: 2.0
Capacity per track (Bytes)	U: 6,250	U: 6,250	U: 6,250/12,500	U: 6,250	U: 12,500
Data surfaces per spindle	1	2	2	2	2
Tracks per surface	80	80	80	80	80
Track density (TPI)	135	135	135	135	135
Maximum linear density (BPI)	8187	8717	8717/17434	8717	17434
Rotational speed (RPM)	300	300	300	300	300
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING:Track to track(msec)	6	6	6	3	3
Settling time (msec)	15	15	15	15	15
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	100	100	100	100	100
Data transfer rate (KBytes/sec)	31.25	31.25	31.25/62.5	31.25	62.5
SIZE (Inches: H x W x D)	1.625 x 4.0 x 6.0	1.625 x 4.0 x 6.0	1.0 x 4.0 x 5.9	1.2 x 4.0 x 5.9	1.2 x 4.0 x 5.9
FIRST CUSTOMER SHIPMENT	1986	1986	3/88	11/87	11/87
U.S. OEM PRICE FOR 500 UNITS	\$50	\$80	--	--	--
COMMENTS					

## 1988 DISK/TREND REPORT

## MANUFACTURER

## DRIVE

## DISK/TREND GROUP

## MARKET

MEDIA: Generic type

Nominal disk diameter

Recording medium

## CAPACITY/RECORDING DENSITY

Total capacity (Mbytes)

Capacity per track (Bytes)

Data surfaces per spindle

Tracks per surface

Track density (TPI)

Maximum linear density (BPI)

Rotational speed (RPM)

## PERFORMANCE

Actuator type

POSITIONING:Track to track(msec)

Settling time (msec)

Head load time(msec)

Average rotational delay (msec)

Data transfer rate (KBytes/sec)

SIZE (Inches: H x W x D)

FIRST CUSTOMER SHIPMENT

U.S. OEM PRICE FOR 500 UNITS

COMMENTS

TECO	TECO	TECO	TECO	TECO
VF 3540	VF 3542	VF 3560	VF 3640	VF 3660
16	16	16	16	16
OEM	OEM	OEM	OEM	OEM
3.5" -- 2/80	3.5" -- 2/80	3.5" -- 2/80	3.5" -- 2/80	3.5" -- 2/80
3.5"	3.5"	3.5"	3.5"	3.5"
High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
U: 1.0	U: 1.0	U: 2.0	U: 1.0	U: 2.0
U: 6,250	U: 6,250	U: 12,500	U: 6,250	U: 12,500
2	2	2	2	2
80	80	80	80	80
135	135	135	135	135
8717	8717	17434	8717	17434
300	300	300	300	300
Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor
3	3	3	3	3
15	15	15	15	15
Continuous Contact 100	Continuous Contact 100	Continuous Contact 100	Continuous Contact 100	Continuous Contact 100
31.25	31.25	62.5	31.25	62.5
1.18 x 4.0 x 5.9	1.64 x 5.84 x 8.74	1.2 x 4.0 x 5.9	1.0 x 4.0 x 5.9	1.0 x 4.0 x 5.9
1987	1987	1988	1988	1988
\$79 (5000)	--	--	--	--

## 1988 DISK/TREND REPORT

MANUFACTURER	TOSHIBA	TOSHIBA	TOSHIBA	TOSHIBA	TOSHIBA
DRIVE					
	ND-04DT-A	ND-06D/DT	ND-08DE	ND-08DE-A	ND-352SH/TH
DISK/TREND GROUP	15	15	15	15	16
MARKET	OEM	Captive, OEM	Captive, OEM	OEM	OEM
MEDIA: Generic type	5.25" -- 2/40	5.25" -- 2/80	5.25" - 2/80 HD	5.25" - 2/80 HD	3.5" -- 2/80
Nominal disk diameter	5.25"	5.25"	5.25"	5.25"	3.5"
Recording medium	Oxide Coated	Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: .5	U: .5/1.0	U: 1.0/1.6	U: 1.0/1.6	U: .5/1.0
Capacity per track (Bytes)	U: 6,250	U: 3,125/6,250	U: 6,250/10,416	U: 6,250/10,416	U: 6,250
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	40	80	80/77	80/77	80
Track density (TPI)	48	96	96	96	135
Maximum linear density (BPI)	5876	2961/5922	5922/9646	5922/9646	8717
Rotational speed (RPM)	300	300	300/360	360	300
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Lead Screw, Stepping Motor	Band, Stepping Motor
POSITIONING:Track to track(msec)	6	3	3	3	3
Settling time (msec)	15	15	15	15	15
Head load time(msec)	Continous Contact 100	Continuous Contact 100	Continuous Contact 100/83.3	Continous Contact 100/83.3	Continuous Contact 100
Average rotational delay (msec)	100	100	100/83.3	100/83.3	100
Data transfer rate (KBytes/sec)	31.25	15.63/31.25	37.5/62.5	31.25/62.5	31.25
SIZE (Inches: H x W x D)	1.6 x 5.7 x 8.2	1.625 x 5.75 x 8.3	1.625 x 5.75 x 8.3	1.6 x 5.7 x 8.2	1.0 x 4.0 x 5.9
FIRST CUSTOMER SHIPMENT	1Q88	2Q82	1Q84	1Q88	4Q86
U.S. OEM PRICE FOR 500 UNITS	\$55 (1000)	\$85 (1000)	\$70 (1000)	\$70 (1000)	\$60 (1000)
COMMENTS					

## 1988 DISK/TREND REPORT

MANUFACTURER	TOSHIBA	TOSHIBA	TOSHIBA	VIDEO TECHNOLOGY	WELTEC DIGITAL
DRIVE					
	ND-355S/T	ND-356S/T	PD-211	FDM 110	WT 16A
DISK/TREND GROUP	16	16	16	14	15
MARKET	OEM	OEM	OEM	OEM, PCM	OEM, PCM
MEDIA: Generic type	3.5" -- 2/80 HD	3.5" -- 2/80 HD	3.5" -- 2/80 BF	5.25" -- 1/40	5.25" - 2/80 HD
Nominal disk diameter	3.5"	3.5"	3.5"	5.25"	5.25"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	Barium Ferrite	Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: 1.0/1.6	U: 1.0/2.0	U: 1.0/2.0/4.0	U: .250	U: 1.6/1.0
Capacity per track (Bytes)	U: 6,250/10,416	U: 12,500	U: 6,250/25,000	U: 6,250	U: 10,416/6,250
Data surfaces per spindle	2	2	2	1	2
Tracks per surface	80/77	80	80	40	80
Track density (TPI)	135	135	135	48	96
Maximum linear density (BPI)	8717/14184	8717/17434	8717/34768	5536	9870/5922
Rotational speed (RPM)	300/360	300	300	300	360/300
PERFORMANCE					
Actuator type	Band, Stepping Motor	Lead Screw, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor
POSITIONING:Track to track(msec)	3	3	3	12	2.8
Settling time (msec)	15	15	15	15	10
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	100/83.3	100	100	100	83/100
Data transfer rate (KBytes/sec)	31.25/62.5	31.25/62.5	31.25/62.5/125	31.25	62.5/31.25
SIZE (Inches: H x W x D)	1.0 x 4.0 x 5.9	1.0 x 4.0 x 6.3	1.625 x 4.0 x 5.6	1.625 x 5.75 x 7.6	1.625 x 5.75 x 8.0
FIRST CUSTOMER SHIPMENT	4Q86	1Q87	1988	1984	1984
U.S. OEM PRICE FOR 500 UNITS	--	\$70 (1000)	\$125 (1000)	--	\$86 (1000)
COMMENTS				FDM 110V & FD 100 are Apple II PCM versions	Compatibility: M16-A:IBM PC AT M16-P:IBM PC XT

MANUFACTURER	WELTEC DIGITAL	Y-E DATA	Y-E DATA	Y-E DATA	Y-E DATA
DRIVE					
	WT 36	YD-180	YD-380-1710	YD-380-1714	YD-380B-1710B
DISK/TREND GROUP	15	13	15	15	15
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	5.25" -- 2/40	8" -- 2/77	5.25" - 2/80 HD	5.25" - 2/80 HD	5.25" - 2/80 HD
Nominal disk diameter	5.25"	8"	5.25"	5.25"	5.25"
Recording medium	Oxide Coated	Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY				U: .5/1.0 or U: .8/1.6	
Total capacity (Mbytes)	U: .250/.5	U: .8/1.6	U: .8/1.6	U: .8/1.6	U: 1.6
Capacity per track (Bytes)	U: 3,125/6,250	U: 5,208/10,416	U: 5,208/10,416	U: 6,250/10,416	U: 10,416
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	40	77	77	80/77	77
Track density (TPI)	48	48	96	96	96
Maximum linear density (BPI)	2938/5876	3408/6816	4823/9646	5922/9646	9646
Rotational speed (RPM)	300	360	360	300/360	360
PERFORMANCE					
Actuator type	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor
POSITIONING:Track to track(msec)	5.6	3	3	3	3
Settling time (msec)	10	15	15	15	15
Head load time(msec)	Continuous Contact	50	50	50	50
Average rotational delay (msec)	100	83.3	83.3	100/83.3	83.3
Data transfer rate (KBytes/sec)	15.63/31.25	31.25/62.5	31.25/62.5	31.25/62.5	62.5
SIZE (Inches: H x W x D)	1.625 x 5.75 x 8.0	2.25 x 8.55 x 12.6	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0
FIRST CUSTOMER SHIPMENT	7/83	9/81	2/82	1984	4/86
U.S. OEM PRICE FOR 500 UNITS	\$60 (1000)	--	--	--	--
COMMENTS					

## 1988 DISK/TREND REPORT

MANUFACTURER	Y-E DATA	Y-E DATA	Y-E DATA	Y-E DATA	Y-E DATA
DRIVE					
	YD-380B-1711B	YD-380B-1714B	YD-380B-1736B	YD-480	YD-480B
DISK/TREND GROUP	15	15	15	15	15
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	5.25" - 2/80 HD	5.25" - 2/80 HD	5.25" - 2/80 HD	5.25" -- 2/80	5.25" -- 2/80
Nominal disk diameter	5.25"	5.25"	5.25"	5.25"	5.25"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	Oxide Coated	Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: 1.0/1.6	U: 1.0/1.6	U: 1.0/1.6	U: .5/1.0	U: 1.0
Capacity per track (Bytes)	U: 6,250/10,416	U: 6,250/10,416	U: 6,250/10,416	U: 3,125/6,250	U: 6,250
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80	80/77	80	80	80
Track density (TPI)	96	96	96	96	96
Maximum linear density (BPI)	5922/9870	5922/9646	5922/9870	2961/5922	5922
Rotational speed (RPM)	360	300/360	360	300	300
PERFORMANCE					
Actuator type	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor
POSITIONING:Track to track(msec)	3	3	3	3	3
Settling time (msec)	15	15	15	15	15
Head load time(msec)	50	50	50	50	50
Average rotational delay (msec)	83.3	100/83.3	83.3	100	100
Data transfer rate (KBytes/sec)	37.5/62.5	31.25/62.5	37.5/62.5	15.63/31.25	31.25
SIZE (Inches: H x W x D)	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0
FIRST CUSTOMER SHIPMENT	4/86	4/86	2Q87	4Q82	4/86
U.S. OEM PRICE FOR 500 UNITS	--	--	--	--	--
COMMENTS			Also sold as YD-380B-PC		



MANUFACTURER	Y-E DATA	Y-E DATA	Y-E DATA	Y-E DATA	Y-E DATA
DRIVE					
	YD-580	YD-580B-1354B YD-580B-1355B	YD-580B-1376B	YD-801	YD-620B YD-625B
DISK/TREND GROUP	15	15	15	15	16
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	5.25" -- 2/40	5.25" -- 2/40	5.25" -- 2/40	5.25" - 2/80XHD	3.5" -- 2/40
Nominal disk diameter	5.25"	5.25"	5.25"	5.25"	3.5"
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: .250/.5	U: .5	U: .5	U: 3.333	U: .250/.5
Capacity per track (Bytes)	U: 3,125/6,250	U: 6,250	U: 6,250	U: 20,832	U: 3,125/6,250
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	40	40	40	80	40
Track density (TPI)	48	48	48	96	67.5
Maximum linear density (BPI)	2938/5876	5876	5876	19740	4324/8647
Rotational speed (RPM)	300	300	300	180	300
PERFORMANCE					
Actuator type	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor
POSITIONING:Track to track(msec)	5	5	5	3	5
Settling time (msec)	15	15	15	15	15
Head load time(msec)	50	50	50	50	Continuous Contact 100
Average rotational delay (msec)	100	100	100	166.7	100
Data transfer rate (KBytes/sec)	15.63/31.25	31.25	31.25	62.5	15.63/31.25
SIZE (Inches: H x W x D)	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0	1.625 x 4.0 x 6.0
FIRST CUSTOMER SHIPMENT	4Q82	4/86	2Q87	1Q87	4/84
U.S. OEM PRICE FOR 500 UNITS	--	--	--	--	--
COMMENTS			Also sold as YD-580B-PC	Compatible with 1.0 and 1.6 MB formats	

## 1988 DISK/TREND REPORT

MANUFACTURER	Y-E DATA	Y-E DATA	Y-E DATA	Y-E DATA	Y-E DATA
DRIVE					
	YD-640B YD-645B	YD-645C YD-646C	YD-665B	YD-665C	YD-686
DISK/TREND GROUP	16	16	16	16	16
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	3.5" -- 2/80	3.5" -- 2/80	3.5" -- 2/80 HD	3.5" -- 2/80 HD	3.5" -- 2/80 HD
Nominal disk diameter	3.5"	3.5"	3.5"	3.5"	3.5"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: .5/1.0	U: .5/1.0	U: 1.6	U: 1.6	U: 1.0/1.6
Capacity per track (Bytes)	U: 3,125/6,250	U: 3,125/6,250	U: 10,416	U: 10,416	U: 6,250/10,416
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80	80	77	77	80/77
Track density (TPI)	135	135	135	135	135
Maximum linear density (BPI)	4358/8717	4358/8717	14184	14184	8717/14184
Rotational speed (RPM)	300	300	360	360	300/360
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING:Track to track(msec)	6	6	3	3	3
Settling time (msec)	15	15	15	15	15
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	100	100	83.3	83.3	100/83.3
Data transfer rate (KBytes/sec)	15.63/31.25	15.63/31.25	62.5	62.5	31.25/62.5
SIZE (Inches: H x W x D)	1.625 x 4.0 x 6.0	1.0 x 4.0 x 5.9	1.625 x 4.0 x 6.0	1.0 x 4.0 x 5.9	1.0 x 4.0 x 5.9
FIRST CUSTOMER SHIPMENT	4/85	1986	10/85	1986	1Q87
U.S. OEM PRICE FOR 500 UNITS	--	--	--	--	--
COMMENTS					

## 1988 DISK/TREND REPORT

MANUFACTURER	Y-E DATA	Y-E DATA			
DRIVE					
	YD-701 YD-702	YD-740			
DISK/TREND GROUP	16	16			
MARKET	OEM	OEM			
MEDIA: Generic type	3.5" -- 2/80 HD	3.5" -- 2/80 HD			
Nominal disk diameter	3.5"	3.5"			
Recording medium	High Density Oxide Coated	Cobalt Modified Oxide Coated			
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: 2.0	U: 1.0/2.0/4.0			
Capacity per track (Bytes)	U: 12,500	U: 6,250/25,000			
Data surfaces per spindle	2	2			
Tracks per surface	80	80			
Track density (TPI)	135	135			
Maximum linear density (BPI)	17434	8717/34868			
Rotational speed (RPM)	300	300/150			
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor			
POSITIONING:Track to track(msec)	3	3			
Settling time (msec)	15	15			
Head load time(msec)	Continuous Contact	Continuous Contact			
Average rotational delay (msec)	100	100/200			
Data transfer rate (KBytes/sec)	62.5	31.25/62.5/125			
SIZE (Inches: H x W x D)	1.0 x 4.0 x 5.9	1.0 x 4.0 x 5.9			
FIRST CUSTOMER SHIPMENT	1Q87	3Q88			
U.S. OEM PRICE FOR 500 UNITS	--	--			
COMMENTS					

# 1988 DISK/TREND REPORT



## MANUFACTURER PROFILES

All manufacturers now producing flexible magnetic disk drives, or which have indicated specific plans to enter the market, are listed in this section. The heading "1987 disk sales" refers to the DISK/TREND estimate of flexible 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. "1987 total net sales" covers the fiscal year ending in 1987 for each firm unless noted otherwise, or for the parent company if the disk drive manufacturer is a subsidiary. The fiscal year of listed firms ends on December 31, 1987, unless otherwise noted.

### Exchange rates

The exchange rates used in converting the financial data of non-U.S. manufacturers to dollars is given below. The average exchange rate for 1987 is used, as reported by the U.S. Federal Reserve Bulletin and rounded to three significant figures.

<u>Country</u>	<u>Currency</u>	<u>Currency units per U.S. dollar</u>
Hong Kong	Dollar	7.80
Italy	Lira	1297.00
Japan	Yen	145.00
South Korea	Won	826.00
Taiwan	Dollar	31.8

U.S. Manufacturers

BRIER TECHNOLOGY, INC.  
2363 Bering Drive  
San Jose, CA 95131

Incorporated in April, 1986, Brier was founded by managers from Data Technology and other data storage firms. The company is developing high capacity 3.5 inch floppy disk drives. The initial product is a 21.4 megabyte drive using conventional 2.0 megabyte diskettes scheduled for early 1989, with a 43.2 megabyte version using barium ferrite media scheduled for late 1989. Both models will employ embedded servo, using preformatted diskettes. In 1987, the firm announced that Irwin Magnetic Systems had taken a license for the drive and media and was planning to second source the products. A prototype of the drive was shown to a selected audience at the 1987 Fall Comdex show, and an updated version was shown at Comdex in 1988. In the Spring of 1988, an interest in Brier was purchased by Intelligent Systems, which also owns Peachtree Software, Princeton Graphics Systems, Quadram, and other PC oriented peripherals companies.

DATA TECHNOLOGY CORPORATION (See Qume Corporation)

DIGITAL EQUIPMENT CORPORATION  
146 Main Street  
Maynard, MA 01754

1987 FDD sales:	\$28,000,000	
1987 total net sales:	\$9,389,444,000	Net income: \$1,137,435,000
	(FY ending 6/30/87)	

DEC started production of 8 inch one side floppy drives in 1976, originally under a Calcomp license. All of these drives were produced for captive use with its own systems, and the last shipments were made in 1986. DEC introduced its first 5.25 inch floppy, the RX50, along with the company's personal computer systems in late 1982 -- and at one time produced large quantities. The RX50 uses a single stepping motor to position heads on two 96 TPI one sided diskettes, and is adapted from a product acquired originally from T & E Engineering, a late 1970's floppy drive startup that never achieved large scale production.

EASTMAN KODAK COMPANY  
343 State Street  
Rochester, NY 14650

1987 total net sales:	\$13,305,000,000	Net income: \$1,178,000,000
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Although the Spin Physics operation of Eastman Kodak had previously introduced flexible disk media using isotropic particulate coatings, Kodak's

action in licensing the Drivetec embedded servo 5.25 inch drive was the firm's first step into disk drive hardware. Production started in 1984 at Rochester, New York. Following an earlier OEM sales program by Data Technology Corporation (now Qume), a Santa Clara controller manufacturer in which Kodak had an investment, marketing responsibility has now been turned over to the Verbatim subsidiary. In late 1985, the company announced 6.6 and 12 megabyte half high 5.25 inch drives. Qume now manufactures the 12 megabyte version on a contract basis for Eastman Kodak. Eastman Kodak also has a position in the floppy media business through its acquisition of Verbatim Corporation, and Verbatim now distributes the Eastman Kodak high capacity drives under its own brand name.

GENISCO TECHNOLOGY CORPORATION  
Genisco Peripheral Systems Division  
10874 Hope Street  
Cypress, CA 90630

Genisco produces ruggedized and militarized peripherals. The firm purchased rights to the Shugart Associates 3.5 inch microfloppy program, which was aborted when Xerox lost interest in the disk drive business. Limited quantities of a 1.0 megabyte microfloppy have been used in a militarized subsystem since 1987.

HI-TECH PERIPHERALS  
Subsidiary of Worthmore Industries  
5431 Commercial Drive  
Huntington Beach, CA 92649

Hi-Tech Peripherals was started in 1982, with founders from Xerox and Remex, to develop and manufacture 5.25 inch half high OEM flexible disk drives. Production started third quarter, 1983, at its Huntington Beach facility, and in Hong Kong. In late 1984, Hi-Tech went into Chapter 11, caught in a cash shortage as a major customer suddenly returned excess purchases. After reorganization, Hi-Tech Peripherals has a new parent, and is active in personal computer subsystem products. The company discontinued floppy drive production in 1987.

INSITE PERIPHERALS, INC.  
2363 Calle del Mundo  
Santa Clara, CA 95054

Insite's announcement of a 20 megabyte 3.5 inch microfloppy, combining an optical head positioning scheme with magnetic recording, has aroused widespread interest in the industry. Dubbed the "floptical", the drive uses an LED on the head assembly to follow servo tracks pre-etched on the surface of a standard 2.0 megabyte 3.5 inch disk with a laser. Headed by Jim Adkisson, a key figure in development of the original 5.25 inch floppy, Insite is attempting to achieve mainstream status for the "floptical" through licensing with established drive and media manufacturers, in addition to its own manufacturing program starting in early 1989.

INTERNATIONAL BUSINESS MACHINES CORPORATION  
Route 22  
Armonk, NY 10504

1987 FDD sales: \$35,200,000

1987 total net sales: \$54,217,000,000

Net income: \$5,258,000,000

IBM introduced the original one and two sided 8 inch flexible disk drives, and has used them on a wide variety of business systems, word processing systems, terminals and specialized equipment. After years of neglecting the minifloppy product area, IBM emerged as the world's largest buyer of OEM floppy drives, when it used two sided 48 TPI 5.25 inch drives for the successful PC program. This choice established the two sided 48 TPI format as the mainstream minifloppy configuration. More recently, the IBM blessing was given to 1.6 megabyte 5.25 inch drives and to 3.5 inch micro-floppies, and these configurations are now industry standards. The 1987 introduction of the PS/2 series of personal computers using both 1.0 and 2.0 megabyte microfloppies reinforced the 3.5 inch trend and gave the 2.0 megabyte format a major boost. IBM made extensive preparations to design and manufacture its own 5.25 inch and microfloppy drives, but abruptly cancelled the program in mid-1985 -- choosing to rely on the low cost floppy drives available from numerous suitable vendors. Internal production of 8 inch floppy drives, while declining, is continuing in order to support older product families.

IOMEGA CORPORATION  
1821 West 4000 South  
Roy, UT 84067

1987 FDD sales: \$59,300,000

1987 total net sales: \$89,417,000

Net income: (\$36,688,000)

Iomega, founded in 1980 by former IBM managers, was successful in establishing production capability for its unique 8 inch drive, which maintains control of head/disk contact with the Bernoulli effect, and a 5.25 inch version was added in mid-1983. The products were originally intended as OEM drives, but Iomega has had much better luck with subsystems sold in the personal computer add-on market. The 8 inch subsystem for the IBM PC market has been shipping since 1983 and provided most of the company's early revenue growth until surpassed by the half high 8 inch drives introduced in 1985, with current capacities up to 20 megabytes per drive. However, half high 5.25 inch models have been in production since 1987 and are now rapidly displacing 8 inch drives. Current half high 5.25 inch drives offering 21.4 megabytes capacity will be joined by 44.5 megabyte models in mid-1989. SCI Systems has been licensed to make Iomega drives for use with its own systems and for sale by Iomega. Nippon Chemi-Con has been licensed to make and sell Iomega drives in Japan, and Verbatim has been granted a media license.



MILTOPE CORPORATION  
1770 Walt Whitman Road  
Melville, NY 11747

1987 total net sales: \$61,435,000

Net income: (\$4,883,000)

8 inch flexible disk drives are manufactured internally by Miltope for use in its line of militarized peripherals, which include disk, tape and bubble memory subsystems. Both one and two sided 8 inch drives are manufactured. Miltope also produces small numbers of militarized rigid disk drives.

QUME CORPORATION  
500 Yosemite Drive  
Milpitas, CA 95035

Qume's floppy drive operations started in 1979, with a manufacturing license from Y-E Data. Except for some confusion when the firm reorganized its marketing and manufacturing programs in 1981, Qume maintained continuous growth in the OEM market -- and received a big boost in 1983 by being selected as a vendor for half high 5.25 inch floppy drives to IBM for the PC Junior. However, Qume's management didn't care for today's floppy drive prices, and after licensing production in China, closed down floppy drive manufacturing. A significant number of already completed drives were sold in 1986, and a small remainder was sold in 1987. In June, 1988, Qume's parent sold the operation to Data Technology Corporation, which adopted the Qume name for the combined operation, which now makes printers, terminals and data storage products.

DTC, founded in 1979, operated for several years as a controller manufacturer and subsystem vendor, with founders originally from Xebec. Eastman Kodak had a minority investment in the firm, and arrangements were made to manufacture and market the 12 megabyte 5.25 inch floppy drive developed by Kodak, which is being marketed by that firm's Verbatim subsidiary. A 24 megabyte version began shipping in mid-1988. The drives are manufactured in Taiwan by DTC Technology Corp., a subsidiary firm.

SHUGART CORPORATION  
9292 Jeronimo  
Irvine, CA 92718

The original Shugart Associates became the world leader in OEM floppy drives before being acquired by Xerox in the late 1970's. Within a few years of the acquisition, the spark was gone and the company was in trouble. Product reliability problems and a failure to keep the product line up to date left Shugart in bad shape when confronted by increasing competition. In the end, Xerox management decided to stop the bleeding, and most of the Shugart operations were closed down in 1985. U.S. distribution rights to the half high 5.25 inch floppy products were sold to

Matsushita. 8 inch floppy drives remained in production until the end, but were sold to the Narlinger Group in early 1986, along with rights to use of the Shugart Corporation name. The new Shugart Corporation continues to manufacture the 8 inch product line, along with additional models acquired from Control Data and Tandon. Shugart also makes tape drives (acquired from Kennedy) and terminals (acquired from TEC).

TANDON CORPORATION  
20320 Prairie Street  
Chatsworth, CA 91311

1987 total net sales: \$289,086,000  
(FY ending 6/30/87)

Net income: \$23,455,000

Tandon Corporation started shipment of two sided 5.25 inch floppy drives in 1979, and by 1982 Tandon had also become the world leader in OEM floppy drives by aggressive introduction of new products and development of low cost manufacturing facilities through extensive vertical integration. IBM became Tandon's largest (and dominant) customer for floppy drives as the IBM PC grew to prominence, and IBM's purchases were critical to keeping Tandon's OEM floppy drive revenues at a high level. But with the collapse in floppy drive prices during 1984-85, Tandon found it impossible to stay profitable. The company has now changed direction, with its entry into the IBM compatible personal computer business, and has sold its rigid disk drive operations to Western Digital. Production of 5.25 inch half high floppy drives continued in the firm's Bombay facilities until late 1987, but the program was transferred to a firm controlled by Jugi Tandon's relatives, Eastern Peripherals, in which Tandon has a minority interest.

Asian Manufacturers

(All fiscal years for Japanese companies end in March, 1987, unless otherwise noted.)

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

1987 FDD sales: \$211,800,000

1987 total net sales: \$2,549,283,000

Net income: \$29,110,000

Alps Electric is a high-growth manufacturer of electronic components and subassemblies for television, audio, instruments and computer applications. Production of captive 5.25 inch floppy drives for use with Alps systems started several years ago, but has not been emphasized. The firm's big increase in floppy drive shipments came in 1981, with a rapid build-up of shipments to Apple Computer.

Alps' shipments have topped all other floppy drive manufacturers' deliveries of one side 5.25 inch drives since 1981. Alps also started shipping 3.5 inch microfloppy drives in mid-1984, and enjoyed a major increase in shipments in 1987 as a vendor to IBM for the PS/2 personal computer family. The microfloppy product line now includes one and two megabyte drives. Production of 25 mm high drives began in 1987. Alps has also announced a product line of rigid disk drives. In the spring of 1987, Alps became the first Japanese company to manufacture floppy drives in the U.S., with 5.25 inch drives made at a facility located in Garden Grove, California.

ASIA COMMERCIAL CO., LTD.  
444-452 Des Voeux Road West  
Hong Kong

Asia Commercial offers floppy drives for IBM, Apple, MSX and other microcomputers. Shipments of 5.25 inch one side drives began in 1985, and two sided drives were added in 1986. A 3.5 inch drive was added in 1987. Manufacturing is done by Manhattan Electronics, a closely associated firm at the same location.

BROTHER INDUSTRIES  
9-35, Horita-dori  
Mizuhoku, Nagoya 467  
Japan

1987 total net sales: \$1,398,319,000

(FY ending 11/30/87)

Net income: \$45,456,000

Brother is Japan's largest manufacturer of sewing machines, knitting machines and typewriters, with rapid growth in recent years in printers

and other office equipment. Brother has been shipping a 100 kilobyte 3.5 inch microfloppy drive since 1984 and added one inch high 1, 1.6, and 2 megabyte versions in 1986.

CANON ELECTRONICS CO., INC.  
 Subsidiary of Canon, Inc.  
 1248, Shimokagemori, Chichibu-city  
 Saitama, 369-18  
 Japan

1987 FDD sales: \$81,200,000  
 1987 total net sales: \$228,616,000 Net income: (\$21,369,000)  
 (FY ending 12/31/87)

Canon Electronics produces electronic subassemblies for Canon cameras, as well as other electronic components and systems. One and two sided 5.25 inch floppy drives have been in production since 1979 under a BASF license, and the firm has added captive and OEM one third high drives of its own design. Canon also developed its own unique microfloppy using a 97 mm disk, but these drives have been dropped, and the firm began shipments of 3.5 inch microflopies in late 1984. Floppy drives are produced for both captive applications and for sale to the OEM market, both domestic and export, and represented about 24% of revenue for 1987. One inch high 3.5 inch drives began production in mid-1986. Canon began supplying an erasable 5.25 inch optical drive to NeXT, Inc., in 1988. Also in 1988 Canon commenced production of a 2.0 megabyte 3.5 inch drive.

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

1987 FDD sales: \$63,200,000  
 1987 total net sales: \$332,053,000 Net income: \$7,973,000  
 (FY ending 10/31/87)

Chinon is a manufacturer of cameras and auto radios, with worldwide distribution. Eastman Kodak is a minority shareholder in the firm, holding about 14.9% ownership. Due to decreasing growth in the camera industry, Chinon intends to emphasize its data product lines in the future. The company produces printers as well as floppy disk drives. During 1984, the firm introduced its flexible disk drive product line, consisting of half high 5.25 inch drives and 3.5 inch microflopies. In 1984, data products accounted for less than 10% of company revenues, but grew to 38% in 1988, with a major proportion contributed by floppy drive shipments.

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

1987 FDD sales: \$29,300,000

1987 total net sales: \$1,836,196,000

Net income: \$23,195,000

Citizen is steadily expanding its diversification into additional products, from its basic position of strength as Japan's second largest watch manufacturer. Watches are now down to 59% of sales, while machine tools and office equipment are rapidly rising. In addition to printers, displays, and small computers, Citizen introduced 3.5 inch microfloppies in 1984, offering the first one inch floppy drive, and began an aggressive sales program in the U.S. and Europe, aimed at the OEM market. Citizen intended to manufacture a 10 megabyte 5.25 inch drive under an agreement with Konica, but this plan has been suspended due to the small size of the market.

COPAL CO., LTD.  
2-16-20, Shimura  
Itabashi-ku, Tokyo 174  
Japan

1987 total net sales: \$455,705,000

Net income: \$2,614,000

Starting with camera shutters, still the firm's largest product, Copal has diversified into a wide range of electronic components, photographic equipment, clocks, machine tools and printers. Electronic information systems products accounted for about 30% of revenues in 1987. Copal has been involved in contract manufacturing for floppy drives, and announced its own 3.5 inch microfloppy drives for shipment in early 1985. A line of 5.25 inch drives is also in production. Fujitsu, Ltd. has a 6.5% ownership position in Copal and has supplied key personnel to assist in joint product development efforts. Copal manufactures the floppy drives sold by Fujitsu America.

ERGO ELECTRONICS CO., LTD.  
388 Castle Peak Road  
Tsuen Wan, New Territories  
Hong Kong

Ergo was founded in 1978 as the Evergo Corporation and changed its name in 1985 to reflect new management. The firm assembles personal computers and also manufactures 5.25 inch floppy disk drives for the Apple-compatible market, with drives for the IBM personal computer market added in 1986.

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

1987 FDD sales: \$69,600,000  
1987 total net sales: \$12,340,807,000      Net income: \$149,028,000

Despite its role as Japan's leading computer manufacturer and a major participant in the worldwide market for OEM rigid disk drives, Fujitsu was not a participant in the flexible disk drive industry until 1984, except as a buyer of OEM drives for use with its systems. After a short-lived internal manufacturing program, an investment was made in Copal, which is now producing Fujitsu's floppy drives. In 1985, marketing of floppy drives began in the U.S., with production provided by Copal. A line of 3.5 inch drives was added in late 1987. The 3.5 inch microfloppy manufacturing program, which was discontinued in the mid-1980's, was later sold to Hyundai.

GOLDSTAR TELECOMMUNICATION CO., LTD.  
20, Yoido-dong  
Youngdungpo-gu, Seoul 150  
South Korea

1987 total net sales: \$190,527,000      Net income: \$4,445,000

A member of the Lucky-GoldStar Group, one of Korea's major industrial families, GoldStar Telecommunication is a diversified manufacturer of telecommunication equipment, automation systems and computer peripherals. Computer peripherals account for about 5% of sales. A 25% ownership is held by Siemens, the largest shareholder. In an effort to expand beyond existing terminal and printer products, the company markets half high 5.25 inch floppy drives with distribution limited, so far, to Korea. Sales in the U.S. were delayed due to a lawsuit by Tandon Corporation, since settled, claiming improper use of Tandon product designs by ex-employees. 3.5 inch microflopies were added in 1988.

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

1987 total net sales: \$33,439,007,000      Net income: \$680,524,000

Hitachi is Japan's largest electric and electronics manufacturer, with about 42% of its total sales generated by the computer and communications industry. Hitachi has been making 8 inch floppy drives since 1976 for both captive and OEM applications. In 1982, the firm entered the 5.25 inch market, and also joined in the 3.0 inch microfloppy standard with

Matsushita Electric Industrial, but has since dropped production of 3.0 inch floppy drives. In early 1986, the firm began shipping a 1.6 megabyte 3.5 inch drive, but manufacturing ceased in 1987. Hitachi has taken something of a leadership role in introducing high capacity flexible disk drives designed to use high density particulate media developed by Maxell, including a 9.6 megabyte 8 inch drive and a 6.5 megabyte 5.25 inch drive. The firm has also made technology announcements concerning vertical recording.

HO SHIN SUB-SYSTEM CO., LTD.  
3-5 Lane 145  
Hsien Sheng S. Road, Section 1  
Taipei 106  
Taiwan

Founded in 1983, Ho Shin originally produced 8 inch drives, but later switched to production of 5.25 inch drives. Current products include half high drives for IBM and Apple systems.

HYUNDAI ELECTRONICS INDUSTRIES CO., LTD.  
San 136-1, Ami-ri, Bubal-myun  
Ichon-kun, Kyoungki-do  
South Korea

Hyundai's first attempt to enter the disk drive business was a disastrous joint venture with Tandon, which was abandoned in early 1987 after serious friction between the joint venturers. Hyundai later concluded an agreement with Fujitsu to take over the 3.5 inch microfloppy program which Fujitsu was preparing for market introduction at the time it acquired control of Copal, which then was chosen as the Fujitsu floppy drive manufacturing arm. Using the Fujitsu products as a starting point, Hyundai has now established its own microfloppy drive manufacturing program at the large electronics complex at Ichon.

JVC (VICTOR COMPANY OF JAPAN, LTD.)  
4-8-14, Nihonbashi-Honcho  
Chuo-ku, Tokyo 103  
Japan

1987 total net sales: \$4,872,869,000

Net income: \$45,083,000

JVC's revenues are generated mostly by consumer electronics products. The firm has been the beneficiary of sharp growth in home video tape recorder shipments, and VTRs account for almost 70% of total revenues. JVC is now expanding into computer peripherals, with 3.5 inch Winchester and flexible disk drives among its first products in the field. Half high 5.25 inch drives were first shipped in mid-1984, and the firm began shipping

3.5 inch microfloppies in early 1985. Although continued development of the Winchester product line is still underway, floppy drives have been terminated due to the pressure of intense price competition.

KONICA CORPORATION  
1-26-2, Nishi-Shinjuku  
Shinjuku-ku, Tokyo 163  
Japan

1987 total net sales:	\$2,955,504,000	Net income:	(\$7,372,000)
	(FY ending 4/30/87)		

Konica announced a formatted 10 megabyte, half high 5.25 inch floppy disk drive in 1986, but production did not begin until the fourth quarter of 1987. The drive uses standard media with prewritten servo tracks and is backward compatible with standard 48 TPI and 96 TPI formats. Citizen also has rights to manufacture the drive, but only Konica currently has an active marketing program.

LUNG HWA ELECTRONICS CO., LTD.  
33, Pao-Hsing Road, 5th Floor  
Hsin-Tien, Taipei  
Taiwan

Established in 1973, Lung Hwa offers 2/3 high 5.25 inch floppy disk drives. Most are shipped to the U.S. add-on market for use with home computers. A line of controller cards is also supplied.

MANTEC TECHNOLOGY, LTD.  
Flat A, 18/F., Chai Wan Industrial Center  
20 Lee Chung Street  
Chai Wan  
Hong Kong

Mantec was founded in 1985 as a producer of floppy disk drives and modems. The drives produced are two sided 5.25 inch 360 kilobyte models and a one side drive which is Apple compatible. The company is a spinoff from Manhattan Electronics, which is associated with Asia Commercial, another Hong Kong producer of floppy disk drives.



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

1987 FDD sales: \$240,800,000  
 1986 total net sales: \$2,187,724,000 Net income: \$55,724,000  
 (FY ending 11/30/86)

Matsushita Communication Industrial is a member of the Matsushita Electric Industrial group, a worldwide giant in appliances and electronics. MCI manufactured most of the Shugart floppy drive line under license for the Japanese OEM market. MCI later added floppy drives of its own design, including half high 5.25 inch and 3.5 inch microfloppy drives. The firm made half high 5.25 inch drives on a contract manufacturing basis for Shugart and in 1985 acquired the rights to market them in the United States, which has resulted in significant sales by the firm's U.S. Panasonic subsidiary. MCI also has major customers for its OEM drives in Japan, including IBM. The firm's product line includes one inch high microflopies, and MCI has made a preliminary announcement of a 2 inch floppy drive. In 1987, MCI became one of several firms that licensed the barium ferrite technology used in the Toshiba 4 megabyte 3.5 inch floppy drive. MCI also has a joint venture with a manufacturer in the Philippines, Precision Electronics Corporation, to manufacture floppy disk drives and other computer components.

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

1987 FDD sales: \$55,700,000  
 1986 total net sales: \$31,638,347,000 Net income: \$1,131,839,000  
 (FY ending 11/30/86)

Matsushita's Panasonic, National, Technics and Quasar brandnames are among the most widely known in the world for appliances, consumer electronics and communications equipment. Matsushita Electric, the parent company, joined with Hitachi in attempting to establish a 3.0 inch microfloppy standard, and now manufactures 3.0 inch microfloppy drives for the worldwide OEM market. Matsushita has been particularly successful with the 3.0 inch floppy drive in the European market, but is currently the only firm still producing 3.0 inch floppies. The company continues to show interest in developing floppy disk drives in sub-3.5 inch diameters. In addition, production of one inch high 3.5 inch microflopies began in 1987 and has reached substantial volumes.

MITAC, INC.  
75 Nanking East Road, Section 4  
Taipei  
Taiwan

Mitac is a ten year old firm which started as an importer and system integrator of U.S. and European computer systems and evolved into a manufacturer of microcomputers, terminals and flexible disk drives. The firm initially acquired a Shugart license, and later designed its own half high 5.25 inch drive, sold mainly in the personal computer add-on market, but also as an OEM drive. Production quantities were small, and manufacturing ceased in May of 1988.

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

1987 FDD sales:	\$193,500,000	
1987 total net sales:	\$14,534,517,000	Net income: \$73,090,000

Mitsubishi Electric is a leader in the Japanese domestic small business systems market, and one of the country's leading electronic and electrical products manufacturers. Captive 8 inch drives have been used with the firm's Melcom systems for several years, and the firm also participates in the domestic OEM market. A family of half high two sided 5.25 inch floppy drives was introduced in 1982, with capacities up to 2.0 megabytes. Mitsubishi also started shipping a 3.5 inch microfloppy drive in 1983 and introduced a 2.0 megabyte version in 1985. Production of flexible disk drives has been moved to expanded facilities at Mitsubishi's Koriyama Works. A new joint venture for the manufacture of floppy disk drives has been established in Thailand with Kang Yong Electric Manufacturing Co., a firm 80% owned by Mitsubishi. This operation is making 5.25 inch drives. Production of one inch high 3.5 inch drives at Koriyama began in 1987.

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

1987 FDD sales:	\$70,900,000	
1987 total net sales:	\$804,710,000	Net income: (\$4,359,000)
	(FY ending 1/31/87)	

Mitsumi is a leading manufacturer of electronic subassemblies and components, including magnetic heads. The firm established a joint venture facility with Commodore, named Newtronics, to produce 5.25 inch and 3.5 inch floppy drives, and acquired complete ownership of Newtronics in 1986. In 1984, Mitsumi introduced a very low cost 2.8 inch drive using a special

Maxell disk under the name "Quick Disk", which uses a single spiral track with 64,000 kilobytes capacity. It is used primarily in low-end home systems, including games. One inch high 3.5 inch drives began production in 1987. Mitsumi has established a manufacturing facility in Malaysia for floppy disk drives.

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

1987 FDD sales: \$494,100,000

1987 total net sales: \$16,894,724,000

Net income: \$103,683,000

About 43% of NEC's revenues are generated by computer mainframes, small business systems, minicomputers and desktop systems -- and the firm is the clear leader in the growing Japan domestic personal computer market. Since 1978 the company has manufactured two sided 8 inch floppy drives, and was one of the earliest firms to offer half high 8 inch drives, with shipments starting in late 1981. 3.5 inch microfloppy drives and half high 5.25 inch drives were introduced in 1984. The majority of NEC's floppy drive shipments have been for captive applications, with total revenues making the company the world leader in total DISK/TREND revenues for flexible disk drives. NEC is moving into the high capacity floppy drive market with the 1988 introduction of a 3.5 inch 9.4 megabyte (formatted) drive for sale with its microcomputer systems.

OCEANIC ELECTRONICS CORPORATION  
123 Section 1, Nei Hu Road  
Taipei, Taiwan

Oceanic began to ship one side 5.25 inch floppy drives in 1985. The product line now includes one and two sided drives for Apple, Commodore and IBM compatible personal computers. Current production emphasizes two sided half high drives used with Commodore equipment.

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

1987 total net sales: \$2,817,531,000

Net income: \$15,297,000

Oki is a diversified manufacturer of electronic communications and data processing equipment, with a major role in the Japanese market for terminals. For several years the company manufactured 8 inch one side floppy drives at low levels for captive applications. In 1983, the firm introduced one third high 5.25 inch drives for captive and OEM usage, but in 1987 floppy drive production was de-emphasized and OEM sales activity discontinued. Modest captive production is continuing.

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

1987 total net sales: \$129,813,000

Net income: \$1,911,000

OPC, established in 1953, is a diversified producer of electronic products and systems including terminals, telecommunication products, small computers and radio products. Computer equipment accounts for about one fifth of annual sales. The firm manufactures a line of 5.25 inch floppy drives under license from Teac, and also does contract manufacturing of small rigid disk drives.

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

1987 total net sales: \$4,085,338,000

Net income: \$75,510,000

Copiers, sensitized papers and photographic equipment provide the major part of Ricoh's revenues, but the firm has been investing in the growing line of data processing equipment now manufactured. Since 1979, Ricoh has made 8 inch floppy drives, in both one and two sided versions, originally under a Calcomp manufacturing license. The firm has introduced half high 5.25 inch drives intended for both captive and OEM applications, plus a spiral track floppy drive. All of Ricoh's floppy drives are made by Ricoh Elemex, a subsidiary.

ROCTEC ELECTRONICS LTD.  
Subsidiary of Roctec Enterprises  
Cheung Kong Building  
661 Kings Road  
Hong Kong

Roctec was established in 1986 when a group of engineers approached the parent organization and proposed establishing floppy drive manufacturing. There was no significant production in 1986, but substantial shipments of 5.25 inch drives, mostly two sided, were made in 1987. Roctec has its assembly facilities in Hong Kong, and also makes use of manufacturing facilities in the People's Republic of China, working with an organization which provides manufacturing on a contract basis. In 1988, Roctec began assembling 3.5 inch drives based on a Teac mechanism.

SAMSUNG ELECTRONICS  
 Subsidiary of the Samsung Group  
 Taipyung-ro, Chung-ku  
 Seoul  
 South Korea

1987 total net sales: \$2,480,480,000      Net income: \$41,807,000

Samsung Electronics is the leading manufacturer of consumer electronics and appliances in Korea. About 2/3 of sales are electronic products. In 1988, the firm merged with Samsung Semiconductor and Telecommunications, with Samsung Electronics the surviving organization.

Samsung got started in floppy drive production in 1983 when Shugart granted a license to manufacture and market the Shugart 5.25 inch floppy drives in South Korea, but consumer electronics and appliances are the firm's major sources of income. Samsung is currently making half high 5.25 inch drives with capacities up to 1.6 megabytes, and has initiated an export program.

SANKYO SEIKI MFG. CO., LTD.  
 17-2, 1-chome, Shinbashi  
 Minato-ku, Tokyo 105  
 Japan

1987 total net sales: \$730,145,000      Net income: \$4,827,000  
 (FY ending 9/30/87)

Sankyo Seiki is a leading manufacturer of musical movements, industrial robots and a wide variety of small electromechanical components used in cameras, video recorders, timers and other products. In 1981, the firm began shipping a spiral track flexible disk drive for word processing, program loading and special industrial applications, and in mid-1984 added 3.5 inch microfloppies. The current 3.5 inch line consists only of one inch high models. Production of spiral track drives ended in 1987.

SEIKO EPSON CORPORATION  
 3-5, Owa 3-chome, Suwa-shi  
 Nagano, 392  
 Japan

1987 FDD sales: \$108,300,000

Seiko Epson is the new name for the privately held Suwa Seikosha/Epson group owned by members of the Hattori family, who also control Japan's Seiko companies active in watches and electronics. Epson is best known for matrix printers, now used worldwide with personal computers. Epson also manufactures line printers, LCD's, paper tape equipment, watch components, and its own portable computer. The first Epson floppy drive was a

captive 5.25 inch one third high unit first shipped in 1982 and used with the Epson portable computer. Starting in October, 1983, Epson added an OEM floppy drive product line of 5.25 and 3.5 inch models, including 3.5 inch drives with very low power requirements. At the 1985 Fall Comdex, Seiko Epson showed a 2.5 inch floppy disk drive prototype for which no manufacturing program has ever been announced.

SONY CORPORATION  
6-7-35, Kita-Shinagawa  
Shinagawa-ku, Tokyo 141  
Japan

1987 FDD sales:	\$225,300,000	
1987 total net sales:	\$9,283,331,000	Net income: \$288,883,000
	(FY ending 10/31/87)	

As it becomes more difficult to meet Sony's growth objectives in the consumer electronics market, several portions of which appear saturated, the firm's management has made it clear that expansion in office products markets is a major company objective. Among the products announced so far are word processing and personal computer equipment -- both of which use the Sony 3.5 inch microfloppy which has been shipping since late 1981. The drive has also been offered worldwide as an OEM product, with growing success.

After initially taking a somewhat stiff posture on granting licenses, Sony demonstrated flexibility in working with the U.S. manufacturers concerned with establishing common standards. The result was agreement on the 3.5 inch media standard by Sony and several U.S. drive and media manufacturers -- and a growing number of Japanese firms rushing to make 3.5 inch microfloppy drives.

After a big early boost when Hewlett-Packard selected Sony's drive for a variety of personal computers, there was a two year period of attack from contentious sponsors of rival standards, but the industry consensus on the Sony media standard is now firmly established. Sony's microfloppy drive and media shipments have grown, after Apple chose the drive for its Macintosh system and other systems manufacturers signed on.

Sony proposed to the industry a 2.0 megabyte, 3.5 inch media standard in 1985, which has become a de facto industry standard, with a little help from IBM. In 1987, Sony introduced one inch high 3.5 inch drives, as well as a very high bandwidth 1.0 megabyte, 2 inch floppy based upon a design used in the Mavica video camera storage device. Sony is also an active producer of CD-ROM, erasable and write-once optical disk drives, and is expected to eventually enter the 3.5 inch rigid disk drive market.

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

1987 FDD sales:	\$179,900,000	
1987 total net sales:	\$632,986,000	Net income: \$3,483,000
	(FY ending 9/30/87)	

Teac is a leading manufacturer of consumer and professional audio recorders, but digital recording equipment is a major portion of the firm's product mix, now accounting for over 66% of total revenues. Shipments of 5.25 inch floppies for the OEM market started in 1978, and rapid growth has made Teac the leader in 1986 worldwide OEM floppy drive revenues. Major products today are half high 5.25 inch drives, plus microfloppy drives. In 1985, Teac announced a line of 3.5 inch drives, including a 2.0 megabyte model, plus one inch high models, and the firm joined Toshiba in 1987 in announcing 4 megabyte 3.5 inch floppy drives using barium ferrite media. A line of 5.25 inch rigid drives was introduced in 1983. Teac has made manufacturing and licensing arrangements with a number of other firms in Japan, Korea, and other countries.

TECMATE ELECTRONIC INC.  
30 Section 3, Chung-Shan N. Road  
Taipei  
Taiwan

Tecmate, also known under its NPH brand name, was founded in 1982 and has become one of Taiwan's largest floppy disk drive producers. The firm produces 5.25 and 3.5 inch floppy disk drives and other electronic products for small computers. Current production has shifted strongly to two sided drives.

TECO ELECTRIC & MACHINERY CO., LTD.  
156-2 Sung-Chiang Road  
Taipei  
Taiwan

Founded in 1956, TECO began as a supplier of electric motors. Its product line now includes electric motors, including stepping motors, consumer appliances, heavy industrial equipment, and computer peripherals. TECO announced a 3.5 inch one megabyte floppy drive in 1986. Floppy disk drives and other peripherals are marketed in the U.S. through Relisys, a subsidiary established in 1987.

TOKYO ELECTRIC COMPANY, LTD.  
14-10, 1-chome, Uchikanda  
Chiyoda-ku, Tokyo  
Japan

1987 total net sales: \$1,389,619,000

Net income: \$8,340,000

Tokyo Electric is a member of the Toshiba group, and manufactures electronic cash registers, POS systems, lighting fixtures, household appliances, and a growing family of data processing products. Starting in 1982 the firm made 5.25 inch floppy drives for the worldwide OEM market, in 1982 added a small spiral track drive using 66 mm flexible disks, and in 1984 added 3.5 inch microfloppy drives. Due to unfavorable market conditions, Tokyo Electric withdrew from the floppy drive market in late 1986.

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

1987 FDD sales: \$188,800,000

1987 total net sales: \$22,874,087,000

Net income: \$236,362,000

Toshiba is one of Japan's major diversified electric and electronics manufacturers, with products ranging from heavy electric machinery to home appliances and communications equipment. Toshiba has a major share of the Japanese minicomputer and small business system markets. 8 inch floppy drives for both captive and OEM markets have been produced since 1977. Half high two sided 5.25 inch drives were added in 1982, with the more recent addition of microfloppy drives. Toshiba has actively promoted advanced technology, including optical drives. High capacity barium ferrite media has been proposed by the firm for 4 megabyte 3.5 inch floppies, with production of drives and media underway in 1988. Several other firms have licensed the drive and media, and Toshiba is also working on a 3.5 inch drive with 15-20 megabyte capacity for later release.

VIDEO TECHNOLOGY, LTD.  
23/F, Tai Ping Ind. Centre, Blk.1, Lot No. 1637  
Ting Kok Road, Nam Hang  
Tai Po, N.T.  
Hong Kong

Video Technology is a nine year old Hong Kong firm active in manufacture of consumer electronics, personal computers and computer peripherals. The firm is now making half high 5.25 inch floppy drives which are marketed as OEM and add-on drives in the personal computer market.



WELTEC DIGITAL, INC.  
Subsidiary of Wearnes Brothers  
17981 Skypark Circle North  
Irvine, CA 92714

The Remex flexible disk drive operation was sold to a group controlled by Wearnes Brothers, Singapore manufacturers of electronics products, in mid-1984. All manufacturing is now in China, with marketing responsibility still maintained in California. Products are 5.25 inch drives.

Y-E DATA, INC.  
60, 1-1, Higashi-Ikebukuro 3-chome  
Toshima-ku, Tokyo 170  
Japan

1987 FDD sales: \$128,600,000

1987 total net sales: \$269,566,000

Net income: \$5,738,000

Y-E Data is a spin-off of Yaskawa Electric, a diversified manufacturer of heavy electric, factory automation and data processing equipment. Data processing products are the responsibility of Y-E Data, which first manufactured 8 inch one side floppy drives in 1974 under an Orbis license. Y-E Data became an early leader in the Japanese OEM markets for both 8 and 5.25 inch two sided drives. Y-E Data also cooperated with NTT on the standard for 1.6 megabyte 5.25 inch drives and has been shipping its version since early 1982. Microfloppy drives were added in 1984. Y-E Data's biggest sale of all came in 1984, with IBM's selection of the firm's 1.6 megabyte 5.25 inch drive for use with the PC AT. In 1986, one inch high 3.5 inch drives were added to the product line. In addition to its drive manufacturing activities, Y-E Data is supplying drive kits to manufacturers in India and mainland China. A 4 megabyte 3.5 inch microfloppy drive was introduced in 1988.

European Manufacturers

ELCOMATIC LTD.

Subsidiary of British & Commonwealth Shipping Co., Ltd.  
Kirktonfield Road  
Nielston, Glasgow  
Scotland

In July, 1981, Elcomatic acquired the 8 inch flexible disk product line of MFE. These drives had been manufactured mostly in a two sided version at plants in Salem, Massachusetts, and in Livingston, Scotland. Elcomatic moved manufacturing to a Glasgow plant and is continuing to produce 8 inch two sided floppy drives for the European market.

ISOT

51, Chapaev St.  
1113 Sofia 49  
Bulgaria

Isotimpex is the foreign trade organization for Bulgarian computer equipment and other electronic products. Disk drives manufactured by ISOT, the Bulgarian state computer organization, are exported to Eastern Bloc countries, with some magnetic media products also exported to Western countries. Rigid disk drives, in several older IBM configurations, have been produced for several years, later joined by 8 inch and 5.25 inch floppy drives.

KOVO

Jankovcova 2  
17088 Praha 7  
Czechoslovakia

KOVO is the Czechoslovakian import/export agency with jurisdiction over that country's trade in computers and related products. Included in the current product line are computers and peripheral equipment manufactured by Zbrojovka Brno and Aritma, both diversified manufacturing operations. 8 inch floppy drives, 14 inch disk cartridge drives and disk pack drives are produced in small quantities.

LEXIKON S.P.A. (Previously Olivetti Peripheral Equipment)

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

1987 total net sales: \$5,705,474,000

Net income: \$309,946,000

Olivetti has made many changes in the last few years. In order to stay competitive in the rapidly changing office equipment market, investments

have been made in a long list of high technology growth firms, and older Olivetti products have been discontinued. In 1980, Olivetti Peripheral Equipment, now known as Lexikon, was established as a consolidation of the firm's printer and disk memory activities. Lexikon made small Winchesters at Ivrea for OEM markets as well as for the firm's established captive requirements, but is now relying on a joint venture with Conner Peripherals for its rigid disk drives. Due to declining world pricing levels for floppy drives, Lexikon discontinued floppy production in 1986, with last shipments made in 1987.

MAGYAR OPTIKAI MUVEK  
XII, Csorsz u.35  
H-1525 Budapest  
Hungary

Usually known by the abbreviation of its Hungarian name, MOM, or the "Hungarian Optical Works", this organization has produced 8 inch one side floppy drives for several years, including various subsystems. A full size 5.25 inch one side drive was added in 1980, replaced by half high one and two sided drives in 1987. MOM's extensive export program, primarily to other Eastern Bloc countries, was handled through Videoton, a state-run foreign trade organization, but MOM now relies on its own trade organization.

PERIPHERAL DATA SYSTEMS  
Asenovgradsko Shose  
Plovdiv  
Bulgaria

1987 FDD sales: \$34,400,000

Peripheral Data Systems (formerly known as Instrumentation and Automation) has the charter from the Bulgarian government for product development, and to establish high volume manufacturing facilities for peripherals used in personal computers, in order to facilitate usage of personal computers throughout the country. With assistance from ISOT, plus acquisition of tooling from outside countries, the organization started production of 5.25 inch flexible disk drives in 1985.

ROBOTRON  
VEB Robotron-Buchungsmaschinenwerk Karl-Marx-Stadt  
Annabergerstrasse 93  
DDR-9010 Karl-Marx-Stadt  
East Germany

The Robotron group is the East German organization responsible for manufacture of computing and office equipment, communication equipment,

electronic instruments and consumer electronics devices. The Robotron facility for peripheral equipment initiated manufacture of 5.25 inch one side floppy drives during 1984, after several years of buying similar drives from outside sources for Robotron equipment.

South American Manufacturers

COBRA COMPUTADORES E SISTEMAS BRASILEIROS S.A.  
Avenida Commandante Guaranys, 447  
Jacarepagua  
22700 Rio de Janeiro/RJ  
Brazil

Cobra, founded in 1974, is Brazil's largest computer company. Its products include minicomputers, microcomputers, terminals and other computer peripherals. The company makes a variety of floppy and rigid disk drives, usually under license from U.S. manufacturers. Cobra's floppy disk manufacturing is currently limited to an 8 inch one side drive originally designed by Caldisk. Production levels are modest, and the drives are used in Cobra's own system products.

ELEBRA INFORMATICA S.A.  
Rua Maestro Joaquim Capocchi, 165  
Jurubatuba  
04696 Sao Paulo/SP  
Brazil

Elebra was founded in 1979, and is believed to be the most significant specialized manufacturer of computer peripherals in South America. Its product lines include floppy disk drives, rigid disk drives, printers and tape drives. Floppy disk production includes one and two sided 5.25 inch drives, both 48 and 96 TPI versions.

FLEXDISC TECNOLOGIA S.A.  
Rua Francisco Tramontano, 100  
05686 Sao Paulo/SP  
Brazil

Originally known as Electrodigi S.A. Electronica Digital, Flexdisc has had several name changes. Its present name was adopted in mid-1986. Floppy disk drives have been produced by Flexdisc since 1979, originally under a Shugart license. Current products also include rigid disk drives, controllers, and other peripheral products. The floppy disk product line began with 8 inch drives, but now includes one and two sided 5.25 inch floppy drives.

MULTIDIGIT TECNOLOGIA S.A.  
BR 290, Km 75  
Distrito Industrial de Gravatai  
94000 Gravatai/RS  
Brazil

Multidigit was founded in 1980 with a cadre of Brazilian university students, and so qualifies as a genuinely homegrown company. Products include floppy and rigid drives, controllers, and tape drives. The floppy drives are all half high 5.25 inch models using both 48 and 96 TPI, with capacities up to 2 megabytes.



## DISK/TREND ON DISK

### Introduction

DISK/TREND ON DISK is a set of floppy disks containing the statistical tables and specification tables from the annual DISK/TREND reports. The disk files have been prepared in a format usable by Lotus 1-2-3 on IBM or IBM-compatible computers running under the MS-DOS or PC-DOS operating system. All files contain data only -- manipulation of the data is the user's responsibility. Because some of the files can be very large, system memory of 640K or more is recommended. While the files supplied can be used with Lotus 1-2-3 versions 1A and up, we recommend the use of versions 2.0 and up in order to be able to take advantage of Lotus advanced features to manipulate data.

Two or three disks are used for each DISK/TREND disk drive report. The first disk contains the statistical tables. File names are keyed to the table numbers in the report for easy identification. The second (and third disk, if needed) contain the specification section in a data base format. Two disks are provided for specifications when the specification data base is too large to fit on a single 360 KB floppy disk. Both types of data are directly loadable by Lotus 1-2-3. The color used on the label of each floppy disk is similar to the color used on the cover of the corresponding report for ease in identification.

Because the statistical tables are provided in ASCII format, they can be used with any spreadsheet program that can import ASCII text files. However, the specification tables have been prepared specifically in Lotus 1-2-3 format to allow them to be searchable using Lotus 1-2-3 data base commands. If you are using a spreadsheet program other than Lotus 1-2-3 that can translate Lotus WK1 formatted files to its own format, it may be able to import the specification tables.

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

Note: Please read the license information on the following page.



### DISK/TREND ON DISK Information License

DISK/TREND supplies diskettes containing selected information from the 1988 DISK/TREND Report as a separately purchased option to subscribers to the corresponding 1988 DISK/TREND Report volume.

#### YOU MAY:

- 1) Install and use the information on a single computer system, provided that you or the organization by which you are employed has purchased at least one copy of the DISK/TREND report volume associated with the information.
- 2) Make backup copies of the information for your own use. Such backup copies may be used only on the computer on which the information is installed. You must reproduce the copyright notice on any copies.
- 3) Reproduce the information, but not the associated programs or documentation, contained in the Product for use within internal documents distributed within the organization by which you are employed.

#### YOU MAY NOT:

- 1) Install, or allow the use of, the information on more than a single computer system.
- 2) Transfer the information through or within a computer network.
- 3) Distribute the information or any portion thereof in any form outside the organization by which you are employed or modify the information for purposes of distribution.
- 4) Transfer this license to another party.

### Trademarks

IBM is a trademark of International Business Machines Corporation.

Lotus and Lotus 1-2-3 are trademarks of Lotus Development Corporation.

MS-DOS is a trademark of Microsoft Corporation.

### Getting started

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

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

## STATISTICAL TABLES

### Loading

1. Place the floppy disk marked 'Tables' in a floppy disk drive able to read 5.25", 360 KB disks. This is usually drive A, but if you are using a dual floppy only system, use drive B and put the Lotus 1-2-3 system disk in drive A. Use the DOS 'DIR' command to examine the file directory on the 'Tables' disk. If there are any special instructions, they will be in a file named READ.ME. To see these instructions, at the DOS prompt type:

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

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

TYPE A:READ.ME>PRN

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

COPY A:?T\*.\*

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

COPY A:\*.PRN

3. Now you are ready to start Lotus 1-2-3. If you are using a two floppy system, place the DISK/TREND disk in drive B and the Lotus 1-2-3 system disk in drive A. If you are using a rigid disk system, place the Lotus 1-2-3 system disk in floppy drive A. Now start Lotus 1-2-3 as usual. After obtaining the blank spreadsheet image on the screen, use the Lotus File Import Text command to select a file. The command is:

/FIT<filename>

The file names are in the format XYY.ZZX, where:

X= Type of data  
     F (Flexible disk drive data)  
     R (Rigid disk drive data)  
     O (Optical disk drive data)

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

ZZ= Year of Report.

Examples:

File RT10.88R is 1988 Rigid Disk Drive Report Table 10  
 File FT2.88F is 1988 Flexible Disk Drive Report Table 2  
 File OT1.88O is 1988 Optical Disk Drive Report Table 1

The file selected will be loaded as a worksheet in text block format. You can use Lotus 1-2-3 commands to edit the worksheet and embed it in some other document or, using the Lotus 1-2-3 Data Parse commands, you can convert the numeric content to individual cells which can be manipulated or graphed using Lotus 1-2-3 commands. See the Lotus 1-2-3 reference manual for details on numerical manipulations and graphics.

Data parsing made easy

Most Lotus 1-2-3 users are not familiar with the Data Parse commands. They allow the user to convert a table which has been imported in the form of a block of text to a form in which the individual numbers and labels can be manipulated as spreadsheet elements or used to prepare graphics.

Before proceeding, it would be useful to read the Lotus reference manual on this subject if you are not a regular user of the Data Parse commands.

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

- o FORMLINA.PRN      Used with Table 1 and the Revenue and Unit Shipment tables found in the product group sections of the reports.
- o FORMLINB.PRN      Used with Table 2.
- o FORMLINF.PRN      Used with Tables 3 and 4.
- o FORMLIND.PRN      Used with Application tables.
- o FORMLINE.PRN      Used with Track Height and Track Density tables.

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

A step by step process for parsing and an example are shown on the following pages.

## The parsing process

The basic process of parsing the data table goes like this:

1. Enter Lotus 1-2-3 and obtain the blank spreadsheet screen.
2. Import the file to be parsed using the /FIT<filename>command.
3. Move the cursor in the A column to the blank row just above the first line of numbers.
4. Import the Formline file.

Example: /FIT FORMLINA.PRN

A sample format line will appear in the row. See the figure below.

Portion of sample file with sample format line imported

TABLE 1

## CONSOLIDATED WORLDWIDE REVENUES

## ALL EXISTING MOVING HEAD DISK DRIVE GROUPS

## REVENUE SUMMARY

	<div style="text-align:center;">REVENUE SUMMARY</div>					
	1986					
	----Revenues----		-----1987-----		-----1988---	
	U.S.	WW	U.S.	WW	U.S.	WW
	-----	-----	-----	-----	-----	----
U.S. Manufacturers ----- <div>L&gt;*&gt;&gt;&gt;&gt;&gt;&gt;*V&gt;&gt;&gt;&gt;&gt;&gt;*V&gt;&gt;&gt;&gt;&gt;&gt;*V&gt;&gt;&gt;&gt;&gt;&gt;*V&gt;&gt;&gt;&gt;&gt;&gt;*V&gt;&gt;&gt;&gt;&gt;&gt;*V&gt;&gt;&gt;&gt;&gt;</div>						
IBM Captive	3,810.3	6,412.0	4,791.9	7,707.0	4,987.9	8,039.
Other U.S. Captive	1,123.8	1,902.8	1,355.0	2,059.3	1,808.9	2,649.
TOTAL U.S. CAPTIVE	4,934.1	8,314.8	6,146.9	9,766.3	6,796.8	10,688.

5. Move the cursor down one row to the first row of numbers. In the example above, this will place it on the 'IBM Captive' label.
6. Use the Data Parse format command /DPFCFE. This creates the actual format line and puts it into EDIT mode. You will now see two format lines: the sample format line (above) and the actual format line (below).

7. Now edit the actual format line until it is identical to the sample format line.

Optional: The sample format line can now be deleted if you wish. It is not needed for further operations. You will have to quit the Data Parse mode, delete the line, and re-enter Data Parse mode.

8. Create the input range. Select the Input-Column command and then move the cursor to column 'A' of the format line. Anchor the cursor with a period and then set the range to include all columns from 'A' to the right side of the table and all rows from the format line to the bottom of the table by using the arrow keys.

Be careful not to include footnotes or other similar material in the input range, because the parsing process will cause unusual spacing to appear in text sentences or paragraphs.

9. Create the output range. This is where the parsed data will appear. It is convenient to locate it a few rows below the input range and directly in line with the input range. Select the Output-Range command and locate the cursor in the 'A' column a few rows below the input range, then hit 'Return'. Now expand the 'A' column to 27 spaces in width to accommodate the left margin labels. (You will have to leave the parse mode to do this)
10. Return to the Data Parse mode. Select the GO command. The parsed data will appear in the output range. You will have to use the /RF (range format) command on the output data to obtain a consistent format because figures terminating in .0 will drop the decimal places unless the format is prescribed with a decimal place. You may also have to reformat some lines containing percentages in some tables.
11. You now have a table in which all of the elements may be manipulated, but there are no formulas. You must create your own formulas.

Optional: You can delete the input range now if you wish. This will bring the newly parsed data up to the headers at the top of the page for easier reading.

While the procedure described above seems complex, it is not difficult or time consuming in practice. After you have done it once or twice, it will take only two or three minutes per table to do data parsing.

## SPECIFICATION TABLES

The 1988 flexible disk drive specifications are supplied on one diskette.

### Loading

1. Place the floppy disk marked 'Specifications' in a floppy disk drive able to read 5.25", 360 KB disks. This is usually drive A, but if you are using a dual floppy only system, use drive B and put the Lotus 1-2-3 system disk in drive A. Use the DOS 'DIR' command to examine the file directory on the 'Tables' disk. If there are any special instructions, they will be in a file named READ.ME. To see these instructions, at the DOS prompt type:

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

COPY A:?S\*.\*

3. Now you are ready to start Lotus 1-2-3. If you are using a two floppy system, place the DISK/TREND disk in drive B and the Lotus 1-2-3 system disk in drive A. If you are using a rigid disk system, place the Lotus 1-2-3 system disk in floppy drive A. Now start Lotus 1-2-3 as usual. After obtaining the blank spreadsheet image on the screen, use the Lotus File Retrieve command to select a file. The command is:

/FR<filename>

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

X= F (Flexible disk drive data)  
     O (Optical disk drive data)  
     R (Rigid disk drive data)

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

ZZ= Year of report.

Examples: FS188 Flexible disk specification table  
 RS188A Rigid disk spec table: Groups 1-5  
 RS188B Rigid disk spec table: Groups 6-9

Note that the specification tables load directly as a data base. You can use the data base functions of Lotus 1-2-3 to sort, count or otherwise manipulate the data for purposes of special analysis.

### Using the specification data base

Introduction: If you have not used the Lotus 1-2-3 /DATA QUERY commands, it will be helpful for you to review the sections of the Lotus 1-2-3 reference manual that pertain to their use before proceeding further.

The specification data base fits into a worksheet format of 25 to 30 columns, depending upon whether rigid, optical or floppy drives are involved, and a row count of up to 500 rows. Each row represents a specific record, and is equivalent to a column in the Specifications section of the DISK/TREND report. Each column represents a specific specification parameter, and is equivalent to one row of the DISK/TREND report.

The database has been set up for data extraction using Lotus 1-2-3 commands. The Input, Output and Criterion ranges have been predefined, but you, the user, will have to decide how you want the extracted data manipulated and place the appropriate Lotus functions, such as @COUNT, in the appropriate cells. Some rows between the bottom of the input range and the top of the output range have been left empty so that you can do this easily. When the database is first loaded, you will see the top of the input range, showing the first column (manufacturer name) for the first several manufacturers. Use the arrow keys to find other manufacturers or specific product specs.

### Operating tips

Expanding the input or output ranges: The predefined output range is of a nominal size, and a search with broad parameters may result in overflowing the output range. In such a case, merely extend the output range (add more rows) using the Lotus 1-2-3 /DQEO command. Similarly, it is possible to extend the input range to add more products, but be sure you move the output range so that there is no overlap.



Memory overflow: If you should receive a memory overflow message while manipulating the specification data, it is usually because:

- o There are other 'pop-up' programs resident in the memory of your computer. These should be removed.
- o You have selected too large an output range. Use a smaller output range or delete some of the columns that contain data not relevant to your analysis. If you delete data, be sure that if you save your spreadsheet you use a different file name, otherwise you will overwrite the original file with the modified spreadsheet.
- o If you receive a memory overflow message while loading the data base, the data base is too large for your computer's available memory. You probably will have to remove other resident programs and reload Lotus 1-2-3 and the data base. If your computer doesn't have 640K memory, you will probably get this message.

### Saving time

The flexible disk specification data base is large and takes significant time to recompute or perform other operations. If you are interested in drives that belong to only a few product groups, it will probably save you time in the long run if you extract only those groups you are interested in into a new worksheet and use that for the analysis. Use Lotus 1-2-3 file extract and file combine commands for this purpose.

Another way to save time is to use the SORT capabilities of Lotus 1-2-3 to organize the data the way you find it most useful. The most commonly done sorts are by manufacturer name and by DISK/TREND product group, but it would also be possible to sort by average seek time, price, etc.

Make sure that when you save a worksheet using the /FS command that you save it in a new file name. If you save it in the file name from which it was loaded, the original copy will be overwritten. If a file is overwritten unintentionally, it can take a long time to recreate.

### Technical support

Just about all of your questions regarding the use of DISK/TREND ON DISK should be answered in this manual or in the Lotus 1-2-3 reference manual. However, if you need to contact us to resolve any points of confusion, report errors, or otherwise receive comfort:

Call us at: 415-961-6209

Ask for Technical Support

In order to make this process efficient, when you call--

1. Tell us what is on the diskette label.
2. Have your computer up and displaying the data or operation that is the subject of your call.
3. Have this manual and the Lotus 1-2-3 reference manual handy.