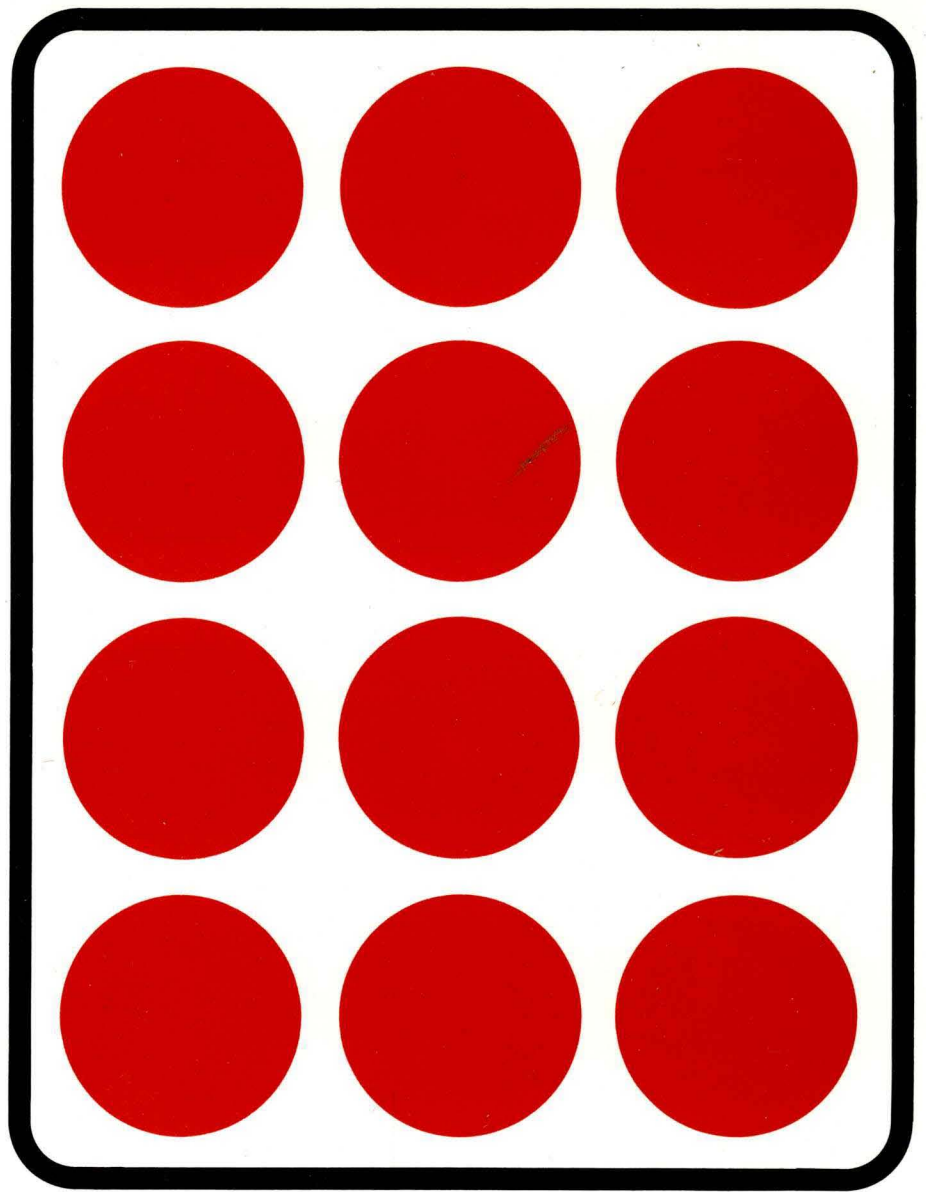
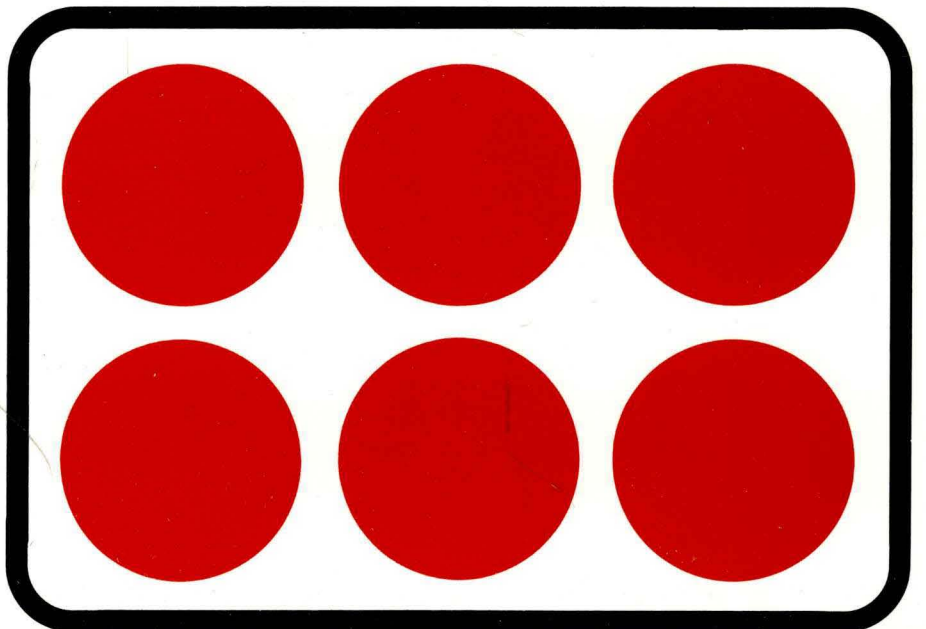




1989 DISK/TREND[®] REPORT

**FLEXIBLE
DISK
DRIVES**



1989 DISK/TREND® REPORT

FLEXIBLE DISK DRIVES

November, 1989

DISK/TREND, Inc.
1925 Landings Drive
Mountain View, California, 94043

Telephone: 415/961-6209
Facsimile: 415/969-2560
Telex: 171914

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FOREWORD

No one has any doubts about the current supremacy of 3.5 inch micro-floppies in the flexible disk drive industry. Although Sony's original 3.5 inch drive first shipped as recently as 1981, 3.5 inch floppies became the shipment leader in 1988 and now are the choice of most system manufacturers for every kind of newly designed computer.

Nevertheless, these are not easy times for floppy drive manufacturers. Drive heights for 3.5" are starting to shrink again, from 1 inch to 3/4 inch high, and the rush to get into production on 4 megabyte drives is now underway. There is continuing confusion over standards for high capacity drives in the 16 to 40 megabyte range. And the continuing pressure on average unit prices is expected to continue indefinitely.

This is the thirteenth year of the DISK/TREND Report, which is now published in three volumes, including the report on optical disk drives, published in July. A separate report on rigid disk drives was published in October.

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

TABLE OF CONTENTS

	<u>Page</u>
INTRODUCTION	SUM-1
SUMMARY	SUM-2
Industry size	SUM-2
Marketing channels	SUM-4
Product mix	SUM-6
Application mix	SUM-14
TECHNICAL REVIEW	SUM-16
Competing technologies	SUM-16
Flexible disk drive enhancements	SUM-22
DEFINITIONS	SUM-28
FLEXIBLE DISK DRIVES, 8 INCH	DT13-1
FLEXIBLE DISK DRIVES, 5.25 INCH	DT14-1
FLEXIBLE DISK DRIVES, MICROFLOPPIES	DT15-1
FLEXIBLE DISK DRIVES, OVER 5 MEGABYTES	DT16-1
DISK DRIVE SPECIFICATIONS	FSPEC-1
MANUFACTURER PROFILES	MFGR-1
DISK/TREND ON DISK	DTDISK-1

LIST OF TABLES

<u>Table</u>	<u>Page</u>
1 CONSOLIDATED WORLDWIDE SHIPMENTS, All Drive Groups, Revenue Summary	SUM-3
2 CONSOLIDATED WORLDWIDE SHIPMENTS, All Drive Groups, Market Class Summary	SUM-5
3 PRODUCT CATEGORY SUMMARY, Worldwide Shipments, All Manufacturers	SUM-8
4 PRODUCT CATEGORY SUMMARY, Worldwide Shipments, Manufacturers of Non-Captive Flexible Disk Drives	SUM-10
5 1988 MARKET SHARES Worldwide Flexible Disk Drive Manufacturers	SUM-12
6 CURRENT PRODUCT LINES, Flexible Disk Drive Manufacturers	SUM-13
7 FLEXIBLE DISK DRIVE APPLICATION SUMMARY, Consolidated Worldwide Shipments	SUM-15
8 FLEXIBLE DISK DRIVES, 8 INCH, Revenue Summary	DT13-7
9 FLEXIBLE DISK DRIVES, 8 INCH, Unit Shipment Summary	DT13-8
10 FLEXIBLE DISK DRIVES, 8 INCH, Drive Height Analysis	DT13-9
11 FLEXIBLE DISK DRIVES, 8 INCH, Application Summary	DT13-10
12 FLEXIBLE DISK DRIVES, 8 INCH, Market Share Summary, Non-Captive Drives	DT13-11
13 FLEXIBLE DISK DRIVES, 5.25 INCH, Revenue Summary	DT14-11
14 FLEXIBLE DISK DRIVES, 5.25 INCH, Unit Shipment Summary	DT14-12

LIST OF TABLES (Continued)

<u>Table</u>	<u>Page</u>
15 FLEXIBLE DISK DRIVES, 5.25 INCH, Drive Height Analysis	DT14-13
16 FLEXIBLE DISK DRIVES, 5.25 INCH, Track Density Analysis	DT14-14
17 FLEXIBLE DISK DRIVES, 5.25 INCH, Application Summary	DT14-15
18 FLEXIBLE DISK DRIVES, 5.25 INCH, Market Share Summary, Non-Captive Drives	DT14-16
19 FLEXIBLE DISK DRIVES, MICROFLOPPIES, Revenue Summary	DT15-11
20 FLEXIBLE DISK DRIVES, MICROFLOPPIES, Unit Shipment Summary	DT15-12
21 FLEXIBLE DISK DRIVES, MICROFLOPPIES, Revenue Breakdown by Disk Diameter	DT15-13
22 FLEXIBLE DISK DRIVES, MICROFLOPPIES, Shipment Breakdown by Disk Diameter	DT15-14
23 FLEXIBLE DISK DRIVES, MICROFLOPPIES, Application Summary	DT15-15
24 FLEXIBLE DISK DRIVES, MICROFLOPPIES, Market Share Summary, Non-Captive Drives	DT15-16
25 FLEXIBLE DISK DRIVES, OVER 5 MEGABYTES, Revenue Summary	DT16-11
26 FLEXIBLE DISK DRIVES, OVER 5 MEGABYTES, Unit Shipment Summary	DT16-12
27 FLEXIBLE DISK DRIVES, OVER 5 MEGABYTES, Revenue Breakdown by Disk Diameter	DT16-13
28 FLEXIBLE DISK DRIVES, OVER 5 MEGABYTES, Shipment Breakdown by Disk Diameter	DT16-14
29 FLEXIBLE DISK DRIVES, OVER 5 MEGABYTES, Application Summary	DT16-15

LIST OF TABLES (Continued)

<u>Table</u>	<u>Page</u>
30 FLEXIBLE DISK DRIVES, OVER 5 MEGABYTES, Market Share Summary, Non-Captive Drives	DT16-16

LIST OF FIGURES

<u>Figure</u>	<u>Page</u>
1 CHANGING PRODUCT MIX, Consolidated Revenue, Worldwide Flexible Disk Drive Shipments	SUM-7
2 CHANGING PRODUCT MIX, All Manufacturers, Worldwide Flexible Disk Drive Shipments	SUM-9
3 CHANGING PRODUCT MIX, Manufacturers of Non-Captive Drives, Worldwide Flexible Disk Drive Shipments	SUM-11

INTRODUCTION

5.25 inch product groups combined, spiral track group dropped

As we indicated in last year's DISK/TREND Report on flexible disk drives, we were considering changes in the floppy drive product groups, in order to conform to the continuing changes in the industry's product mix. Accordingly, this year we have combined the previously separate product groups for one side and two sided 5.25 inch floppy drives into a single group, in recognition of the fact that shipments of one side drives have now shrunk to about 5% of the combined total for the group. We have also discontinued the previous product group covering spiral track drives, since the shipments are now dropping rapidly and only one producer remains in the business.

Here is the list of product groups used in this report:

<u>Group number</u>	<u>Products</u>
13.	Flexible disk drives, 8 inch
14.	Flexible disk drives, 5.25 inch
15.	Flexible disk drives, microfloppies
16.	Flexible disk drives, over 5 megabytes

Changes in market channel definitions

Due to the growth in "aftermarket" distribution of drives in the personal computer market, we have made a change this year in some of our market channel definitions. Here are the terms, as used in this report:

- * Captive -- no change; drives sold with systems also manufactured by the same company.
- * PCM/Reseller -- drives used in add-on subsystems for use with computer systems of all types and sizes, plus aftermarket distribution through wholesalers, dealers and other resellers.
- * OEM/Integrator -- drives sold to system manufacturers to be used as part of computer systems, plus sales to system integrators and value-added resellers which assemble complete systems.

We suggest that you read the complete description of these definitions included in the definitions section of the report. Because market channel shipment data was organized differently in previous DISK/TREND Reports, it was not possible to show 1989 percentage change figures for PCM/Reseller and OEM/Integrator channels in several tables.

Summary

Industry size

1988 worldwide shipments of 35.1 million floppy drives were slightly higher than expected, as was the \$2.8 billion worldwide revenue total. However, the news for 1989 is less promising. DISK/TREND estimates for 1989 indicate a worldwide unit shipment increase of only 1.5% and a revenue decrease of 8.4%, as personal computer shipments increase this year at a slower rate than during the last two years, combined with the continuing impact of lower average unit prices.

Unfortunately, there doesn't appear to be any development underway in the industry which could be expected to boost growth rates for personal computer shipments to the level of 1987, or even of 1988. Therefore, we assume continuing growth for personal computer markets, which are so essential to the floppy drive industry's prosperity, but at the current sluggish rate. As a result, the average annual unit shipment growth forecasted for all floppy drives during the 1990-92 period is only 3.9%. During the same period, we expect worldwide revenues to decline at the annual average of 2.9%, as a result of product mix changes and continuing pressure on average unit prices.

The withdrawal of U.S. manufacturers from the floppy drive industry is now almost complete, except for the emerging high capacity floppy drive market. A few 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 -- but the future development pattern for this part of the industry is still speculative.

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

	-----DISK DRIVE REVENUES, BY SHIPMENT DESTINATION (\$M)-----									
	1988		1989		1990		1991		1992	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM Captive	13.3	20.1	6.9	10.5	--	--	--	--	--	--
Other U.S. Captive	8.8	16.8	3.2	7.2	--	--	--	--	--	--
TOTAL U.S. CAPTIVE	22.1	36.9	10.1	17.7	--	--	--	--	--	--
PCM/Reseller	45.6	61.6	43.5	60.1	54.1	72.2	43.6	57.0	33.8	43.7
OEM/Integrator	12.5	17.0	7.8	9.7	12.5	15.5	34.3	43.2	57.2	73.4
TOTAL U.S. NON-CAPTIVE	58.1	78.6	51.3	69.8	66.6	87.7	77.9	100.2	91.0	117.1
TOTAL U.S. REVENUES	80.2	115.5	61.4	87.5	66.6	87.7	77.9	100.2	91.0	117.1
Non-U.S. Manufacturers										
Captive	53.6	744.2	40.8	676.9	31.5	610.7	22.7	533.5	23.1	478.4
PCM/Reseller	147.9	196.5	134.9	180.7	135.2	181.1	135.4	181.5	139.9	188.4
OEM/Integrator	740.4	1,798.0	725.3	1,668.3	758.8	1,642.1	810.7	1,614.9	877.5	1,605.7
TOTAL NON-U.S. REVENUES	941.9	2,738.7	901.0	2,525.9	925.5	2,433.9	968.8	2,329.9	1,040.5	2,272.5
Worldwide Recap										
TOTAL WORLDWIDE REVENUES	1,022.1	2,854.2	962.4	2,613.4	992.1	2,521.6	1,046.7	2,430.1	1,131.5	2,389.6

Marketing channels

The total number of flexible disk drive manufacturers is now shrinking again. The current list of 52 manufacturers is down four from last year's total.

It is interesting to note that this total overstates the actual activity level in certain sections of the industry, since several firms are expected to drop their manufacturing programs within the coming year. Four U.S. manufacturers, including IBM and Digital Equipment Corporation, are expected to stop making new drives. And the number of floppy drive manufacturers in Hong Kong and Taiwan, down a few participants this year, may drop further next year as several subsystem producers shift to purchased 3.5 inch mechanisms while phasing out their internally produced 5.25 inch drives.

There are now 33 Asian flexible disk drive manufacturers, three less than the total of a year ago. The same 21 Japanese companies identified in last year's DISK/TREND Report are still participating in the industry, and these firms generated 93% of the 1988 worldwide revenue for non-captive floppy 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/Reseller or OEM/Integrator levels. An understanding of the relative prices at captive and non-captive levels 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	-----1988-----		-----1989-----		-----1990-----		-----Forecast-----		-----1992-----	
	-----Revenues-----									
	\$M	%	\$M	%	\$M	%	\$M	%	\$M	%
U.S. Manufacturers										
IBM Captive	20.1 -42.9%	.7%	10.5 -47.8%	.4%	-- -100.0%	--	-- --	--	-- --	--
Other U.S. Captive	16.8 -56.4%	.5%	7.2 -57.1%	.2%	-- -100.0%	--	-- --	--	-- --	--
PCM/Reseller	61.6 --	2.1%	60.1 -2.4%	2.2%	72.2 +20.1%	2.8%	57.0 -21.1%	2.3%	43.7 -23.3%	1.8%
OEM/Integrator	17.0 --	.5%	9.7 -42.9%	.3%	15.5 +59.8%	.6%	43.2 +178.7%	1.7%	73.4 +69.9%	3.0%
Total U.S. Manufacturers	115.5 -27.1%	3.8%	87.5 -24.2%	3.1%	87.7 +.2%	3.4%	100.2 +14.3%	4.0%	117.1 +16.9%	4.8%
Non-U.S. Manufacturers										
Captive	744.2 +7.4%	26.0%	676.9 -9.0%	25.9%	610.7 -9.8%	24.2%	533.5 -12.6%	21.9%	478.4 -10.3%	20.0%
PCM/Reseller	196.5 --	6.8%	180.7 -8.0%	6.9%	181.1 +.2%	7.1%	181.5 +.2%	7.4%	188.4 +3.8%	7.8%
OEM/Integrator	1,798.0 --	63.4%	1,668.3 -7.2%	64.1%	1,642.1 -1.6%	65.3%	1,614.9 -1.7%	66.7%	1,605.7 -.6%	67.4%
Total Non-U.S. Manufacturers	2,738.7 +8.1%	96.2%	2,525.9 -7.8%	96.9%	2,433.9 -3.6%	96.6%	2,329.9 -4.3%	96.0%	2,272.5 -2.5%	95.2%
Worldwide Recap										
Captive	781.1 +1.9%	27.4%	694.6 -11.1%	26.6%	610.7 -12.1%	24.2%	533.5 -12.6%	22.0%	478.4 -10.3%	20.0%
PCM/Reseller	258.1 --	9.0%	240.8 -6.7%	9.2%	253.3 +5.2%	10.0%	238.5 -5.8%	9.8%	232.1 -2.7%	9.7%
OEM/Integrator	1,815.0 --	63.6%	1,678.0 -7.5%	64.2%	1,657.6 -1.2%	65.8%	1,658.1 --	68.2%	1,679.1 +1.3%	70.3%
Total All Manufacturers	2,854.2 +6.1%	100.0%	2,613.4 -8.4%	100.0%	2,521.6 -3.5%	100.0%	2,430.1 -3.6%	100.0%	2,389.6 -1.7%	100.0%

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

Product mix

1988 worldwide unit shipments of microfloppy drives were even stronger than expected, increasing by a resounding 46.8%, for a total of 18.1 million drives. Although the forecasted average annual growth in unit shipments for the 1989-92 period is only 12%, in view of the sluggish growth rate expected for personal computers, the microfloppy shipment total for 1992 is placed at 31 million drives. Unfortunately, the average annual revenue increase for the same period is forecasted at only 7.2%, as competition continues to depress average prices.

Shipments of 5.25 inch floppy drives grew slightly over 2% in 1988, but that was the last year of expanding sales for the 5.25 inch floppy format. Although there is continuing momentum in the marketplace for the numerous PC AT compatible personal computers still in production, 5.25 inch floppy drive shipments are expected to decline an average of 16% per year in the 1989-92 period. This rate of decline is not as severe as might be expected for most disk drives which have been superseded by newer technology, and reflects IBM's inability to arbitrarily change the industry's direction in personal computers on short notice.

Even though current shipment levels for high capacity floppy drives over 5 megabytes are weak, high growth rates are expected for this product group as new 3.5 inch drives become available. The product group includes Iomega's Bernoulli principle 8 and 5.25 inch drives, as well as other 8 and 5.25 inch drives in the 6 to 24 megabyte range, none of which is likely to provide significant future growth. The expected demand for the new 3.5 inch drives will probably be sufficient to boost shipments in this product group to new heights, despite manufacturing start-up problems and continuing lack of an effective media interchange standard.

Figure 1

CHANGING PRODUCT MIX

Worldwide Flexible Disk Drive Revenue

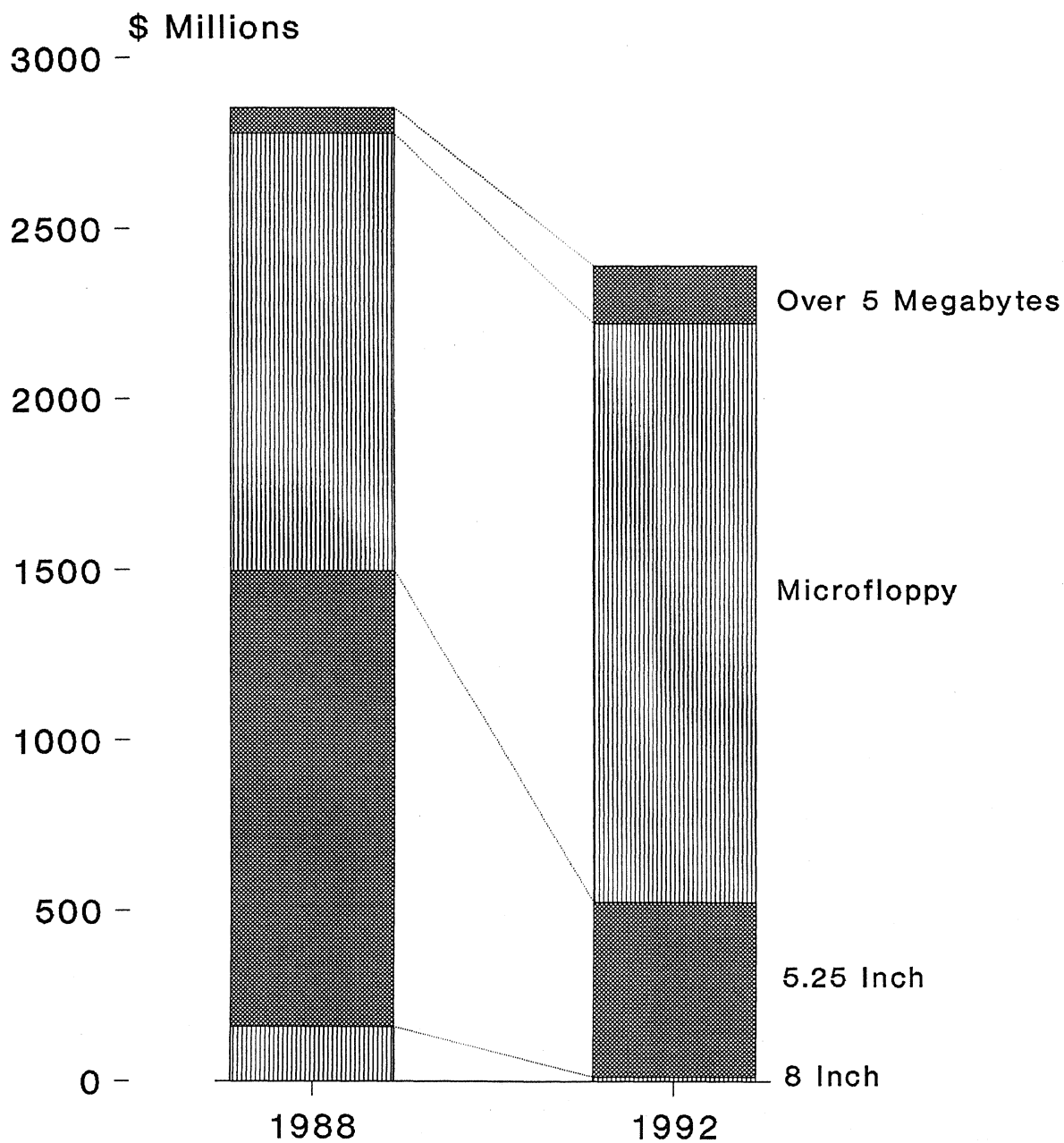


TABLE 3
WORLDWIDE SHIPMENTS
PRODUCT CATEGORY SUMMARY
ALL MANUFACTURERS

Units: Thousands
Dollars: \$ Million

		-----1988-----		-----1989-----		-----1990-----		-----Forecast-----		-----1992-----	
		---Shipments---		---Ship---		---Ship---		---Ship---		---Ship---	
		Ship	%	Ship	%	Ship	%	Ship	%	Ship	%
8 INCH DRIVES											

Units		363.5	-16.2	243.7	-32.9	141.1	-42.1	68.2	-51.6	30.5	-55.2
\$M		161.3	-28.1	108.3	-32.8	60.8	-43.8	29.4	-51.6	13.0	-55.7
5.25 INCH DRIVES											

Units		16,573.8	+2.1	14,089.5	-14.9	11,895.0	-15.5	9,980.0	-16.0	8,240.0	-17.4
\$M		1,336.1	-5.1	1,072.3	-19.7	850.5	-20.6	660.5	-22.3	511.6	-22.5
MICROFLOPPY DRIVES											

Units		18,115.4	+46.8	21,257.6	+17.3	25,276.3	+18.9	28,487.8	+12.7	31,072.5	+9.0
\$M		1,282.4	+33.8	1,363.5	+6.3	1,511.7	+10.8	1,616.2	+6.9	1,695.4	+4.9
DRIVES OVER 5 MEGABYTES											

Units		126.4	+13.6	118.2	-6.4	217.6	+84.0	419.0	+92.5	817.0	+94.9
\$M		74.4	+10.5	69.3	-6.8	98.6	+42.2	124.0	+25.7	169.6	+36.7
TOTAL ALL DRIVES											

Units		35,179.1	+16.2	35,709.0	+1.5	37,530.0	+5.0	38,955.0	+3.7	40,160.0	+3.0
\$M		2,854.2	+6.0	2,613.4	-8.4	2,521.6	-3.5	2,430.1	-3.6	2,389.6	-1.6

Figure 2

CHANGING PRODUCT MIX

Worldwide Flexible Disk Drive Shipments All Manufacturers

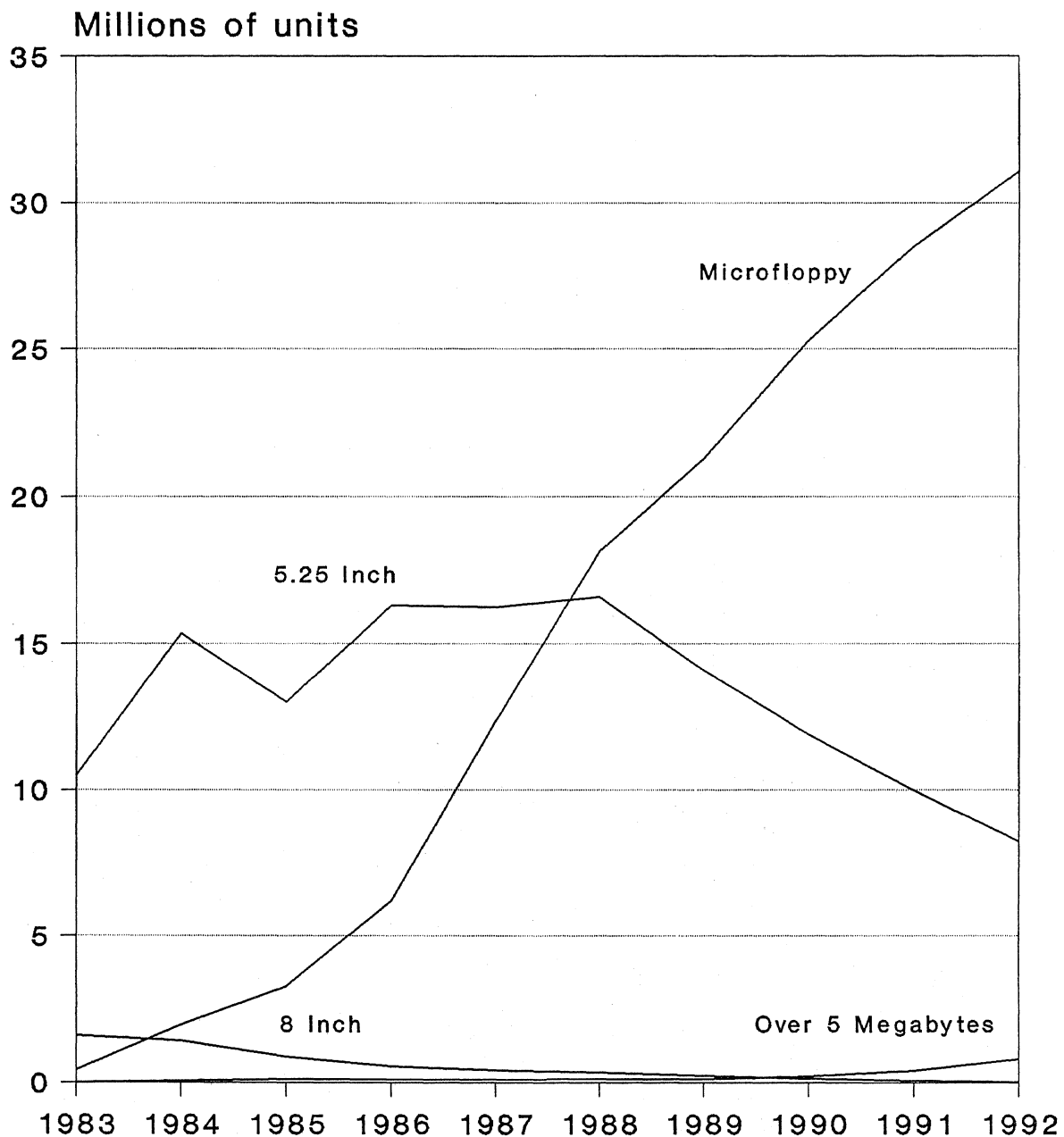


TABLE 4
WORLDWIDE SHIPMENTS
PRODUCT CATEGORY SUMMARY
MANUFACTURERS OF NON-CAPTIVE DRIVES

Units: Thousands
Dollars: \$ Million

	-----1988-----		-----1989-----		-----1990-----		-----Forecast-----		-----1992-----	
	Shipments	%	Ship	%	Ship	%	Ship	%	Ship	%
8 INCH DRIVES										
Units	236.5	-16.3	149.7	-36.7	80.1	-46.4	39.2	-51.0	18.5	-52.8
\$M	71.0	-16.1	44.9	-36.7	23.8	-46.9	12.0	-49.5	5.8	-51.6
5.25 INCH DRIVES										
Units	15,306.8	+1.9	12,765.5	-16.6	10,864.0	-14.8	9,228.0	-15.0	7,702.0	-16.5
\$M	942.4	-5.6	734.0	-22.1	602.7	-17.8	487.7	-19.0	392.9	-19.4
MICROFLOPPY DRIVES										
Units	16,552.8	+46.5	19,692.0	+18.9	23,534.3	+19.5	26,638.8	+13.1	29,112.5	+9.2
\$M	985.4	+32.8	1,073.1	+8.8	1,193.4	+11.2	1,285.1	+7.6	1,359.1	+5.7
DRIVES OVER 5 MEGABYTES										
Units	126.3	+13.5	113.2	-10.3	201.6	+78.0	392.0	+94.4	779.0	+98.7
\$M	74.3	+10.4	66.8	-10.0	91.0	+36.2	111.8	+22.8	153.4	+37.2
TOTAL ALL DRIVES										
Units	32,222.4	+15.6	32,720.4	+1.5	34,680.0	+5.9	36,298.0	+4.6	37,612.0	+3.6
\$M	2,073.1	+7.7	1,918.8	-7.4	1,910.9	-.4	1,896.6	-.7	1,911.2	+7

Figure 3

CHANGING PRODUCT MIX

Non-Captive Flexible Drive Shipments

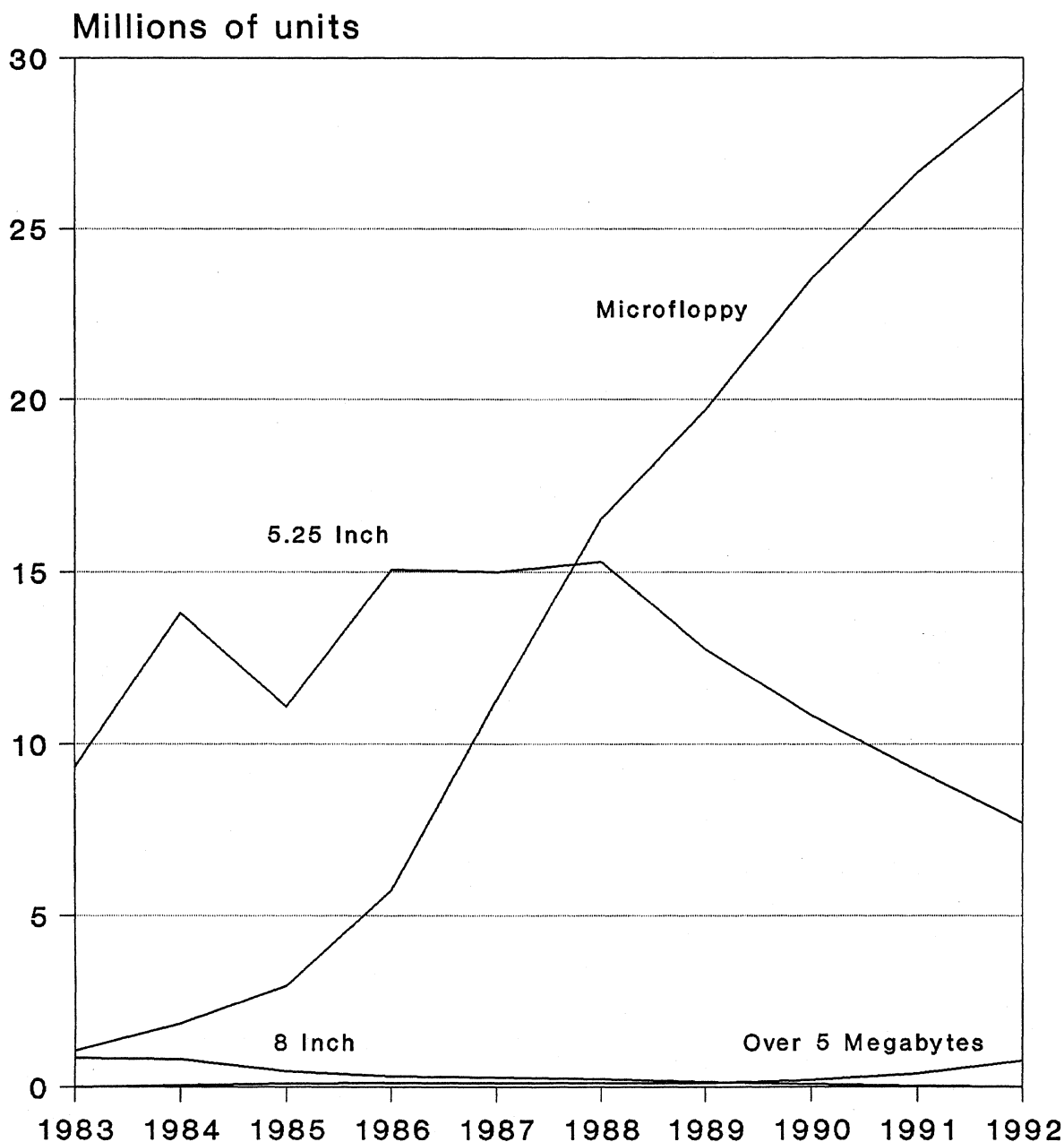


TABLE 5

1988 ESTIMATED MARKET SHARES

WORLDWIDE REVENUES OF ALL FLEXIBLE MAGNETIC DISK DRIVES
(Value of non-U.S. currencies estimated at average 1988 rates)

	CAPTIVE		PCM		OEM		TOTAL INDUSTRY	
	\$M	%	\$M	%	\$M	%	\$M	%
U.S. MANUFACTURERS								
IBM	20.2	2.6	--	--	--	--	20.2	.7
Iomega	--	--	55.0	21.3	9.5	.5	64.5	2.3
Other U.S.	16.7	2.1	6.6	2.6	7.5	.4	30.8	1.1
U.S. Total	36.9	4.7	61.6	23.9	17.0	.9	115.5	4.0
NON-U.S. MANUFACTURERS								
Alps Electric	--	--	--	--	171.6	9.5	171.6	6.0
Canon	21.6	2.8	--	--	38.0	2.1	59.6	2.1
Chinon	--	--	31.3	12.1	41.2	2.3	72.5	2.5
Citizen	--	--	--	--	58.5	3.2	58.5	2.0
Fujitsu	--	--	39.6	15.3	9.4	.5	49.0	1.7
Matsushita Comm. Ind.	8.3	1.1	--	--	232.6	12.8	240.9	8.4
Matsushita Elec. Comp.	--	--	--	--	64.7	3.6	64.7	2.3
Mitsubishi Electric	26.0	3.3	53.0	20.5	178.5	9.8	257.5	9.0
Mitsumi Electric	--	--	5.7	2.2	49.3	2.7	55.0	1.9
NEC	450.1	57.6	--	--	100.8	5.6	550.9	19.3
Seiko Epson	53.3	6.8	--	--	103.5	5.7	156.8	5.5
Sony	33.0	4.2	--	--	275.3	15.2	308.3	10.8
Teac	--	--	21.3	8.3	163.3	9.0	184.6	6.5
Toshiba	97.3	12.5	15.9	6.2	94.2	5.2	207.4	7.3
Y-E Data	--	--	8.4	3.3	134.2	7.4	142.6	5.0
Other Non-U.S.	54.6	7.0	21.3	8.3	82.9	4.6	158.8	5.6
Non-U.S. Total	744.2	95.3	196.5	76.1	1,798.0	99.1	2,738.7	96.0
WORLDWIDE TOTAL	781.1	100.0	258.1	100.0	1,815.0	100.0	2,854.2	100.0

TABLE 6

Codes: C = Captive
P = PCM
O = OEM

CURRENT PRODUCT LINES
MANUFACTURERS OF FLEXIBLE DISK DRIVES

Numbers in table indicate TPI	DISK/TREND PRODUCT GROUP:	13	14	15	16
U.S. MANUFACTURERS	TYPE	8 INCH	5.25 INCH	MICRO FLOPPIES	HIGH CAPACITY >5 MB
Brier Technology	0				777,1555
Digital Equipment	C		96		
Eastman Kodak/Verbatim	C,O		192		333,384
Genisco	0			135	
IBM	C	48			
Insite Peripherals	0				1250
Iomega	P,O				300,570,641,1095
Miltope	0	48			
Qume	0				333,666
Shugart	0	48			
ASIAN MANUFACTURERS					
Alps Electric	0		48,96	135	
Asia Commercial	0		48,96		
Brother	C,O			67.5,135	
Canon	C,O		48,96	135	
Chinon	P,O		48,96	135	
Citizen	C,O			135	540
Copal	0		48,96	135	
Eastern Peripherals	0		48,96		
Ergo	C,O		48		
Fujitsu	0		48,96	135	
GoldStar Telecommunication	C,O		48,96	135	
Hitachi	C,O	48			96,125
Ho Shin	0		48,96		
Hyundai Electronics	C,O			135	
Konica	0				480
Mantec Technology	P,O		48,96		
Matsushita Communication Indust.	0	48	48,96	135,254	542
Matsushita Electronic Components	0			100,200,135	
Mitsubishi Electric	C,O	48	48,96	135	
Mitsumi Electric	0		48,96	135,254	
NEC	C,O	48	48,96	135	406
Oceanic	P,O		48		
Oriental Precision	C,O		48,96		
Ricoh	C,O	48	48,96		
Roctec	0		48,96		
Samsung Electronics	C,O		48,96	135	
Sankyo Seiki	0			135	
Seiko Epson	C,O		48,96	135	
Sony	C,O			135,254	
Teac	0		48,96	135	
Tecmate	0		48,96	135	
Toshiba	C,O		48,96	135	542
Y-E Data	0	48	48,96	135	
SOUTH AMERICAN MANUFACTURERS					
Cobra	C	48			
Elebra Informatica	0		48,96		
Flexdisc	0		48,96		
Multidigit	0		48,96		
EUROPEAN MANUFACTURERS					
DZU	C,O	48	48,96	135	
Elcomatic	0	48,96			
Magyar Optikai Muvek	0	48	48,96		
Peripheral Data Systems	C,O		48		
Robotron	C,O		48,96		

Application mix

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. 80.2% of 1988 floppy drive unit shipments were used with office personal computers, a share which has continued to grow each year but which may now be approaching saturation.

DISK/TREND forecasts anticipate that 78.4% of 1992 unit shipments, totaling 31.4 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 1988, shipments of microfloppies for business personal computer applications surpassed 5.25 inch drive shipments for the first time. By 1992, microfloppies are expected to dominate business personal computer applications by more than 3 to 1 over 5.25 inch floppies.

Consumer and hobby applications used 6.5% of 1988 shipments, a slight growth over the previous year. It is expected that this application will grow faster than any other, and by 1992 will consume 11.2% of all floppy drive shipments, totaling 4.5 million units. 5.25 inch drives accounted for more than half of 1988 shipments for consumer and hobby applications, but microfloppies are expected to provide most of the 1992 shipment total.

The share of total shipments held by dedicated application office systems and workstations, including the remnants of the traditional word processing market, continued to decline in 1988. Microfloppy drives moved into the lead in 1988 with almost 60% of worldwide shipments. This application is expected to decline to 5.2% of 1992 shipments, of which more than 80% will be microfloppies, as personal computers continue to invade older office markets.

TABLE 7
FLEXIBLE DISK DRIVE APPLICATIONS SUMMARY
CONSOLIDATED WORLDWIDE SHIPMENTS

	-----1988 Estimate-----					-----1992 Projection-----				
	All FDD*	8" All Types	5.25" All Types	Micro Floppy	Over 5 MB	All FDD*	8" All Types	5.25" All Types	Micro Floppy	Over 5 MB
MAINFRAME/SUPERMINI										
General purpose										
Units (000)	81.9	36.6	--	45.3	--	41.1	1.8	8.2	31.1	--
Share %	.2%	10.0%	--	.2%	--	.1%	6.0%	.1%	.1%	--
MINICOMPUTERS AND MULTIPLE USER MICROS										
Including networks										
Units (000)	1,347.8	127.8	878.4	331.5	10.1	979.6	13.4	395.5	497.2	73.5
Share %	3.8%	35.1%	5.3%	1.8%	8.0%	2.4%	44.0%	4.8%	1.6%	9.0%
PERSONAL COMPUTERS										
Single user										
Units (000)	28,220.3	88.9	13,297.2	14,731.4	102.8	31,466.3	.6	6,995.8	23,832.6	637.3
Share %	80.2%	24.4%	80.2%	81.3%	81.3%	78.4%	2.0%	84.9%	76.7%	78.0%
OFFICE SYSTEMS AND WORKSTATIONS										
Dedicated application										
Units (000)	2,213.4	70.8	873.4	1,268.1	1.1	2,100.0	4.0	346.1	1,709.0	40.9
Share %	6.3%	19.4%	5.2%	7.0%	0.8%	5.2%	13.0%	4.2%	5.5%	5.0%
NON-OFFICE SYSTEMS AND WORKSTATIONS										
Dedicated application										
Units (000)	840.8	26.6	455.8	346.0	12.4	695.8	10.4	247.2	372.9	65.3
Share %	2.4%	7.3%	2.7%	1.9%	9.8%	1.7%	34.0%	3.0%	1.2%	8.0%
CONSUMER AND HOBBY COMPUTERS										
Units (000)	2,286.8	--	986.1	1,300.7	--	4,515.0	--	164.8	4,350.2	--
Share %	6.5%	--	5.9%	7.1%	--	11.2%	--	2.0%	14.0%	--
OTHER APPLICATIONS										
Units (000)	188.1	12.8	82.9	92.4	--	362.2	.3	82.4	279.5	--
Share %	.6%	3.4%	.5%	.5%	--	1.0%	1.0%	1.0%	.9%	--
TOTAL, ALL APPLICATIONS*										
Units (000)	35,179.1	363.5	16,573.8	18,115.4	126.4	40,160.0	30.5	8,240.0	31,072.5	817.0
Share %	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

TECHNICAL REVIEW

Competing technologies

For most small and medium-scale computing systems, the flexible disk drive remains the leading 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 of current flexible disk drives is 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 continue to make floppy drives more cost effective against competitive data storage technologies. Consequently, alternate technologies continue to have limited success in breaking into floppies' established markets, and such success has occurred only where flexible disk drive capacities have been insufficient to conveniently handle software or user data files. The rate of innovation currently enjoyed by floppy drives isn't decreasing -- high capacity floppy drives now entering the production phase 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, some with capacities as high as 175 megabytes, offer one of the best ways to accomplish fast save/restore of files. They also have 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. Several high capacity floppy drives have been announced and some are in the early stages of production. 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, making use of a magnetic recording layer coated on 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 may 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 a rigid disk. 3M has had various arrangements with other firms interested in developing SSR drives for several years. Most, if not all, of these efforts have become inactive. No SSR drives or media have been announced, though reports of joint activity between 3M and Sony appeared in the trade press in the first half of 1989.

* 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, resulting in relatively low manufacturing costs. 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. 3.15 inch CD-ROM drives will become available in 1990. Most read-only optical drives are essentially part of a data 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 disk drives for distribution of software for personal computers and other small systems. Even when CD-ROM appears as a system peripheral device, floppy disk drives will continue to be required, because only selected software will be distributed on CD-ROM for some years to come.

* Non-reversible optical disks: The first optical disk recording systems to enter the market were "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 and CD format writable disk drives in 4.72 inch and 3.14 inch formats have been demonstrated.

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 characteristics 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. 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 expected to be over 100 megabytes, and they will be produced in 3.5 inch formats, albeit at high prices compared to floppy disk technology. Due to optical disk drive complexity and the thickness of the optical cartridge,

optical drives will have great difficulty in matching the 3/4 inch or 1 inch high form factors which will be the standards for 3.5 inch floppy drives which will be used in most applications in the near future.

For optical drives offering nominal performance and a limited degree of erasability, prices may someday be comparable with high capacity floppy drive prices, 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 and network servers.

- * 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 when it sold its bubble memory business to Memtech Technology.

Nevertheless, the non-volatility and environmental insensitivity 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.

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 and other locations have shown promise, but much remains to be done to make VBL a practical technology. Ultimately, the ability of bubble memory to be a major competitor requires greatly reduced costs.

- * Tape drives: When disk drive capacities used with small computer systems are above 20-30 megabytes, the functional requirements for a removable media backup device cannot be met conveniently by today's flexible disk drives. Floppies' comparatively limited capacity is usually adequate for applications with which the typical file is also small, such as with word processing systems and home

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 3.5 inch high capacity floppies being developed by Insite Peripherals, NEC, Citizen, Brier Technology, 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. Tape standards, plus new tape cartridge drives designed to the same form factor as 3.5 inch and 5.25 inch Winchesters, are resulting in significant penetration by tape cartridge streamers (and 4 millimeter helical scan drives in the future) in the backup market for Winchesters in the 20-30 megabyte range and above.

Will small tape cartridge drives displace conventional flexible disk drives? 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 20-40 megabytes. Anything larger will continue to 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 they will remain a convenient backup method for the small files which usually accompany large files.

- * Semiconductor memory: Semiconductor DRAM memory is still too expensive to compete directly with floppy disks. 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. Ferroelectric memory shows some promise of being a signi-

ficant future competitor due to its inherent non-volatility and a production process similar to that of the well understood CMOS. 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 late 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 continue to advance as expected, difficult problems in manufacturing technology must be overcome -- especially those concerned with producing narrower line widths. The rate of development will slow down as the plant and equipment costs increase and lead times for advanced manufacturing and production equipment become significantly longer.

Small plastic cards containing IC memories ranging from 8 kilobytes to over 1 megabyte 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. 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 Nippon Telephone & Telegraph 1.6 megabyte version of the 5.25 inch drive and the Sony 3.5 inch microfloppy. 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 1.6 megabyte 5.25 inch and the 3.5 inch (including the 2 megabyte version) formats through product introductions.

Recently the leading edge in floppy drive innovation has shifted to two areas: Decreasing height and increasing capacity. The vertical form factor for the newest 3.5 inch drives has decreased to 3/4 inch, spurred by the requirements of notebook and laptop system producers, while drives with capacities over 20 megabytes are going into production.

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 drive technology:

- * Form factor: The newest 3.5 inch floppy drives now arriving on the scene require approximately 3/4 inch of vertical front panel space. This is significant because it permits two drives to be mounted in the space of a standard 41.3 millimeter drive bay, a real advantage to system manufacturers in offering flexibility to dealers and users in installing options on a modular basis. The smaller volume also permits designers of laptop and notebook computers to reduce weight and system package size.

Drives ranging from 17 to 19 millimeter height are currently being offered as "3/4 inch" drives. Whatever height eventually becomes the industry standard, 3/4 inch high drives are expected to rapidly displace one inch high floppy disk drives, much as the one inch high units have already largely displaced the 1.625 inch form factor.

- * 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 4 megabyte 3.5 inch drives using barium ferrite media record at 34,768 FCI. Matsushita Communication Industrial has made a preliminary announcement of a 3.5 inch drive using metal particle media that stores 16 megabytes and Y-E Data has made a preliminary announcement of a 27.8 megabyte drive, also using metal particle media. The Iomega Bernoulli 44 megabyte 5.25 inch drives record data at over 21,400 FCI, using a barium ferrite diskette. 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 1990 delivery, will utilize an effective BPI of 26,000 using run length limited code on barium ferrite media.

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 pioneered development of barium ferrite recording technology for flexible disk drives, and after several years of tentative market exploration introduced a 4 megabyte drive in 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 achieved 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 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. Insite Peripherals has achieved a track density of 1,250 TPI using optical tracking of a visible servo pattern on the disk surface. Brier has announced future availability of a drive with 1,555 TPI and 43.2 megabytes that may become available in 1990.

In the short-term, 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 for capacity-hungry applications such as graphics and desktop publishing. The largest market will be driven by the need for more cost-effective backup of the small hard disk drives now used with most office computers. 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 join 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 multi-function head designs to provide read/write/erase capability at multiple densities. This feature allows downward 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 closed loop head positioning systems. 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 applies a visible track pattern to the media surface, and employs simple optics with an inexpensive LED light source to monitor head position.
- * 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 and has won at least one major OEM contract for a notebook computer, Sony has been making a drive and media based upon a video drive used in the Mavica camera. While the Sony 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. Lack of media interchange capability with the 3.5 inch floppy drives now becoming the dominant standard for office computers will also restrain the industry's enthusiasm.

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

Example:

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

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

Example:

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

PCM/Reseller: Disk drives sold or leased by "plug compatible manufacturers" or their distributing organizations directly to end users for use with systems sold by another manufacturer. Also includes drives sold in the "aftermarket" -- shipments by drive manufacturers to subsystem producers, distributors, retail chains, mail order firms and individual dealers. It includes drives to be connected to systems of all types, including personal computers, minicomputers and mainframes, or drives sold as add-on devices by dealers and distributors.

Examples:

- * Disk drives sold by Iomega to end users of IBM or Apple systems.
- * Standard drives sold by drive manufacturers to distributors or dealers are considered to be PCM/Reseller drives.

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

Example:

- * Drives sold by independent drive manufacturers to IBM or other system manufacturers for use with personal computers 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.

Examples:

- * 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 1989 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.

APPLICATION CLASSIFICATION

Shipments of disk drives are analyzed by attachment to the following classes of equipment:

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

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

Personal computers: Attached to a general purpose microcomputer normally used by a single user. Examples: IBM PS/2 model 70, Apple Macintosh.

Office systems/workstations: 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, Toshiba TOSFILE, typesetters.

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

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

Other applications: Any application not included above.

FLEXIBLE DISK DRIVES, 8 INCH

FLEXIBLE DISK DRIVES, 8 INCHCoverage

Examples of flexible disk drives in this group include:

One side

Elcomatic	ACP 500
Magyar Optikai Muvek	Momflex 6400
Miltope	DD 400
Shugart	801, 848-1

Two sides

DZU	ES 5083
Elcomatic	ACP 700
Hitachi	FDD-412
IBM	4964, 4966
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

Since last year, the DISK/TREND Report has combined all 8 inch flexible disk 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 den-

sities. 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. Almost all of the many 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>1988</u>	<u>1989</u>	<u>1990</u>	<u>1991</u>	<u>1992</u>
U.S. manufacturers	25.6	15.0	2.6	1.6	.5
All manufacturers	161.3	108.3	60.8	29.4	13.0

There have been no surprises in this product group -- the shipments of 8 inch flexible disk drives have continued to decline as expected. Worldwide shipments for 8 inch one side drives peaked in 1981, at 746,600 units, and two sided drives peaked two years later, with 1,275,900 units. Total shipments in 1988 for all 8 inch floppy drive models were 340,500 drives, down another 70,000 units.

In recent years, the largest factor in maintaining shipments of drives in this product group at a high level has been continuing usage of the two sided 8 inch format in the Japanese domestic market for office computers. But the tide has long since turned, as 8 inch drives were displaced first by the 1.6 megabyte 5.25 inch models, and later by the 3.5 inch drives used in most of the newer systems.

U.S. production of 8 inch drives was only 23,000 drives in 1988, and continues to decline. The low U.S. total is attributed to the fact that

1989 DISK/TREND REPORT

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, but is expected to discontinue these product lines when inventories are depleted.

Y-E Data continues to dominate recent OEM shipments in this group, with 54.1% of 1988 worldwide shipments, followed by DZU's Eastern Bloc shipments at 8.9%, and Mitsubishi Electric with 8.0%.

Marketing trends

The drives in this product group are considered obsolete by most system manufacturers. An average annual decline in shipments in excess of 50% is expected during the next three years, with worldwide shipments dropping to 30,500 units in 1992. By that time, U.S. shipments 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 during the 1980s 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 expected soon.

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 in 1989.
2. The Japanese domestic market will continue to move away from 8 inch, two sided floppy drives, in favor of 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)-----									
	1988		-----Forecast-----							
	Revenues		1989		1990		1991		1992	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM Captive	13.3	20.1	6.9	10.5	--	--	--	--	--	--
Other U.S. Captive	--	--	--	--	--	--	--	--	--	--
TOTAL U.S. CAPTIVE	13.3	20.1	6.9	10.5	--	--	--	--	--	--
PCM/Reseller	--	--	--	--	--	--	--	--	--	--
OEM/Integrator	4.3	5.5	3.8	4.5	1.9	2.6	1.1	1.6	.5	.5
TOTAL U.S. NON-CAPTIVE	4.3	5.5	3.8	4.5	1.9	2.6	1.1	1.6	.5	.5
TOTAL U.S. REVENUES	17.6	25.6	10.7	15.0	1.9	2.6	1.1	1.6	.5	.5
Non-U.S. Manufacturers										
Captive	--	70.2	--	52.9	--	37.0	--	17.4	--	7.2
PCM/Reseller	1.3	2.6	.9	1.3	.2	.4	--	--	--	--
OEM/Integrator	12.3	62.9	6.9	39.1	2.2	20.8	1.6	10.4	.2	5.3
TOTAL NON-U.S. REVENUES	13.6	135.7	7.8	93.3	2.4	58.2	1.6	27.8	.2	12.5
Worldwide Recap										
TOTAL WORLDWIDE REVENUES	31.2	161.3	18.5	108.3	4.3	60.8	2.7	29.4	.7	13.0
OEM Average Price (\$000)										
	.311	.297	.351	.297	.344	.296	.318	.306	.500	.314

TABLE 9
FLEXIBLE DISK DRIVES, 8 INCH
UNIT SHIPMENT SUMMARY

	-----DISK DRIVE UNIT SHIPMENTS, BY SHIPMENT DESTINATION (000)-----									
	1988		1989		1990		1991		1992	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM Captive	8.6	13.0	4.6	7.0	--	--	--	--	--	--
Other U.S. Captive	--	--	--	--	--	--	--	--	--	--
TOTAL U.S. CAPTIVE	8.6	13.0	4.6	7.0	--	--	--	--	--	--
PCM/Reseller	--	--	--	--	--	--	--	--	--	--
OEM/Integrator	6.3	10.0	4.5	6.5	2.9	4.1	1.5	2.2	.4	.5
TOTAL U.S. NON-CAPTIVE	6.3	10.0	4.5	6.5	2.9	4.1	1.5	2.2	.4	.5
TOTAL U.S. SHIPMENTS	14.9	23.0	9.1	13.5	2.9	4.1	1.5	2.2	.4	.5
Non-U.S. Manufacturers										
Captive	--	114.0	--	87.0	--	61.0	--	29.0	--	12.0
PCM/Reseller	3.0	6.0	2.0	3.0	.5	1.0	--	--	--	--
OEM/Integrator	47.0	220.5	26.0	140.2	9.0	75.0	7.0	37.0	1.0	18.0
TOTAL NON-U.S. SHIPMENTS	50.0	340.5	28.0	230.2	9.5	137.0	7.0	66.0	1.0	30.0
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	64.9	363.5	37.1	243.7	12.4	141.1	8.5	68.2	1.4	30.5
Cumulative Shipments (000,000)										
IBM	1.2	1.7	1.2	1.7	1.2	1.7	1.2	1.7	1.2	1.7
Non-IBM	4.0	9.9	4.1	10.1	4.1	10.2	4.1	10.3	4.1	10.3
WORLDWIDE TOTAL	5.2	11.7	5.3	11.9	5.3	12.0	5.3	12.1	5.3	12.1

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

	1988		1989		1990		1991		1992	
	Units	%	Units	%	Units	%	Units	%	Units	%
U.S. MANUFACTURERS										
Captive Total	13.0		7.0		--		--		--	
Full Size	13.0	100.0	7.0	100.0	--	--	--	--	--	--
OEM Total	10.0		6.5		4.1		2.2		.5	
Full Size	8.8	88.1	4.5	69.3	2.6	63.5	1.4	63.7	.2	40.0
Half High	1.2	11.9	2.0	30.7	1.5	36.5	.8	36.3	.3	60.0
Total U.S.	23.0		13.5		4.1		2.2		.5	
Full Size	21.8	94.9	11.5	85.3	2.6	63.5	1.4	63.7	.2	40.0
Half High	1.2	5.1	2.0	14.7	1.5	36.5	.8	36.3	.3	60.0
NON-U.S. MANUFACTURERS										
Captive Total	114.0		87.0		61.0		29.0		12.0	
Full Size	4.0	3.5	2.0	2.3	1.0	1.6	--	--	--	--
Half High	110.0	96.5	85.0	97.7	60.0	98.4	29.0	100.0	12.0	100.0
OEM Total	226.5		143.2		76.0		37.0		18.0	
Full Size	36.2	16.0	22.7	15.9	15.0	19.7	10.0	27.0	7.0	38.9
Half High	190.3	84.0	120.5	84.1	61.0	80.3	27.0	73.0	11.0	61.1
Total Non-U.S.	340.5		230.2		137.0		66.0		30.0	
Full Size	40.2	11.8	24.7	10.7	16.0	11.7	10.0	15.2	7.0	23.3
Half High	300.3	88.2	205.5	89.3	121.0	88.3	56.0	84.8	23.0	76.7
WORLDWIDE RECAP										
Total Worldwide Shipments	363.5		243.7		141.1		68.2		30.5	
	-16.2%		-32.9%		-42.1%		-51.6%		-55.2%	
Full Size	62.0	17.1	36.2	14.9	18.6	13.2	11.4	16.7	7.2	23.6
	-37.6%		-41.6%		-48.6%		-38.7%		-36.8%	
Half High	301.5	82.9	207.5	85.1	122.5	86.8	56.8	83.3	23.3	76.4
	-9.9%		-31.1%		-40.9%		-53.6%		-58.9%	

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 -----	1988 Estimate -----		1992 Projection -----	
	Units (000) -----	% -----	Units (000) -----	% -----
MAINFRAME/SUPERMINI General purpose	36.6	10.1	1.8	6.0
MINICOMPUTERS AND MULTI-USER MICROS Business and professional, including networks	127.8	35.2	13.4	44.0
PERSONAL COMPUTERS Business and professional, single user	88.9	24.4	.6	2.0
OFFICE SYSTEMS AND WORKSTATIONS Dedicated application	70.8	19.5	4.0	13.0
NON-OFFICE SYSTEMS AND WORKSTATIONS Technical, distribution, medical, other specialized	26.6	7.3	10.4	34.0
CONSUMER AND HOBBY COMPUTERS	--	--	--	--
OTHER APPLICATIONS	12.8	3.5	.3	1.0
Total	363.4	100.1	30.5	100.0

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

Drive Manufacturers	1988 Net Shipments			
	To United States Destinations		Worldwide	
	Units (000)	%	Units (000)	%
Y-E Data	37.0	65.7	128.0	54.1
DZU	--	--	21.0	8.9
Mitsubishi Electric	10.0	17.8	19.0	8.0
Other U.S.	6.3	11.2	10.0	4.3
Other Non-U.S.	3.0	5.3	58.5	24.7
	-----	-----	-----	-----
TOTAL	56.3	100.0	236.5	100.0

FLEXIBLE DISK DRIVES, 5.25 INCH

FLEXIBLE DISK DRIVES, 5.25 INCHCoverage

Examples of flexible disk drives in this group include:

One side: 48 tracks per inch

Asia Commercial	FD-103
Chinon	FZ-501A
DZU	ES 5088M
Flexdisc	FF450
Ho Shin	HS-550
Magyar Optikai Muvek	MF 54S
Mantec	MTL-FD102E/C
Multidigit	DF0211
Oceanic	OC-118, OH-2
Peripheral Data Systems	MFDD-110
Robotron	K 5600.10
Roctec	RF501A
Tecmate	MT-501A

One side: 96/100 tracks per inch

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

Two sides: 48 tracks per inch

Alps Electric	DFE 222A
Asia Commercial	FD-104
Canon	MD 5201
Chinon	FZ-502
Copal	F-5002
DZU	ES 5321
Ergo	DS-7
Flexdisc	FF 650
Fujitsu	M2551A
Goldstar Telecommunication	GSF 548
Ho Shin	HD-551
Magyar Optikai Movek	MF 54D
Mantec	MTL-FD128
Matsushita Communication Ind.	JA-455
Mitsubishi Electric	MF501B
Mitsumi Electric	D 503V
Multidigit	DF0511
NEC	FD 1054
Oceanic	OB-1
Oriental Precision	OFD 546R
Peripheral Data Systems	BD-120

Two sides: 48 tracks per inch (continued)

Ricoh	RF5050
Roctec	RF 502B
Samsung Electronics	SFD-500V
Seiko Epson	SD-621L
Teac	FD-55BR
Tecmate	MT-502
Toshiba	ND-04DT-A
Y-E Data	YD-580

Two sides: 96 tracks per inch, 1.0 megabyte

Alps Electric	DFE 422A
Asia Commercial	FD-106
Copal	F-5014
DZU	ES 5323
Fujitsu	M2552K
Ho Shin	HD-552
Magyar Optikai Movek	MF 58D
Matsushita Communication Ind.	JA-465
NEC	FD 1057
Oriental Precision	OFD 596R
Teac	FD-55FR
Toshiba	ND-06D/DT

Two sides: 96 tracks per inch, 1.6 megabytes

Alps Electric	DFE 642A, DFE 682A
Asia Commercial	FD-106
Canon	MD-5501
Chinon	FZ-506
Copal	F-5018
Flexdisc	FF 950
Fujitsu	M2553K, M2554K
Goldstar Telecommunication	GSF 596
Ho Shin	HD-553
Matsushita Communication Ind.	JU-475
Mitsubishi Electric	MF504B
Mitsumi Electric	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
Y-E Data	YD-380, YD-380B

Two sides: 96 tracks per inch, 2.0 megabytes

Multidigit

DF 2011

Two sides: 96 or more tracks per inch, 3.3 megabytes

Eastman Kodak
Y-E Data

Kodak 3.3
YE-801

In view of the continuing decline in shipments for one sided 5.25 inch flexible disk drives, the DISK/TREND Report now combines all 5.25 inch drives into a single product group, replacing the previous separate groups for one and two sided drives.

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 sided 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 and now offered by most drive manufacturers, have become the dominant physical size standard for floppy drives using 5.25 inch diskettes.

Two sided 5.25 inch floppy drives became a reality in 1978. 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.

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, but 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 limited, 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>1988</u>	<u>1989</u>	<u>1990</u>	<u>1991</u>	<u>1992</u>
U.S. manufacturers	17.6	7.4	--	--	--
All manufacturers	1,336.1	1,072.3	850.5	660.5	511.6

Shipments of 5.25 inch drives finally peaked in 1988, 12 years after the introduction of the original SA400 by Shugart Associates in 1976. Worldwide shipments for 1988 were up 2.1% over the previous year, at

1989 DISK/TREND REPORT

16,573,800 drives, but 1989 shipments are expected to decline to 14,089,500 units, down 14.9%.

1988 shipments of one sided 5.25 inch drives were below one million units for the first time since 1980, with a worldwide total of 947,000 drives, down 37% for the year, with another 23% decline expected in 1989.

15.6 million two sided drives were shipped in 1988, an increase of 6.1%, but all of the growth was provided by 1.6 megabyte models, which were up 39.6%. It is expected that 1988 will have been the peak year for total shipments of two sided 5.25 inch drives, with worldwide shipments in 1989 down 14.5%, to 13.3 million drives. 1.6 megabyte drive shipments are continuing to grow this year, but at a rate of only 5.2%.

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 contributed to increased sales of two sided 5.25 inch drives.

Worldwide revenues are another story, however. Despite a modest increase in 1988, the long-term trend for this product group since 1984 has been a continuing decline in revenues, which is expected to continue. The reason is well known: Average unit prices for OEM drives continue to decline, from \$114 in 1984, to \$62 in 1988, with a further drop underway in 1989, to \$57.

Despite the major shift in dollar/yen exchange rates during recent years, the price decline has continued, as major Japanese producers concentrate on aggressive cost reduction programs, including product redesign and plant relocation.

1989 DISK/TREND REPORT

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. 80.2% of 1988 shipments were used with personal computers, with minor usage attributed to consumer and hobby computers, office systems and minicomputer applications.

Matsushita Communication Industrial continued to lead in 1988 shipments of non-captive drives, with 2.7 million units, 18.1% of the worldwide total. Teac held 14.7% and Mitsubishi Electric, 10.8%.

Marketing trends

Although shipments of 1.6 megabyte drives are expected to increase by a nominal 1.5% in 1990, the outlook for later years is downward as the momentum of PC AT compatible PC systems drops off.

The result will be a long, gradual decline in shipments for all two sided 5.25 inch drives, averaging more than 15% per year during the 1990-92 period. Shipments of one sided 5.25 inch drives are forecasted to deteriorate even faster during the same period, declining an average of almost 50% per year.

<u>Worldwide floppy drive unit shipments (000)</u>	<u>1988</u>	<u>1989</u>	<u>1990</u>	<u>1991</u>	<u>1992</u>
5.25" one side	947.0 5.7%	729.0 5.2%	441.0 3.7%	230.0 2.3%	89.0 1.1%
5.25" two side <1 MB	6,866.0 41.4%	4,177.5 29.6%	2,224.0 18.7%	1,312.0 13.1%	823.0 10.0%
5.25" two side 1 MB	268.1 1.6%	250.0 1.8%	165.0 1.4%	95.0 1.0%	55.0 .7%
5.25" two side >1 MB	8,492.7 51.3%	8,933.0 63.4%	9,065.0 76.2%	8,343.0 83.6%	7,273.0 88.2%

Total revenue for this product group will decline at a more rapid pace than the shipment decline, averaging -21.8% annually during 1990-92. 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 drive manufacturers will be concentrating on 3.5 inch models and little effort will be expended in the future to redesign 5.25 inch drives for lower cost, now that shipments have peaked.

The current DISK/TREND forecasts assume 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. For this reason, 1.6 megabyte drives are expected to grow from 1988's 39.6% of the total for all 5.25 inch drives to 88.2% of the 1992 total, even though total shipments during this period will decline.

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.

High capacity flexible disk drives over 5 megabytes are covered in a different product group. However, 3.3 megabyte drives are 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 evaporated. At this time, the principal remaining 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.

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 residual market for 1.6 megabyte 5.25 inch drives for several years.
2. A positive growth rate for personal computers 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 13
FLEXIBLE DISK DRIVES, 5.25 INCH
REVENUE SUMMARY

	-----DISK DRIVE REVENUES, BY SHIPMENT DESTINATION (\$M)-----									
	1988		-----Forecast-----							
	Revenues		1989		1990		1991		1992	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW

U.S. Manufacturers										

IBM Captive	--	--	--	--	--	--	--	--	--	--
Other U.S. Captive	8.8	16.8	3.2	7.2	--	--	--	--	--	--
TOTAL U.S. CAPTIVE	8.8	16.8	3.2	7.2	--	--	--	--	--	--
PCM/Reseller	--	--	--	--	--	--	--	--	--	--
OEM/Integrator	.8	.8	.2	.2	--	--	--	--	--	--
TOTAL U.S. NON-CAPTIVE	.8	.8	.2	.2	--	--	--	--	--	--
TOTAL U.S. REVENUES	9.6	17.6	3.4	7.4	--	--	--	--	--	--
Non-U.S. Manufacturers										

Captive	39.0	376.9	25.2	331.1	14.1	247.8	5.3	172.8	1.2	118.7
PCM/Reseller	122.8	160.2	102.1	132.6	89.3	114.3	76.4	95.5	66.5	80.0
OEM/Integrator	257.2	781.4	192.9	601.2	147.2	488.4	111.9	392.2	84.9	312.9
TOTAL NON-U.S. REVENUES	419.0	1,318.5	320.2	1,064.9	250.6	850.5	193.6	660.5	152.6	511.6
Worldwide Recap										

TOTAL WORLDWIDE REVENUES	428.6	1,336.1	323.6	1,072.3	250.6	850.5	193.6	660.5	152.6	511.6
OEM Average Price (\$000)	.062	.062	.058	.057	.054	.055	.052	.052	.050	.050

TABLE 14
FLEXIBLE DISK DRIVES, 5.25 INCH
UNIT SHIPMENT SUMMARY

	-----DISK DRIVE UNIT SHIPMENTS, BY SHIPMENT DESTINATION (000)-----									
	1988		1989		1990		Forecast		Forecast	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM Captive	--	--	--	--	--	--	--	--	--	--
Other U.S. Captive	11.0	21.0	4.0	9.0	--	--	--	--	--	--
TOTAL U.S. CAPTIVE	11.0	21.0	4.0	9.0	--	--	--	--	--	--
PCM/Reseller	--	--	--	--	--	--	--	--	--	--
OEM/Integrator	6.6	6.7	1.0	1.0	--	--	--	--	--	--
TOTAL U.S. NON-CAPTIVE	6.6	6.7	1.0	1.0	--	--	--	--	--	--
TOTAL U.S. SHIPMENTS	17.6	27.7	5.0	10.0	--	--	--	--	--	--
Non-U.S. Manufacturers										
Captive	132.0	1,246.0	101.0	1,315.0	60.0	1,031.0	24.0	752.0	6.0	538.0
PCM/Reseller	2,024.5	2,610.0	1,776.0	2,274.0	1,564.0	1,992.0	1,388.0	1,731.0	1,231.0	1,480.0
OEM/Integrator	4,166.5	12,690.1	3,328.5	10,490.5	2,702.0	8,872.0	2,164.0	7,497.0	1,705.0	6,222.0
TOTAL NON-U.S. SHIPMENTS	6,323.0	16,546.1	5,205.5	14,079.5	4,326.0	11,895.0	3,576.0	9,980.0	2,942.0	8,240.0
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	6,340.6	16,573.8	5,210.5	14,089.5	4,326.0	11,895.0	3,576.0	9,980.0	2,942.0	8,240.0
Cumulative Shipments (000,000)										
IBM	.4	.4	.4	.4	.4	.4	.4	.4	.4	.4
Non-IBM	50.2	95.0	55.4	109.1	59.7	120.9	63.3	130.9	66.2	139.2
WORLDWIDE TOTAL	50.6	95.4	55.8	109.5	60.1	121.4	63.7	131.4	66.7	139.6

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

	1988		1989		1990		1991		1992	
	Units	%	Units	%	Units	%	Units	%	Units	%
U.S. MANUFACTURERS										
Captive Total	21.0		9.0		--		--		--	
Full Size	21.0	100.0	9.0	100.0	--	--	--	--	--	--
Half High	--	--	--	--	--	--	--	--	--	--
OEM Total	6.7		1.0		--		--		--	
Full Size	--	--	--	--	--	--	--	--	--	--
Half High	6.7	100.0	1.0	100.0	--	--	--	--	--	--
Total U.S.	27.7		10.0		--		--		--	
Full Size	21.0	75.9	9.0	90.1	--	--	--	--	--	--
Half High	6.7	24.1	1.0	9.9	--	--	--	--	--	--
NON-U.S. MANUFACTURERS										
Captive Total	1,246.0		1,315.0		1,031.0		752.0		538.0	
Full Size	45.0	3.6	30.0	2.3	30.0	2.9	27.0	3.6	30.0	5.6
Half High	1,201.0	96.4	1,285.0	97.7	1,001.0	97.1	725.0	96.4	508.0	94.4
OEM Total	15,300.1		12,764.5		10,864.0		9,228.0		7,702.0	
Full Size	1.0	--	--	--	--	--	--	--	--	--
Half High	15,299.1	100.0	12,764.5	100.0	10,864.0	100.0	9,228.0	100.0	7,702.0	100.0
Total Non-U.S.	16,546.1		14,079.5		11,895.0		9,980.0		8,240.0	
Full Size	46.0	.3	30.0	.2	30.0	.3	27.0	.3	30.0	.4
Half High	16,500.1	99.7	14,049.5	99.8	11,865.0	99.7	9,953.0	99.7	8,210.0	99.6
WORLDWIDE RECAP										
Total Worldwide Shipments	16,573.8		14,089.5		11,895.0		9,980.0		8,240.0	
	+2.1%		-14.9%		-15.5%		-16.0%		-17.4%	
Full Size	67.0	.4	39.0	.3	30.0	.3	27.0	.3	30.0	.4
	-56.2%		-41.7%		-23.0%		-10.0%		+11.1%	
Half High	16,506.8	99.6	14,050.5	99.7	11,865.0	99.7	9,953.0	99.7	8,210.0	99.6
	+2.6%		-14.8%		-15.5%		-16.1%		-17.5%	

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

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

	1988		1989		1990		Forecast 1991		1992	
	Units	%	Units	%	Units	%	Units	%	Units	%
U.S. MANUFACTURERS										
Captive Total	21.0		9.0		--		--		--	
96 TPI	21.0	100.0	9.0	100.0	--	--	--	--	--	--
OEM Total	6.7		1.0		--		--		--	
48 TPI	6.0	89.7	--	--	--	--	--	--	--	--
96 TPI 1.6 MB	.7	10.3	1.0	100.0	--	--	--	--	--	--
Total U.S.	27.7		10.0		--		--		--	
48 TPI	6.0	21.7	--	--	--	--	--	--	--	--
96 TPI	21.0	75.9	9.0	90.1	--	--	--	--	--	--
96 TPI 1.6 MB	.7	2.4	1.0	9.9	--	--	--	--	--	--
NON-U.S. MANUFACTURERS										
Captive Total	1,246.0		1,315.0		1,031.0		752.0		538.0	
48 TPI	108.0	8.7	147.0	11.2	110.0	10.7	57.0	7.6	25.0	4.6
96 TPI	11.0	.9	11.0	.8	19.0	1.8	27.0	3.6	33.0	6.1
96 TPI 1.6 MB	1,127.0	90.4	1,157.0	88.0	902.0	87.5	668.0	88.8	480.0	89.3
OEM Total	15,300.1		12,764.5		10,864.0		9,228.0		7,702.0	
48 TPI	7,673.0	50.2	4,744.5	37.3	2,546.0	23.4	1,473.0	16.0	874.0	11.3
96 TPI	262.1	1.7	245.0	1.9	155.0	1.4	80.0	.9	35.0	.5
96 TPI 1.6 MB	7,365.0	48.1	7,775.0	60.8	8,163.0	75.2	7,675.0	83.1	6,793.0	88.2
Total Non-U.S.	16,546.1		14,079.5		11,895.0		9,980.0		8,240.0	
48 TPI	7,781.0	47.1	4,891.5	34.8	2,656.0	22.3	1,530.0	15.3	899.0	10.9
96 TPI	273.1	1.7	256.0	1.8	174.0	1.5	107.0	1.1	68.0	.8
96 TPI 1.6 MB	8,492.0	51.2	8,932.0	63.4	9,065.0	76.2	8,343.0	83.6	7,273.0	88.3
WORLDWIDE RECAP										
Total Worldwide Shipments	16,573.8		14,089.5		11,895.0		9,980.0		8,240.0	
	+2.1%		-14.9%		-15.5%		-16.0%		-17.4%	
48 TPI	7,787.0	47.1	4,891.5	34.8	2,656.0	22.3	1,530.0	15.3	899.0	10.9
	-19.8%		-37.1%		-45.7%		-42.3%		-41.2%	
96 TPI	294.1	1.8	265.0	1.9	174.0	1.5	107.0	1.1	68.0	.8
	-32.4%		-9.8%		-34.3%		-38.5%		-36.4%	
96 TPI 1.6 MB	8,492.7	51.1	8,933.0	63.3	9,065.0	76.2	8,343.0	83.6	7,273.0	88.3
	+39.6%		+5.1%		+1.4%		-7.9%		-12.8%	

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 totals in this table.

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

APPLICATION -----	1988 Estimate		1992 Projection	
	Units (000) -----	% -----	Units (000) -----	% -----
MAINFRAME/SUPERMINI General purpose	--	--	8.2	.1
MINICOMPUTERS AND MULTI-USER MICROS Business and professional, including networks	878.4	5.3	395.5	4.8
PERSONAL COMPUTERS Business and professional, single user	13,297.2	80.2	6,995.8	84.9
OFFICE SYSTEMS AND WORKSTATIONS Dedicated application	873.4	5.3	346.1	4.2
NON-OFFICE SYSTEMS AND WORKSTATIONS Technical, distribution, medical, other specialized	455.8	2.8	247.2	3.0
CONSUMER AND HOBBY COMPUTERS	986.1	5.9	164.8	2.0
OTHER APPLICATIONS	82.9	.5	82.4	1.0
Total	----- 16,573.8	----- 100.1	----- 8,240.0	----- 100.0

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

Drive Manufacturers	1988 Net Shipments			
	To United States Destinations		Worldwide	
	Units (000)	%	Units (000)	%
Matsushita Commun. Ind.	445.0	7.2	2,767.1	18.1
Teac	730.0	11.8	2,255.0	14.7
Mitsubishi Electric	1,058.0	17.1	1,655.0	10.8
Alps Electric	940.0	15.2	1,300.0	8.5
Y-E Data	350.0	5.6	1,150.0	7.5
Chinon	400.0	6.5	910.0	5.9
Seiko Epson	350.0	5.6	850.0	5.6
Mitsumi Electric	200.0	3.2	800.0	5.2
Fujitsu	727.0	11.7	727.0	4.8
Toshiba	440.0	7.1	692.0	4.5
NEC	159.0	2.6	691.0	4.5
Canon	190.0	3.1	525.0	3.4
Other U.S.	6.6	.1	6.7	--
Other Non-U.S.	202.0	3.2	978.0	6.5
	-----	-----	-----	-----
TOTAL	6,197.6	100.0	15,306.8	100.0

FLEXIBLE DISK DRIVES, MICROFLOPPIES

FLEXIBLE DISK DRIVES, MICROFLOPPIESCoverage

Examples of flexible disk drives in this group include:

3.5" disk diameter, one side, 67.5 TPI

Brother	FB 300
---------	--------

3.5" disk diameter, one side, 135 TPI

Brother	FB 015
Matsushita Communication Ind.	JU-252
Matsushita Electronic Comp.	EME-112
Teac	FD-35EN

3.5" disk diameter, two sides, 67.5 TPI

Y-E Data	YD-625B
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3.5" disk diameter, two sides, 135 TPI, 1.0 megabyte

Alps Electric	DFL 413, DFP 423
Canon	MD 3411
Chinon	F-354E
Citizen	OSDC, UODC
Copal	F-3534
DZU	ISA 235HF
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	D357T2
NEC	FD 1037A, FD 1038A
Sankyo Seiki	FDU-380
Seiko Epson	SMD-280H, SMD-280L
Sony	MP-F11W
Teac	FD-235F, FD-334F
Tecmate	MT-302
Toshiba	ND-3521
Y-E Data	YD-645C

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

Alps Electric	DFP 683A
Canon	MD 3511
Chinon	F-356
Citizen	OTDB

3.5" disk diameter, two sides, 135 TPI, 1.6 megabytes (continued)

Copal	F-3536, F-3538
Hyundai Electronics	HMF-321, HMF-331
Matsushita Communication Ind.	JU-255
Mitsubishi Electric	MF354C
NEC	FD 1135C, FD 1137C
Sankyo Seiki	FDU-480
Seiko Epson	SMD-320
Teac	FD-235G, FD-334GF
Toshiba	ND-355S/T
Y-E Data	YD-686C

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

Alps Electric	DFP 723
Canon	MD 3611
Chinon	F-357L
Citizen	OSDA, UODA
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, FD 1138A
Samsung Electronics	SFD-321K
Sankyo Seiki	FDU-580
Seiko Epson	SMD-240
Sony	MP-F73W-00D, MP-F17W
Teac	FD-235HF, FD-334HF
Tecmate	NPH-304
Toshiba	ND-356S/T
Y-E Data	YD-701

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

Chinon	FX-358
Teac	FD-235J, FD-135JFN
Toshiba	PD-211
Y-E Data	YD-740

3.0" disk diameter, one side

Matsushita Electronic Comp.	EME-156
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3.0" disk diameter, two sides

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

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

Mitsumi Electric	D 201
Matsushita Communication Ind.	JU-202
Sony	PDD-100, PDD-110

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 Mitsumi Electric (Sony format), and Matsushita Communication Industrial, which uses a separate format.

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 "downward 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 of 3.5 inch drives have also made 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. Several companies have already announced drives with heights of 17-19 millimeters, again prompted by Citizen, which started shipments of 3/4 inch high models earlier this year.

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>1988</u>	<u>1989</u>	<u>1990</u>	<u>1991</u>	<u>1992</u>
U.S. manufacturers	--	--	--	--	--
All manufacturers	1,282.4	1,363.5	1,511.7	1,616.2	1,695.4

Leadership in worldwide unit shipments was taken by microfloppy drives in 1988 for the first time, with 18.1 million drives. 1989 shipments are expected to be 21.2 million drives, up 17.3%, giving microfloppy drives 59.5% of all floppy drive shipments.

In 1989 microfloppy drives also took the overall lead in floppy drive revenues with \$1.3 billion, passing up the declining 5.25 inch drive product group a year after assuming the shipment leadership. Total microfloppy revenue growth has lagged behind shipment increases because of

1989 DISK/TREND REPORT

lower average prices for non-captive drives, combined with relatively low price levels for captive microfloppies less than 3.5 inches.

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 limited production in Taiwan and Eastern Europe.

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 U.S., Japanese and European computers. In addition, the laptop market is achieving excellent growth, with most systems 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.

Shipments of all drives with disks less than 3.5 inches diameter are grouped together in the disk diameter breakdown tables in this year's DISK/TREND Report. OEM shipments of Matsushita Electric 3.0 inch drives have declined in the last few years. The major market for these drives has been the European home computer market, but newer systems with other data storage devices have now gained the initiative. 3.0 inch drives have never significantly penetrated the U.S. market, and after an early lead have been overtaken in the Japan domestic market by 3.5 inch drives.

The subgroup for less than 3.5 inch drives also includes 2.0 inch drives in both the Sony and Matsushita Communication Industrial formats. The MCI drive, which maintains logical file compatibility with 1 megabyte 3.5 and 5.25 inch floppy drives, achieved something of a breakthrough in 1989 as the result of its adoption by Zenith for a major "notebook" computer. But 2.0 inch drives obviously cannot provide physical diskette

compatibility with 3.5 or 5.25 inch drives, and it is still uncertain how rapidly and to what degree they will be utilized for portable computer systems. 2.0 inch drives will probably achieve success with typewriter and game applications, for which they are clearly well suited.

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 almost 65% of all microfloppy unit shipments, but in 1988 two sided drives accounted for over 93.9% of shipments. Almost all new systems introduced in the last few years which use microfloppies have adopted two sided 3.5 inch models.

The 2.0 megabyte models now offered by nearly all major floppy drive manufacturers have become the industry's fastest growing products, stimulated by IBM's adoption of 2.0 megabyte drives for high end PS/2 models. The similar 1.6 megabyte drives are used mostly in Japan, primarily by NEC and with computers designed to be compatible with NEC's PC product line. 1.6/2.0 megabyte drives have taken the lead in 1989 shipments, with an estimated 58% of the total of all microfloppy formats. 4.0 megabyte 3.5 inch drives are expected to become an important part of the industry in future years, but shipments through 1989 have been negligible.

In 1988 91.4% of worldwide microfloppy unit shipments were sold through non-captive distribution channels, either PCM/Reseller or OEM/Integrator. Sony, the originator of the 3.5 inch format, retained the leadership in non-captive unit shipments with 4.3 million drives, 26.2% of the worldwide total. Mitsubishi Electric moved up two places to second position with 1.7 million drives, a 10.7% share. Matsushita Communication Industrial and Alps Electric were almost tied for third place, with 8.3% and 8.2%, respectively.

Marketing trends

The dominant microfloppy trends of 1989 are expected to continue for the next three years. Shipments of two sided 3.5 inch drives are forecasted to reach 29.6 million units in 1992, providing 95.4% of microfloppy worldwide shipments and 73.7% of the shipments of all types of floppy drives. By 1992, 2 megabyte 3.5 inch models are expected to constitute 86.4% of all microfloppy shipments.

Another major emerging microfloppy 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 two inch high drives 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 added one inch high drives, which are now the dominant physical configuration with 70.3% of 1988 shipments of 3.5 inch drives.

Citizen's introduction in 1989 of 3/4 inch drives is already exerting a strong influence on the industry. Several other Japanese floppy drive manufacturers have already announced 3/4 inch high drives, and most of the industry is expected to follow during the next year, stimulated by the potential market in very small portable computers.

There is still some confusion over what the term "3/4 inch high" will mean in actual practice. Strictly speaking, 3/4 inches is 19.05 millimeters, but the various 3/4 inch drives seem to be in a range of 17 to 19

millimeters. It is likely that many of the new drives will be in the low end of that range, to provide maximum versatility.

In view of all of the drive heights still in production (including 17-19, 25.4, 28, 30, 32 and 41.3 millimeters), a simplified system of groups has been used in this table:

<u>Two sided 3.5 inch worldwide total unit shipments (000)</u>	<u>1988</u>	<u>1989</u>	<u>1990</u>	<u>1991</u>	<u>1992</u>
<u>1.625 inches (41.3 mm) or greater height</u>					
1 megabyte	3,396.0	1,708.0	550.0	110.0	10.0
More than 1 megabyte	1,652.0	1,467.0	955.0	343.0	81.0
Total	5,048.0 29.7%	3,175.0 15.7%	1,505.0 6.2%	453.0 1.7%	91.0 .3%
<u>1 inch (25.4 mm) or less height</u>					
1 megabyte	6,593.0	6,728.0	6,839.0	5,730.0	4,000.0
More than 1 megabyte	5,364.0	10,311.0	15,914.3	21,149.8	25,526.5
Total	11,957.0 70.3%	17,039.0 84.3%	22,753.3 93.8%	26,879.8 98.3%	29,526.5 99.7%

This edition of DISK/TREND Report does not include separate forecasts for 4 megabyte 3.5 inch drives, which are included in the two sided 3.5 inch microfloppy totals. Although there has been no formal announcement, most of the floppy drive industry now believes that IBM has selected the barium ferrite 4 megabyte floppy developed by Toshiba as a future standard product in the PS/2 product family. Though it is still early to make forecasts, it is expected that most Japanese floppy drive manufacturers are now preparing to add drives compatible with the Toshiba 4 megabyte floppy to their product lines.

1989 DISK/TREND REPORT

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 until major system manufacturers adopt them. The existence of competing standards will also delay growth.

Technical trends

Now that IBM has apparently settled the argument over barium ferrite versus cobalt modified oxide for 4 megabyte drives, the next challenge for most manufacturers of 3.5 inch drives will be packaging problems in reducing the height of the drive. The industry appears to be moving to a standard height of 3/4 inches, but the change will not be a easy one. Many manufacturers are finding it necessary to use belt drive arrangements instead of the more reliable direct drive motors common with today's floppy drives. Considerable effort will probably be expended to explore various mechanical designs before an industry consensus on this point is reached.

Forecasting assumptions

1. 3/4 inch high 3.5 inch drives will become the dominant floppy drive configuration by 1992 and 2.0 megabyte capacities will maintain leadership through 1992.
2. IBM will continue worldwide usage of 3.5 inch floppy drives with all newly introduced personal computers and will use 4 megabyte 3.5 inch drives on selected high end models starting in 1990.
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 19
FLEXIBLE DISK DRIVES, MICROFLOPPIES
REVENUE SUMMARY

	-----DISK DRIVE REVENUES, BY SHIPMENT DESTINATION (\$M)-----									
	1988		1989		1990		Forecast		1991	
	Revenues		Revenues		Revenues		Revenues		Revenues	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
<u>U.S. Manufacturers</u>										
IBM Captive	--	--	--	--	--	--	--	--	--	--
Other U.S. Captive	--	--	--	--	--	--	--	--	--	--
TOTAL U.S. CAPTIVE	--	--	--	--	--	--	--	--	--	--
PCM/Reseller	--	--	--	--	--	--	--	--	--	--
OEM/Integrator	--	--	--	--	--	--	--	--	--	--
TOTAL U.S. NON-CAPTIVE	--	--	--	--	--	--	--	--	--	--
TOTAL U.S. REVENUES	--	--	--	--	--	--	--	--	--	--
<u>Non-U.S. Manufacturers</u>										
Captive	14.6	297.0	15.6	290.4	17.4	318.3	16.0	331.1	19.3	336.3
PCM/Reseller	22.8	32.5	31.5	46.4	44.9	65.3	55.6	81.2	65.4	95.4
OEM/Integrator	470.9	952.9	525.5	1,026.7	605.8	1,128.1	691.7	1,203.9	778.0	1,263.7
TOTAL NON-U.S. REVENUES	508.3	1,282.4	572.6	1,363.5	668.1	1,511.7	763.3	1,616.2	862.7	1,695.4
<u>Worldwide Recap</u>										
TOTAL WORLDWIDE REVENUES	508.3	1,282.4	572.6	1,363.5	668.1	1,511.7	763.3	1,616.2	862.7	1,695.4
OEM Average Price (\$000)	.063	.059	.057	.054	.051	.050	.048	.048	.047	.046

TABLE 20
FLEXIBLE DISK DRIVES, MICROFLOPPIES
UNIT SHIPMENT SUMMARY

-----DISK DRIVE UNIT SHIPMENTS, BY SHIPMENT DESTINATION (000)-----										
1988		1989		1990		1991		1992		
Shipments						Forecast				
U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	

U.S. Manufacturers										

IBM Captive	--	--	--	--	--	--	--	--	--	--
Other U.S. Captive	--	--	--	--	--	--	--	--	--	--
TOTAL U.S. CAPTIVE	--	--	--	--	--	--	--	--	--	--
PCM/Reseller	--	--	--	--	--	--	--	--	--	--
OEM/Integrator	--	--	--	--	--	--	--	--	--	--
TOTAL U.S. NON-CAPTIVE	--	--	--	--	--	--	--	--	--	--
TOTAL U.S. SHIPMENTS	--	--	--	--	--	--	--	--	--	--
Non-U.S. Manufacturers										

Captive	114.2	1,562.6	129.2	1,565.6	125.5	1,742.0	102.0	1,849.0	120.0	1,960.0
PCM/Reseller	354.0	511.0	542.0	782.0	785.0	1,155.0	1,029.0	1,511.0	1,271.0	1,858.0
OEM/Integrator	7,430.0	16,041.8	9,198.0	18,910.0	11,766.0	22,379.3	14,284.5	25,127.8	16,656.5	27,254.5
TOTAL NON-U.S. SHIPMENTS	7,898.2	18,115.4	9,869.2	21,257.6	12,676.5	25,276.3	15,415.5	28,487.8	18,047.5	31,072.5
Worldwide Recap										

TOTAL WORLDWIDE SHIPMENTS	7,898.2	18,115.4	9,869.2	21,257.6	12,676.5	25,276.3	15,415.5	28,487.8	18,047.5	31,072.5
Cumulative Shipments (000,000)										

IBM	--	--	--	--	--	--	--	--	--	--
Non-IBM	18.3	42.3	28.2	63.6	40.8	88.8	56.3	117.3	74.3	148.4
WORLDWIDE TOTAL	18.3	42.3	28.2	63.6	40.8	88.8	56.3	117.3	74.3	148.4

TABLE 21
FLEXIBLE DISK DRIVES, MICROFLOPPIES
WORLDWIDE REVENUES (\$M)
BREAKDOWN BY DISK DIAMETER

	1988			1989			1990			Forecast			1991			1992		
	Revenues																	
	<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" SS	3.5" DS	<3.5"	3.5" SS	3.5" DS
U.S. MANUFACTURERS																		
IBM Captive	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Other U.S. Captive	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
OEM/Integrator	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
TOTAL U.S. REVENUES	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
NON-U.S. MANUFACTURERS																		
Captive	12.8	12.9	271.3	15.8	15.1	259.5	19.1	9.6	289.6	24.1	3.2	303.8	31.0	1.0	304.3			
PCM/Reseller	--	--	32.5	--	--	46.4	.9	--	64.4	1.8	--	79.4	3.5	--	91.9			
OEM/Integrator	44.6	7.4	900.9	40.0	2.9	983.8	37.3	1.2	1,089.6	41.0	--	1,162.9	45.4	--	1,218.3			
TOTAL NON-U.S. REVENUES	57.4	20.3	1,204.7	55.8	18.0	1,289.7	57.3	10.8	1,443.6	66.9	3.2	1,546.1	79.9	1.0	1,614.5			
WORLDWIDE RECAP																		
Captive	12.8	12.9	271.3	15.8	15.1	259.5	19.1	9.6	289.6	24.1	3.2	303.8	31.0	1.0	304.3			
	+70.7%	-7.9%	+39.1%	+23.4%	+17.1%	-4.3%	+20.9%	-36.4%	+11.6%	+26.2%	-66.7%	+4.9%	+28.6%	-68.7%	+2.2%			
PCM/Reseller	--	--	32.5	--	--	46.4	.9	--	64.4	1.8	--	79.4	3.5	--	91.9			
	--	--	--	--	--	+42.8%	--	--	+38.8%	+100.0%	--	+23.3%	+94.4%	--	+15.7%			
OEM/Integrator	44.6	7.4	900.9	40.0	2.9	983.8	37.3	1.2	1,089.6	41.0	--	1,162.9	45.4	--	1,218.3			
	+9.0%	-43.9%	--	-10.3%	-60.8%	+9.2%	-6.8%	-58.6%	+10.8%	+9.9%	-100.0%	+6.7%	+10.7%	--	+4.8%			
Total Revenues	57.4	20.3	1,204.7	55.8	18.0	1,289.7	57.3	10.8	1,443.6	66.9	3.2	1,546.1	79.9	1.0	1,614.5			
	+18.6%	-25.4%	+36.5%	-2.8%	-11.3%	+7.1%	+2.7%	-40.0%	+11.9%	+16.8%	-70.4%	+7.1%	+19.4%	-68.7%	+4.4%			
ANNUAL SHARE, BY DIAMETER																		
	4.5%	1.6%	93.9%	4.1%	1.3%	94.6%	3.8%	.7%	95.5%	4.1%	.2%	95.7%	4.7%	.1%	95.2%			

TABLE 22
FLEXIBLE DISK DRIVES, MICROFLOPPIES
WORLDWIDE SHIPMENTS (000)
BREAKDOWN BY DISK DIAMETER

	1988 Shipments			Forecast											
	<3.5"	3.5" SS	3.5" DS	1989 <3.5"	3.5" SS	3.5" DS	1990 <3.5"	3.5" SS	3.5" DS	1991 <3.5"	3.5" SS	3.5" DS	1992 <3.5"	3.5" SS	3.5" DS
U.S. MANUFACTURERS															
IBM Captive	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Other U.S. Captive	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
OEM/Integrator	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
TOTAL U.S. SHIPMENTS	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
NON-U.S. MANUFACTURERS															
Captive	85.0	137.6	1,340.0	105.0	163.6	1,297.0	132.0	106.0	1,504.0	172.0	37.0	1,640.0	230.0	12.0	1,718.0
PCM/Reseller	--	--	511.0	--	--	782.0	15.0	--	1,140.0	36.0	--	1,475.0	78.0	--	1,780.0
OEM/Integrator	767.8	120.0	15,154.0	730.0	45.0	18,135.0	745.0	20.0	21,614.3	910.0	--	24,217.8	1,135.0	--	26,119.5
TOTAL NON-U.S. SHIPMENTS	852.8	257.6	17,005.0	835.0	208.6	20,214.0	892.0	126.0	24,258.3	1,118.0	37.0	27,332.8	1,443.0	12.0	29,617.5
WORLDWIDE RECAP															
Captive	85.0 +70.0%	137.6 +108.5%	1,340.0 +44.7%	105.0 +23.5%	163.6 +18.9%	1,297.0 -3.2%	132.0 +25.7%	106.0 -35.2%	1,504.0 +16.0%	172.0 +30.3%	37.0 -65.1%	1,640.0 +9.0%	230.0 +33.7%	12.0 -67.6%	1,718.0 +4.8%
PCM/Reseller	-- --	-- --	511.0 --	-- --	-- --	782.0 +53.0%	15.0 --	-- --	1,140.0 +45.8%	36.0 +140.0%	-- --	1,475.0 +29.4%	78.0 +116.7%	-- --	1,780.0 +20.7%
OEM/Integrator	767.8 +13.6%	120.0 -47.8%	15,154.0 --	730.0 -4.9%	45.0 -62.5%	18,135.0 +19.7%	745.0 +2.1%	20.0 -55.6%	21,614.3 +19.2%	910.0 +22.1%	-- -100.0%	24,217.8 +12.0%	1,135.0 +24.7%	-- --	26,119.5 +7.9%
Total Shipments	852.8 +17.5%	257.6 -13.0%	17,005.0 +50.3%	835.0 -2.1%	208.6 -19.0%	20,214.0 +18.9%	892.0 +6.8%	126.0 -39.6%	24,258.3 +20.0%	1,118.0 +25.3%	37.0 -70.6%	27,332.8 +12.7%	1,443.0 +29.1%	12.0 -67.6%	29,617.5 +8.4%
ANNUAL SHARE, BY DIAMETER	4.7%	1.4%	93.9%	3.9%	1.0%	95.1%	3.5%	.5%	96.0%	3.9%	.1%	96.0%	4.6%	--	95.4%

TABLE 23
FLEXIBLE DISK DRIVES, MICROFLOPPIES
APPLICATIONS SUMMARY
Percentage of Worldwide Shipments

APPLICATION -----	1988 Estimate -----		1992 Projection -----	
	Units (000)	%	Units (000)	% -----
MAINFRAME/SUPERMINI General purpose	45.3	.3	31.1	.1
MINICOMPUTERS AND MULTI-USER MICROS Business and professional, including networks	331.5	1.8	497.2	1.6
PERSONAL COMPUTERS Business and professional, single user	14,731.4	81.3	23,832.6	76.7
OFFICE SYSTEMS AND WORKSTATIONS Dedicated application	1,268.1	7.0	1,709.0	5.5
NON-OFFICE SYSTEMS AND WORKSTATIONS Technical, distribution, medical, other specialized	346.0	1.9	372.9	1.2
CONSUMER AND HOBBY COMPUTERS	1,300.7	7.2	4,350.2	14.0
OTHER APPLICATIONS	92.4	.5	279.5	.9
Total	18,115.4	100.0	31,072.7	100.0

TABLE 24
FLEXIBLE DISK DRIVES, MICROFLOPPIES
MARKET SHARE SUMMARY
Worldwide Shipments of Non-Captive Disk Drives

Drive Manufacturers	1988 Net Shipments			
	To United States Destinations		Worldwide	
	Units (000)	%	Units (000)	%
Sony	3,571.0	45.9	4,344.0	26.2
Mitsubishi Electric	1,411.0	18.1	1,770.0	10.7
Matsushita Commun. Ind.	22.0	.3	1,378.8	8.3
Alps Electric	1,180.0	15.2	1,360.0	8.2
Matsushita Elec. Comp.	--	--	1,182.0	7.1
Toshiba	380.0	4.9	1,131.0	6.8
Citizen	390.0	5.0	1,120.0	6.8
Seiko Epson	330.0	4.2	1,040.0	6.3
NEC	46.0	.6	792.0	4.8
Teac	155.0	2.0	785.0	4.7
Y-E Data	42.0	.5	590.0	3.6
Other U.S.	--	--	--	--
Other Non-U.S.	257.0	3.3	1,060.0	6.5
	-----	-----	-----	-----
TOTAL	7,784.0	100.0	16,552.8	100.0

FLEXIBLE DISK DRIVES, OVER 5 MEGABYTES

FLEXIBLE DISK DRIVES, CAPACITY OVER 5 MEGABYTES

Coverage

Examples of flexible disk drives included in this group are:

8 inch Bernoulli principle drives

Iomega	Alpha-10H, A120H
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5.25 inch Bernoulli principle drives

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

8 inch flexible disk drives

Hitachi	FDD 441
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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, BR 3225BR 3050
Citizen	IFDD-20
Insite Peripherals	I325, I325VM
Matsushita Communication Ind.	JU-3511
NEC	FD 1331
Toshiba	PD-401

All types of floppy drives with capacities over 5 megabytes have been consolidated into this section. 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 drives of other manufacturers, except for the downward compatibility with lower capacity standard floppy drives claimed by a few manufacturers.

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 and a 44 megabyte version 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, which is also sold by Eastman, by doubling the track density to 666 TPI.

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 and Insite Peripherals, plus several drives by Japanese companies. The Japanese announcements include specific models from Matsushita Communication Industrial, Citizen, Toshiba, and NEC, as well as less specific "technology announcements" from other firms.

Because 3.5 inch microfloppies have become the standard floppy format on major personal computer systems from IBM and Apple, as well as many IBM clones, 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, 1990.

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 visible servo pattern applied to the surface of standard 3.5 inch diskettes to achieve high track density (1,250 TPI), resulting in a capacity of 20.8 megabytes for the firm's initial drive. Insite has demonstrated a new version of the drive promised for production next year which provides downward compatibility with 1 and 2 megabyte 3.5 inch drives.

Matsushita Communication Industrial announced a 16 megabyte 3.5 inch drive in 1988 using diskettes with an iron metallic recording surface. 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>1988</u>	<u>1989</u>	<u>1990</u>	<u>1991</u>	<u>1992</u>
U.S. manufacturers	72.3	65.1	85.1	98.6	116.6
All manufacturers	74.4	69.3	98.6	124.0	169.6

Iomega's shipments of Bernoulli type drives still dominate this product group, and the firm's late start in replacing its original 8 inch drives with smaller models is the reason for the group's indifferent shipment history in recent years. 1989 total shipments for the group are expected to be 118,200 drives, 6.4% lower than the previous year.

Since peaking in 1986, shipments of Iomega's 8 inch Bernoulli drives have been dropping fast, with a further reduction in 1989. Significant growth of Iomega 5.25 inch drives started in 1987, and increased rapidly in 1988. But 1989 shipments of Iomega 5.25 inch drives are forecasted to

increase only slightly, contributing to an overall 1989 decline for the entire group of drives with over 5 megabytes capacity.

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.

Although the company followed a policy of emphasizing sales of the 5.25 inch drive in the OEM market in an attempt to diversify its distribution channels, most current shipments are still sold in the PCM/reseller distribution channel.

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 produced through 1988 were 5.25 inch drives previously introduced by Konica, Eastman Kodak, and Qume (previously Data Technology). Qume held shipment leadership in 1988, with 17,000 5.25 inch drives. Most of the non-Bernoulli drives in the group have capacities of about 10 megabytes (formatted), but the new Qume 20 megabyte model is also now in production.

The non-Bernoulli 5.25 inch drives have average head positioning times in the 60 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 most high capacity flexible disk 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 as a tape drive replacement by end users and system OEMs, both of whom usually respond favorably to faster performance and easier system integration.

Marketing trends

Although availability of drives in production quantities is apparently going to be a year later than previously expected, 3.5 inch high capacity drives will establish a serious challenge to 5.25 inch high capacity floppy drives. Because of the large latent demand believed to exist for improved system backup devices, rapid growth is expected for this product group. Once high capacity 3.5 inch drives are in production from multiple vendors, it is anticipated that the window for 5.25 inch drives will start to close.

With the start of volume production for 3.5 inch drives next year, the 5.25 inch share of shipments for this product group is forecasted to drop to 27.8% in 1990, declining to 3.9% in 1992. 3.5 inch drives are expected to provide 96.1% of 1992 shipments, totaling 785,000 units.

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 lack of a 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 downward compatibility with today's standard microfloppies, in both read and write modes, could be offered. Several firms have announced plans to offer drives with the ability to read 1.0 and 2.0 megabyte diskettes, but Insite Peripherals is so far the only company to demonstrate both read and write downward compatibility, with a drive promised for delivery next year.

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 and 44 megabyte 5.25 inch Bernoulli drives are expected to top out in unit shipments in 1990, 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 servo methods for head positioning, 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. Volume production of 3.5 inch high capacity drives from multiple vendors will start in the first half of 1990.
2. No major system OEM, such as IBM or Apple Computer, will adopt a product in this group for system usage through 1990.
3. Shipments of 5.25 inch Bernoulli drives will peak in 1989.

TABLE 25
FLEXIBLE DISK DRIVES, OVER 5 MEGABYTES
REVENUE SUMMARY

	-----DISK DRIVE REVENUES, BY SHIPMENT DESTINATION (\$M)-----									
	1988		1989		1990		Forecast		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/Reseller	45.6	61.6	43.5	60.1	54.1	72.2	43.6	57.0	33.8	43.7
OEM/Integrator	7.4	10.7	3.8	5.0	10.6	12.9	33.2	41.6	56.7	72.9
TOTAL U.S. NON-CAPTIVE	53.0	72.3	47.3	65.1	64.7	85.1	76.8	98.6	90.5	116.6
TOTAL U.S. REVENUES	53.0	72.3	47.3	65.1	64.7	85.1	76.8	98.6	90.5	116.6
Non-U.S. Manufacturers										

Captive	--	.1	--	2.5	--	7.6	1.4	12.2	2.6	16.2
PCM/Reseller	1.0	1.2	.4	.4	.8	1.1	3.4	4.8	8.0	13.0
OEM/Integrator	--	.8	--	1.3	3.6	4.8	5.5	8.4	14.4	23.8
TOTAL NON-U.S. REVENUES	1.0	2.1	.4	4.2	4.4	13.5	10.3	25.4	25.0	53.0
Worldwide Recap										

TOTAL WORLDWIDE REVENUES	54.0	74.4	47.7	69.3	69.1	98.6	87.1	124.0	115.5	169.6
OEM Average Price (\$000)	.536	.502	.543	.399	.301	.302	.217	.218	.173	.173

TABLE 26
FLEXIBLE DISK DRIVES, OVER 5 MEGABYTES
UNIT SHIPMENT SUMMARY

	-----DISK DRIVE UNIT SHIPMENTS, BY SHIPMENT DESTINATION (000)-----									
	1988		1989		1990		1991		1992	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM Captive	--	--	--	--	--	--	--	--	--	--
Other U.S. Captive	--	--	--	--	--	--	--	--	--	--
TOTAL U.S. CAPTIVE	--	--	--	--	--	--	--	--	--	--
PCM/Reseller	73.3	100.4	69.5	96.4	108.0	139.0	114.0	143.0	123.0	156.0
OEM/Integrator	13.8	19.8	7.0	9.8	33.2	40.0	153.0	191.0	331.0	426.0
TOTAL U.S. NON-CAPTIVE	87.1	120.2	76.5	106.2	141.2	179.0	267.0	334.0	454.0	582.0
TOTAL U.S. SHIPMENTS	87.1	120.2	76.5	106.2	141.2	179.0	267.0	334.0	454.0	582.0
Non-U.S. Manufacturers										
Captive	--	.1	--	5.0	--	16.0	3.0	27.0	6.0	38.0
PCM/Reseller	2.4	3.0	1.0	1.0	3.0	4.0	14.0	20.0	40.0	65.0
OEM/Integrator	--	3.1	--	6.0	14.0	18.6	25.0	38.0	80.0	132.0
TOTAL NON-U.S. SHIPMENTS	2.4	6.2	1.0	12.0	17.0	38.6	42.0	85.0	126.0	235.0
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	89.5	126.4	77.5	118.2	158.2	217.6	309.0	419.0	580.0	817.0
Cumulative Shipments (000,000)										
IBM	--	--	--	--	--	--	--	--	--	--
Non-IBM	.4	.5	.4	.6	.6	.8	.9	1.2	1.5	2.0
WORLDWIDE TOTAL	.4	.5	.4	.6	.6	.8	.9	1.2	1.5	2.0

TABLE 27
FLEXIBLE DISK DRIVES, OVER 5 MEGABYTES
WORLDWIDE REVENUES (\$M)
BREAKDOWN BY DISK DIAMETER

	1988			Forecast											
	3.5"	Revenues 5.25"	8"	3.5"	1989 5.25"	8"	3.5"	1990 5.25"	8"	3.5"	1991 5.25"	8"	3.5"	1992 5.25"	
U.S. MANUFACTURERS															
PCM/Reseller	--	38.2	23.4	1.2	47.8	11.1	14.6	51.0	6.6	20.3	34.7	2.0	23.8	19.9	
OEM/Integrator	--	6.7	4.0	.6	3.4	1.0	8.1	4.0	.8	39.3	2.3	--	72.3	.6	
TOTAL U.S. REVENUES	--	44.9	27.4	1.8	51.2	12.1	22.7	55.0	7.4	59.6	37.0	2.0	96.1	20.5	
NON-U.S. MANUFACTURERS															
Captive	.1	--	--	2.5	--	--	7.6	--	--	12.2	--	--	16.2	--	
PCM/Reseller	--	1.2	--	--	.4	--	1.1	--	--	4.8	--	--	13.0	--	
OEM/Integrator	.4	.1	.3	1.0	.1	.2	4.6	.1	.1	8.4	--	--	23.8	--	
TOTAL NON-U.S. REVENUES	.5	1.3	.3	3.5	.5	.2	13.3	.1	.1	25.4	--	--	53.0	--	
WORLDWIDE RECAP															
Captive	.1	--	--	2.5	--	--	7.6	--	--	12.2	--	--	16.2	--	
	--	--	--	--	--	--	+204.0%	--	--	+60.5%	--	--	+32.8%	--	
PCM/Reseller	--	39.4	23.4	1.2	48.2	11.1	15.7	51.0	6.6	25.1	34.7	2.0	36.8	19.9	
	--	--	--	--	+22.3%	-52.6%	+1,208.3%	+5.8%	-40.5%	+59.9%	-32.0%	-69.7%	+46.6%	-42.7%	
OEM/Integrator	.4	6.8	4.3	1.6	3.5	1.2	12.7	4.1	.9	47.7	2.3	--	96.1	.6	
	--	--	--	+300.0%	-48.5%	-72.1%	+693.7%	+17.1%	-25.0%	+275.6%	-43.9%	-100.0%	+101.5%	-73.9%	
Total Revenues	.5	46.2	27.7	5.3	51.7	12.3	36.0	55.1	7.5	85.0	37.0	2.0	149.1	20.5	
	--	+107.2%	-38.4%	+960.0%	+11.9%	-55.6%	+579.2%	+6.6%	-39.0%	+136.1%	-32.8%	-73.3%	+75.4%	-44.6%	
ANNUAL SHARE, BY DIAMETER															
	.7%	62.1%	37.2%	7.6%	74.6%	17.8%	36.5%	55.9%	7.6%	68.5%	29.8%	1.7%	87.9%	12.1%	

TABLE 28
FLEXIBLE DISK DRIVES, OVER 5 MEGABYTES
WORLDWIDE SHIPMENTS (000)
BREAKDOWN BY DISK DIAMETER

	1988			Forecast										
	3.5"	5.25"	8"	3.5"	5.25"	8"	3.5"	5.25"	8"	3.5"	5.25"	8"	3.5"	5.25"
U.S. MANUFACTURERS														
PCM/Reseller	--	63.8	36.6	4.0	75.4	17.0	54.0	75.0	10.0	88.0	52.0	3.0	125.0	31.0
OEM/Integrator	--	13.5	6.3	2.0	6.4	1.4	32.0	7.0	1.0	187.0	4.0	--	425.0	1.0
TOTAL U.S. SHIPMENTS	--	77.3	42.9	6.0	81.8	18.4	86.0	82.0	11.0	275.0	56.0	3.0	550.0	32.0
NON-U.S. MANUFACTURERS														
Captive	.1	--	--	5.0	--	--	16.0	--	--	27.0	--	--	38.0	--
PCM/Reseller	--	3.0	--	--	1.0	--	4.0	--	--	20.0	--	--	65.0	--
OEM/Integrator	2.0	.4	.7	5.0	.4	.6	18.0	.3	.3	38.0	--	--	132.0	--
TOTAL NON-U.S. SHIPMENTS	2.1	3.4	.7	10.0	1.4	.6	38.0	.3	.3	85.0	--	--	235.0	--
WORLDWIDE RECAP														
Captive	.1	--	--	5.0	--	--	16.0	--	--	27.0	--	--	38.0	--
	--	--	--	--	--	--	+220.0%	--	--	+68.8%	--	--	+40.7%	--
PCM/Reseller	--	66.8	36.6	4.0	76.4	17.0	58.0	75.0	10.0	108.0	52.0	3.0	190.0	31.0
	--	--	--	--	+14.4%	-53.6%	+1,350.0%	-1.8%	-41.2%	+86.2%	-30.7%	-70.0%	+75.9%	-40.4%
OEM/Integrator	2.0	13.9	7.0	7.0	6.8	2.0	50.0	7.3	1.3	225.0	4.0	--	557.0	1.0
	--	--	--	+250.0%	-51.1%	-71.4%	+614.3%	+7.4%	-35.0%	+350.0%	-45.2%	-100.0%	+147.6%	-75.0%
Total Shipments	2.1	80.7	43.6	16.0	83.2	19.0	124.0	82.3	11.3	360.0	56.0	3.0	785.0	32.0
	--	+76.6%	-33.4%	+661.9%	+3.1%	-56.4%	+675.0%	-1.1%	-40.5%	+190.3%	-32.0%	-73.5%	+118.1%	-42.9%
ANNUAL SHARE, BY DIAMETER	1.7%	63.8%	34.5%	13.5%	70.4%	16.1%	57.0%	37.8%	5.2%	85.9%	13.4%	.7%	96.1%	3.9%

TABLE 29
FLEXIBLE DISK DRIVES, OVER 5 MEGABYTES
APPLICATIONS SUMMARY
Percentage of Worldwide Shipments

APPLICATION -----	1988 Estimate		1992 Projection	
	Units (000) -----	% -----	Units (000) -----	% -----
MAINFRAME/SUPERMINI General purpose	--	--	--	--
MINICOMPUTERS AND MULTI-USER MICROS Business and professional, including networks	10.1	8.0	73.5	9.0
PERSONAL COMPUTERS Business and professional, single user	102.8	81.3	637.3	78.0
OFFICE SYSTEMS AND WORKSTATIONS Dedicated application	1.1	.9	40.9	5.0
NON-OFFICE SYSTEMS AND WORKSTATIONS Technical, distribution, medical, other specialized	12.4	9.8	65.3	8.0
CONSUMER AND HOBBY COMPUTERS	--	--	--	--
OTHER APPLICATIONS	--	--	--	--
Total	----- 126.4	----- 100.0	----- 817.1	----- 100.0

TABLE 30
 FLEXIBLE DISK DRIVES, OVER 5 MEGABYTES
 MARKET SHARE SUMMARY
 Worldwide Shipments of Non-Captive Disk Drives

Drive Manufacturers	1988 Net Shipments			
	To United States Destinations		Worldwide	
	Units (000)	%	Units (000)	%
Iomega	77.2	86.3	101.3	80.2
Qume	9.5	10.6	17.0	13.5
Other U.S.	.4	.4	1.9	1.5
Other Non-U.S.	2.4	2.7	6.1	4.8
	-----	-----	-----	-----
TOTAL	89.5	100.0	126.3	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.

Specifications of 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.

1989 DISK/TREND product groups for flexible disk drives

<u>Group number</u>	<u>Drives included</u>
13.	Flexible disk drives, 8 inch
14.	Flexible disk drives, 5.25 inch
15.	Flexible disk drives, microfloppies
16.	Flexible disk drives, over 5 megabytes

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

ALPS ELECTRIC	ALPS ELECTRIC	ALPS ELECTRIC	ALPS ELECTRIC	ALPS ELECTRIC
DFC 422A	DFC 642A	DFC 682A	DFE 222A	DFL 413
14	14	14	14	15
OEM	OEM	OEM	OEM	OEM
5.25" -- 2/80	5.25" - 2/80 HD	5.25" - 2/80 HD	5.25" -- 2/40	3.5" -- 2/80
5.25"	5.25"	5.25"	5.25"	3.5"
Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	Oxide Coated	Oxide Coated
U: 1.0	U: 1.6	U: 1.0/1.6	U: .5	U: 1.0
U: 6,250	U: 10,416	U: 6,250/10,416	U: 6,250	U: 6,250
2	2	2	2	2
80	77	80/77	40	80
96	96	96	48	135
5922	9646	5922/9646	5876	8717
300	360	300/360	300	300
Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor
3	3	3	4/6	6
15	15	15	15	15
Continuous Contact 100	Continuous Contact 83.3	Continuous Contact 100/83.3	Continuous Contact 100	Continuous Contact 100
31.25	62.5	31.25/62.5	31.25	31.25
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 5.5
1984	8/85	8/85	1987	4/85
--	--	--	--	--

MANUFACTURER	ALPS ELECTRIC	ALPS ELECTRIC	ALPS ELECTRIC	ALPS ELECTRIC	ASIA COMMERCIAL
DRIVE	DFL 713	DFP 423A DFP 423D DFP 423E DFP 423F	DFP 683A DFP 683D DFP 683E DFP 683F	DFP 723A DFP 723D DFP 723E DFP 723F	FD-103
DISK/TREND GROUP	15	15	15	15	14
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	3.5" -- 2/80 HD	3.5" -- 2/80	3.5" -- 2/80 HD	3.5" -- 2/80 HD	5.25" -- 1/40
Nominal disk diameter	3.5"	3.5"	3.5"	3.5"	5.25"
Recording medium	High Density Oxide Coated	Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: 2.0	U: 1.0	U: 1.0/1.6	U: 1.0/2.0	U: .125/.250
Capacity per track (Bytes)	U: 12,500	U: 6,250	U: 6,250/10,416	U: 6,250/12,500	U: 3,125/6,250
Data surfaces per spindle	2	2	2	2	1
Tracks per surface	80	80	80/77	80	40
Track density (TPI)	135	135	135	135	48
Maximum linear density (BPI)	17434	8717	8717/14528	8717/17434	2768/5536
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	Band, Stepping Motor
POSITIONING:Track to track(msec)	6	3	3	3	6
Settling time (msec)	15	15	15	15	20
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	100	100	100/83.3	100	100
Data transfer rate (KBytes/sec)	62.5	31.25	31.25/62.5	31.25/62.5	15.63/31.25
SIZE (Inches: H x W x D)	1.625 x 4.0 x 5.5	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
FIRST CUSTOMER SHIPMENT	1986	1987	1987	1987	2Q85
U.S. OEM PRICE FOR 500 UNITS	--	--	--	--	--
COMMENTS					For Apple IIC and Apple IIE

MANUFACTURER	ASIA COMMERCIAL	ASIA COMMERCIAL	BRIER TECHNOLOGY	BRIER TECHNOLOGY	BRIER TECHNOLOGY
DRIVE	FD-104 FD-109	FD-106	BR 3020	BR 3050	BR 3225
DISK/TREND GROUP	14	14	16	16	16
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	5.25" -- 2/40	5.25" -- 2/80	3.5" - 2/516 HD	3.5"- 2/1021 HD	3.5" - 2/516 HD
Nominal disk diameter	5.25"	5.25"	3.5"	3.5"	3.5"
Recording medium	Oxide Coated	Oxide Coated	Barium Ferrite	Barium Ferrite	Barium Ferrite
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: .250/.5	U: .8/1.6	F: 21.4	F: 43.2	F: 21.4
Capacity per track (Bytes)	U: 3,125/6,250	U: 5,208/10,416	**	**	**
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	40	80	516	1021	516
Track density (TPI)	48	96	777	1555	777
Maximum linear density (BPI)	2938/5876	4823/9646	26000*	26000*	26000*
Rotational speed (RPM)	300	360	720	720	720
PERFORMANCE					
Actuator type	Band, Stepping Motor	Band, Stepping Motor	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil
POSITIONING:Track to track(msec)	6	3	15	10	15
Settling time (msec)	15	18	--	--	--
Head load time(msec)	Continuous Contact 100	Continuous Contact 83.3	Continuous Contact 41.6	Continuous Contact 41.6	Continuous Contact 41.6
Average rotational delay (msec)	15.63/31.25	31.25/62.5	1250	1250	1250
Data transfer rate (KBytes/sec)	15.63/31.25	31.25/62.5	1250	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 4.0 x 5.75	1.625 x 4.0 x 5.75	1.625 x 4.0 x 5.75
FIRST CUSTOMER SHIPMENT	1Q86	3Q87	1Q90	4Q90	3Q90
U.S. OEM PRICE FOR 500 UNITS	--	--	\$300 (10,000)	--	\$350 (10,000)
COMMENTS	For IBM PC XT FD-109 is externally mounted	For IBM AT	Dual level embedded servo 35 msec average head positioning *RLL Code **Varies by zone	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 IBM diskettes.

1989 DISK/TREND REPORT

MANUFACTURER	BROTHER	BROTHER	BROTHER	CANON	CANON
DRIVE	FB 015 FB 400	FB 100	FB 300	MD 5201	MD 5501
DISK/TREND GROUP	15	15	15	14	14
MARKET	Captive, OEM	Captive, OEM	Captive, OEM	OEM	OEM
MEDIA: Generic type	3.5" -- 1/80	3.5" -- 1/40	3.5" -- 1/40	5.25" -- 2/80	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	Oxide Coated	Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: .320	F: .1024	U: .250	U: .250/.5	U: 1.0/1.6
Capacity per track (Bytes)	U: 4,102	F: 2,560	U: 6,250	U: 3,125/6,250	U: 6,250/10,416
Data surfaces per spindle	1	1	1	2	2
Tracks per surface	78	40	40	40	80/77
Track density (TPI)	135	67.5	67.5	48	96
Maximum linear density (BPI)	5180	4064	8128	2938/5876	5922/9646
Rotational speed (RPM)	300	300	300	300	360
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Band, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING:Track to track(msec)	20	60	24	6	3
Settling time (msec)	10	20	24	15	15
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	100
Data transfer rate (KBytes/sec)	19.50	15.63	31.25	15.63/31.25	31.25/62.5
SIZE (Inches: H x W x D)	1.0 x 4.06 x 6.69	2.16 x 5.1 x 6.5	2.51 5.19 x 8.03	1.06 x 5.75 x 7.8	1.06 x 5.75 x 7.8
FIRST CUSTOMER SHIPMENT	10/87	1984	1985	7/86	7/86
U.S. OEM PRICE FOR 500 UNITS	\$80	--	--	--	--
COMMENTS	FB 400 is kit for typewriter GCR encoded				

MANUFACTURER	CANON	CANON	CANON	CHINON	CHINON
DRIVE					
	MD 3411	MD 3511	MD 3611	FZ-501A	FZ-502
DISK/TREND GROUP	15	15	15	14	14
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	3.5" -- 2/80	3.5" -- 2/80	3.5" -- 2/80	5.25" -- 1/40	5.25" -- 2/40
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/.5
Capacity per track (Bytes)	U: 6,250	U: 6,250/10,420	U: 6,250/12,500	U: 3,125/6,250	U: 3,125/6,250
Data surfaces per spindle	2	2	2	1	2
Tracks per surface	80	80	80	40	40
Track density (TPI)	135	135	135	48	48
Maximum linear density (BPI)	8717	8717/17434	8717/17434	2768/5536	2938/5876
Rotational speed (RPM)	300	300/360	300	300	300
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor
POSITIONING:Track to track(msec)	3	3	3	6	5
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)	250	250/500	250/500	15.63/31.25	15.63/31.25
SIZE (Inches: H x W x D)	1.0 x 4.0 x 5.89	1.0 x 4.0 x 5.89	1.0 x 4.0 x 5.89	1.625 x 5.75 x 8.1	1.625 x 5.75 x 8.0
FIRST CUSTOMER SHIPMENT	4Q88	4/88	4/88	8/83	3/87
U.S. OEM PRICE FOR 500 UNITS	--	--	--	--	--
COMMENTS					

1989 DISK/TREND REPORT

MANUFACTURER	CHINON	CHINON	CHINON	CHINON	CHINON
DRIVE	FZ-506	F-354E F-354EI FB-354 FB-354I	F-354L FX-354	F-354MC F-354MCU	F-356 FB-356
DISK/TREND GROUP	14	15	15	15	15
MARKET	OEM	OEM	OEM	OEM, PCM	OEM
MEDIA: Generic type	5.25" - 2/80 HD	3.5" -- 2/80	3.5" -- 2/80	3.5" -- 2/80	3.5" -- 2/80 HD
Nominal disk diameter	5.25"	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: 1.0/1.6	U: .5/1.0	U: 1.0	U: .8	U: 1.0/1.6
Capacity per track (Bytes)	U: 6,250/10,416	U: 3,125/6,250	U: 6,250	Varies	U: 5,208/10,416
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80/77	80	80	80	77
Track density (TPI)	96	135	135	135	135
Maximum linear density (BPI)	5922/9870	4359/8717	8717	8850	8717/14184
Rotational speed (RPM)	300/360	300	300	390-605	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	3	3	12	3
Settling time (msec)	15	15	15	30	15
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	100/83.3	100	100	76.9/49.6	83.3
Data transfer rate (KBytes/sec)	37.5/62.5	15.63/31.25	31.25	61.2	31.25/62.5
SIZE (Inches: H x W x D)	1.625 x 5.75 x 8.0	1.26 x 4.0 x 6.1	1.0 x 4.0 x 5.75	1.7 x 4.1 x 7.0	1.26 x 4.0 x 6.1
FIRST CUSTOMER SHIPMENT	4/87	11/84	7/86	1985	7/85
U.S. OEM PRICE FOR 500 UNITS	--	--	--	--	--
COMMENTS		F-354E1 in 5.25" frame		Subsystem for Apple MacIntosh	

MANUFACTURER	CHINON	CHINON	CHINON	CHINON	CITIZEN
DRIVE					
	F-356L	FB-357 FB-357I	F-357L FX-357	FX-358	OSDA
DISK/TREND GROUP	15	15	15	15	15
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 BF	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	Barium Ferrite	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: 1.0/1.6	U: 2.0	U: 1.0/2.0	U: 1.0/2.0/4.0	U: 1.0/2.0
Capacity per track (Bytes)	U: 6,250/10,416	U: 12,500	U: 6,250/12,500	U: 6,250/25,000	U: 6,250/12,500
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80/77	80	80	80	80
Track density (TPI)	135	135	135	135	135
Maximum linear density (BPI)	8717/14184	17434	8717/17434	8717/34868	8717/17434
Rotational speed (RPM)	300/360	300	300	300	300
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	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	300	100	100
Data transfer rate (KBytes/sec)	31.25/62.5	62.5	31.25/62.5	31.25/62.5/125	31.25/62.5
SIZE (Inches: H x W x D)	1.0 x 4.0 x 5.75	1.26 x 4.0 x 6.1	1.0 x 4.0 x 5.75	1.0 x 4.0 x 5.75	1.0 x 4.0 x 5.9
FIRST CUSTOMER SHIPMENT	3Q87	7/86	3Q87	1Q90	4Q87
U.S. OEM PRICE FOR 500 UNITS	--	--	--	--	--
COMMENTS		FB-357I in 5.25" frame			Front loading

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

CITIZEN	CITIZEN	CITIZEN	CITIZEN	CITIZEN
OSDB	OSDC	OSDD	OTDA	OTDB
15	15	15	15	15
OEM	OEM	OEM	OEM	OEM
3.5" -- 2/80 HD	3.5" -- 2/80	3.5" -- 2/80	3.5" -- 2/80 HD	3.5" -- 2/80 HD
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: 1.0/1.6	U: 1.0	U: 1.0	U: 1.0/2.0	U: 1.0/1.6
U: 6,250/10,416	U: 6,250	U: 6,250	U: 6,250/12,500	U: 6,250/10,416
2	2	2	2	2
80/77	80	80	80	80/77
135	135	135	135	135
8717/14184	8717	8717	8717/17434	8717/14184
300/360	300	300	300	300/360
Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor
3	3	6	3	3
15	15	15	15	15
Continuous Contact 100/83.3	Continuous Contact 100	Continuous Contact 100	Continuous Contact 100	Continuous Contact 100/83.3
31.25/62.5	31.25	31.25	31.25/62.5	31.25/62.5
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 4.1 x 5.16	1.0 x 4.1 x 5.16
4Q87	4Q87	4Q87	4Q87	4Q87
--	--	--	--	--
Front loading	Front loading	Front loading	Top loading	Top loading

MANUFACTURER	CITIZEN	CITIZEN	CITIZEN	CITIZEN	CITIZEN
DRIVE					
	OTDC	OTDD	UODA U1DA	UODC U1DC	UODD U1DD
DISK/TREND GROUP	15	15	15	15	15
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	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	U: 1.0/2.0	U: 1.0	U: 1.0
Capacity per track (Bytes)	U: 6,250	U: 6,250	U: 6,250/12,500	U: 6,250	U: 6,250
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	8717	8717
Rotational speed (RPM)	300	300	300	300	300
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Rack & Pinion, Stepping Motor	Rack & Pinion, Stepping Motor	Rack & Pinion, Stepping Motor
POSITIONING:Track to track(msec)	3	6	3	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	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	.75 x 4.0 x 5.1	.75 x 4.0 x 5.1	.75 x 4.0 x 5.1
FIRST CUSTOMER SHIPMENT	4Q87	4Q87	3Q89	2Q89	2Q89
U.S. OEM PRICE FOR 500 UNITS	--	--	--	--	--
COMMENTS	Top loading	Top loading			

1989 DISK/TREND REPORT

MANUFACTURER	CITIZEN	COPAL	COPAL	COPAL	COPAL
DRIVE					
	IFDD-20	F-5002	F-5014	F-505-6	F-5018
DISK/TREND GROUP	16	14	14	14	14
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	3.5" -- Special	5.25" -- 2/40	5.25" -- 2/80	5.25" - 2/80 HD	5.25" - 2/80 HD
Nominal disk diameter	3.5"	5.25"	5.25"	5.25"	5.25"
Recording medium	Metal Powder	Oxide Coated	Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					U: 1.0 or U: 1.6
Total capacity (Mbytes)	F: 20.6	U: .5	U: 1.0	U: 1.6	U: 1.6
Capacity per track (Bytes)	F: 32,000	U: 6,250	U: 6,250	U: 10,416	U: 10,416
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	320	40	80	77	80/77
Track density (TPI)	540	48	96	96	96
Maximum linear density (BPI)	64500 BPI* 43000 FCI	5876	5922	9646	9646
Rotational speed (RPM)	600	300	300	360	300/360
PERFORMANCE					
Actuator type	Linear, Voice Coil	Band, Stepping Motor	Band, Stepping Motor	Lead Screw, Stepping Motor	Band, Stepping Motor
POSITIONING:Track to track(msec)	3	6	3	3	3
Settling time (msec)	--	15	15	15	15
Head load time(msec)	Continuous Contact 50	Continuous Contact 100	Continuous Contact 100	Continuous Contact 83.3	Continuous Contact 100/83.3
Average rotational delay (msec)	50	100	100	83.3	100/83.3
Data transfer rate (KBytes/sec)	437.5	31.25	31.25	62.5	31.25/62.5
SIZE (Inches: H x W x D)	1.0 x 4.0 x 6.2	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	3Q90	9/85	12/86	9/88	12/86
U.S. OEM PRICE FOR 500 UNITS	--	--	--	--	--
COMMENTS	*2,7 RLL Code MIG Head 50 msec average head position. SCSI interface. Read compatible with 1 & 2 MB				

MANUFACTURER	COPAL	COPAL	COPAL	COPAL	COPAL
DRIVE					
	F-3534	F-3536	F-3537	F-3538	F-3539
DISK/TREND GROUP	15	15	15	15	15
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: 1.6	U: 2.0	U: 1.0/1.6	U: 1.0/2.0
Capacity per track (Bytes)	U: 6,250	U: 10,416	U: 12,500	U: 6,250/10,416	U: 6,250/12,500
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80	77	80	80/77	80
Track density (TPI)	135	135	135	135	135
Maximum linear density (BPI)	8717	14528	17434	8717/14528	8717/17434
Rotational speed (RPM)	300	360	300	300/360	300
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING:Track to track(msec)	6/3	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	100/83.3	100
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)	1.0 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	6/87	6/87	6/87	6/87	9/87
U.S. OEM PRICE FOR 500 UNITS	--	--	--	--	--
COMMENTS					

1989 DISK/TREND REPORT

MANUFACTURER	DIGITAL EQUIPMENT CORPORATION	DZU	DZU	DZU	DZU
DRIVE					
	RX50	ES 5082	ES 5083	EC 5323.01	EC 5326
DISK/TREND GROUP	14	13	13	14	14
MARKET	Captive	Captive, OEM	Captive, OEM	OEM	OEM
MEDIA: Generic type	5.25" -- 1/80	8" -- 1/77	8" -- 2/77	5.25" -- 2/40	5.25" -- 2/80
Nominal disk diameter	5.25"	8"	8"	5.25"	5.25"
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY	Per Diskette: F: .409 Per Drive: F: .818				
Total capacity (Mbytes)		U: .4/.8	U: .8/1.6	U: .250/.5	U: .5/1.0
Capacity per track (Bytes)	F: 5,120	U: 5,208/10,416	U: 5,208/10,416	U: 3,125/6,250	U: 3,125/6,250
Data surfaces per spindle	1 per diskette 2 per drive	1	2	2	2
Tracks per surface	80	77	77	40	80
Track density (TPI)	96	48	48	48	96
Maximum linear density (BPI)	5536	3268/6536	3408/6816	2938/5876	2961/5922
Rotational speed (RPM)	300	360	360	300	300
PERFORMANCE					
Actuator type	Cam, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor
POSITIONING:Track to track(msec)	6	10	10	6	3
Settling time (msec)		25	20	15	15
Head load time(msec)		40	35	Continuous Contact 100	Continuous Contact 100
Average rotational delay (msec)	100	83.3	83.3		
Data transfer rate (KBytes/sec)	31.25	31.25/62.5	31.25/62.5	15.63/31.25	15.63/31.25
SIZE (Inches: H x W x D)	3.25 x 5.75 x 8.5	5.2 x 10.3 x 16.1	5.2 x 10.3 x 16.1	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0
FIRST CUSTOMER SHIPMENT	4Q82	1983	1983	1988	1988
U.S. OEM PRICE FOR 500 UNITS	--	--	--	--	--
COMMENTS	Dual drive with single head positioning system				

MANUFACTURER	DZU	DZU	DZU	DZU	DZU
DRIVE					
	EC 5327.01	ES 5088M	ES 5321	ES 5323	ES 5326
DISK/TREND GROUP	14	14	14	14	14
MARKET	OEM	Captive, OEM	Captive, OEM	Captive, OEM	Captive, OEM
MEDIA: Generic type	5.25" - 2/80 HD	5.25" -- 1/40	5.25" -- 2/40	5.25" -- 2/80	5.25" -- 2/40
Nominal disk diameter	5.25"	5.25"	5.25"	5.25"	5.25"
Recording medium	High Density Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: 1.6	U: .125/.250	U: .250/.5	U: .5/1.0	U: .250/.5
Capacity per track (Bytes)	U: 10,416	U: 3,125/6,250	U: 3,125/6,250	U: 3,125/6,250	U: 3,125/6,250
Data surfaces per spindle	2	1	2	2	2
Tracks per surface	77	40	40	80	40
Track density (TPI)	96	48	48	96	48
Maximum linear density (BPI)	9646	2768/5536	2938/5876	2961/5922	2938/5876
Rotational speed (RPM)	360	300	300	300	300
PERFORMANCE					
Actuator type	Band, Stepping Motor	Cam, Stepping Motor	Cam, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor
POSITIONING:Track to track(msec)	3	40	25	6	6
Settling time (msec)	15	10	15	15	15
Head load time(msec)	Continuous Contact 83.3	50 100	Continuous Contact 100	Continuous Contact 100	Continuous Contact 100
Average rotational delay (msec)	31.25	15.63/31.25	15.63/31.25	15.63/31.25	15.63/31.25
Data transfer rate (KBytes/sec)					
SIZE (Inches: H x W x D)	1.625 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	1.625 x 5.75 x 8.0
FIRST CUSTOMER SHIPMENT	1988	1982	1984	1985	1988
U.S. OEM PRICE FOR 500 UNITS	--	--	--	--	--
COMMENTS		Apple II compatible			

1989 DISK/TREND REPORT

MANUFACTURER	DZU	DZU	EASTERN PERIPHERALS	EASTERN PERIPHERALS	EASTMAN KODAK
DRIVE					
	ISOT 5050E	ISA 235HF	TM 65-2	TM 75-8	KODAK 3.3
DISK/TREND GROUP	14	15	14	14	14
MARKET	Captive, OEM	Captive, OEM	OEM	OEM	Captive, OEM
MEDIA: Generic type	5.25" -- 1/40	3.5" -- 2/80	5.25" -- 2/40	5.25" - 2/40 HD	5.25" - Special
Nominal disk diameter	5.25"	3.5"	5.25"	5.25"	5.25"
Recording medium	Oxide Coated	High Density Oxide Coated	Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: .250	U: 1.0	U: .5	U: .5/1.6	U: 3.33
Capacity per track (Bytes)	U: 6,250	U: 6,250	U: 6,250	U: 6,250/10,416	U: 10,416
Data surfaces per spindle	1	2	2	2	2
Tracks per surface	40	80	40	80	160
Track density (TPI)	48	135	48	96	192
Maximum linear density (BPI)	5536	8717	5877	4823/9646	9908
Rotational speed (RPM)	300	300	300	360	360
PERFORMANCE					
Actuator type	Cam, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Lead Screw/Dual Stepping Motors
POSITIONING:Track to track(msec)	40	3	6	3/6	3
Settling time (msec)	10	20	15	15	15
Head load time(msec)	50	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	100	100	100	83.3	83.3
Data transfer rate (KBytes/sec)	31.25	31.25	31.25	31.25	62.5
SIZE (Inches: H x W x D)	3.25 x 5.75 x 8.0	1.625 x 4.0 x 5.75	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.5
FIRST CUSTOMER SHIPMENT	1984	1989	1982	1985	1984
U.S. OEM PRICE FOR 500 UNITS	--	--	--	--	--
COMMENTS					Embedded Servo

1989 DISK/TREND REPORT

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	16	16	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	

MANUFACTURER	ERGO	FLEXDISC	FLEXDISC	FLEXDISC	FUJITSU
DRIVE					
	DS-7	FF 450	FF 650	FF 950	M2551A
DISK/TREND GROUP	14	14	14	14	14
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	12/88	--	--	--	1/86
U.S. OEM PRICE FOR 500 UNITS	\$54	--	--	--	\$70
COMMENTS					

MANUFACTURER	FUJITSU	FUJITSU	FUJITSU	FUJITSU	FUJITSU
DRIVE					
	M2552K	M2553K	M2554K	M2532K M2532M	M2537K M2537M
DISK/TREND GROUP	14	14	14	15	15
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: 2.0
Capacity per track (Bytes)	U: 3,125/6,250	U: 5,208/10,416	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)	2961/5922	4823/9646	5922/9646	8717	17434
Rotational speed (RPM)	300	360	300/360	300	300
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	100
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	\$85
COMMENTS					

1989 DISK/TREND REPORT

MANUFACTURER	GENISCO MEMORY PRODUCTS	GOLDSTAR TELE- COMMUNICATION	GOLDSTAR TELE- COMMUNICATION	GOLDSTAR TELE- COMMUNICATION	HITACHI
DRIVE	EDR-350	GSF 548	GSF 596	GSF 313	FDD 412 FDD 413B
DISK/TREND GROUP	15	14	14	15	13
MARKET	OEM	Captive, OEM	Captive, OEM	OEM	Captive, OEM
MEDIA: Generic type	3.5" -- 2/80	5.25" -- 2/40	5.25" -- 2/80	3.5" -- 2/80 HD	8" -- 2/77
Nominal disk diameter	3.5"	5.25"	5.25"	3.5"	8"
Recording medium	High Density Oxide Coated	Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: 1.0	U: .5	U: 1.6	U: 1.0/2.0	U: .8/1.6
Capacity per track (Bytes)	U: 6,250	U: 6,250	U: 10,416	U: 6,250/12,500	U: 5,208/10,416
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80	40	77	80	77
Track density (TPI)	135	48	96	135	48
Maximum linear density (BPI)	8717	5870	9600	8717/17434	3408/6816
Rotational speed (RPM)	300	300	360	300	360
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Band, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Band, Stepping Motor
POSITIONING:Track to track(msec)	6	6	3	3	3
Settling time (msec)	15	15	15	15	35
Head load time(msec)	Continuous Contact 100	Continuous Contact 100	Continuous Contact 83.3	Continuous Contact 100	50
Average rotational delay (msec)	100	100	83.3	100	83.3
Data transfer rate (KBytes/sec)	31.25	31.25	62.5	31.25/62.5	31.25/62.5
SIZE (Inches: H x W x D)	3.75 x 5.75 x 7.37	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0	1.0 x 4.0 x 6.06	2.24 x 8.54 x 13.0
FIRST CUSTOMER SHIPMENT	1987	1983	1989	1989	2/82
U.S. OEM PRICE FOR 500 UNITS	--	--	--	--	--
COMMENTS	Sold as militarized subsystem				

MANUFACTURER	HITACHI	HITACHI	HO SHIN	HO SHIN	HO SHIN
DRIVE					
	FDD 441	FDD 541	HS-550	HS-551	HS-552
DISK/TREND GROUP	16	16	14	14	14
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	Maxell FD2-HD	Maxell MD2-EH	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	High Density Oxide Coated	High Density Oxide Coated	Oxide Coated	Oxide Coated	Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: 9.6	U: 6.5	U: .250	U: .5	U: 1.0
Capacity per track (Bytes)	U: 31,250	U: 31,250	U: 6,250	U: 6,250	U: 6,250
Data surfaces per spindle	2	2	1	2	2
Tracks per surface	154	104	40	40	80
Track density (TPI)	96	125	48	48	96
Maximum linear density (BPI)	20560*	29560	5536	5876	5922
Rotational speed (RPM)	360	720	300	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)	2	2	6	6	3
Settling time (msec)	15	37	15	15	15
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	83.3	41.7	100	100	100
Data transfer rate (KBytes/sec)	187.5	375	31.25	31.25	31.25
SIZE (Inches: H x W x D)	2.24 x 8.54 x 12.9	1.625 x 5.75 x 8.6	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	2/84	1Q85	12/87	3/88	3Q88
U.S. OEM PRICE FOR 500 UNITS	--	--	\$48	\$51	\$55
COMMENTS	*2,7 RLL Code		For use with Apple II	For use with IBM PC XT	For use with IBM PC XT

MANUFACTURER	HO SHIN	HYUNDAI ELECTRONICS	HYUNDAI ELECTRONICS	HYUNDAI ELECTRONICS	HYUNDAI ELECTRONICS
DRIVE					
	HS-553	HMF-311	HMF-321	HMF-331	HMF-341
DISK/TREND GROUP	14	15	15	15	15
MARKET	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 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: 1.6	U: 1.0/1.6	U: 1.0/2.0
Capacity per track (Bytes)	U: 10,416	U: 6,250	U: 10,416	U: 6,250/10,416	U: 6,250/12,500
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	77	80	77	80/77	80
Track density (TPI)	96	135	135	135	135
Maximum linear density (BPI)	9646	8717	14528	8717/14528	8717/17434
Rotational speed (RPM)	360	300	360	300/360	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	20	20	20	20
Head load time(msec)	Continuous Contact 100	Continuous Contact 100	Continuous Contact 83.3	Continuous Contact 100/83.3	Continuous Contact 100
Average rotational delay (msec)	100	100	83.3	100/83.3	100
Data transfer rate (KBytes/sec)	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	1.0 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	3Q88	10/88	10/88	10/88	10/88
U.S. OEM PRICE FOR 500 UNITS	\$59	--	--	--	--
COMMENTS	For use with IBM PC AT				

MANUFACTURER	IBM	IBM	IBM	IBM	IBM
DRIVE					
	3684	3694	4701-1	4701-2	4956 4965
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: .985088	F: .568320	F: .568320	F: .985088	F: .985088 or F: 1.136640 or F: 1.212416
Capacity per track (Bytes)	F: 6,656	F: 3,840	F: 3,840	F: 6,656	F: 6,656/7,680/ 8,192
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	3408	6816	3408/6816
Rotational speed (RPM)	360	360	360	360	360
PERFORMANCE					
Actuator type	Lead Screw, 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	83.3	83.3	83.3	83.3
Data transfer rate (KBytes/sec)	62.5	31.25	31.25	62.5	31.25/62.5
SIZE (Inches: H x W x D)	--	--	--	--	--
FIRST CUSTOMER SHIPMENT	--	--	1982	1982	8/81
U.S. OEM PRICE FOR 500 UNITS	--	--	--	--	--
COMMENTS	Point of sale terminal	3600 finance communication controller	4701 finance communication controller	4701 finance communication controller	Similar drive included with 4952 and 4954 models C and XXD Series/1

MANUFACTURER	IBM	IBM	IBM	IBM	IBM
DRIVE	4964	5231	5360-BXX 5360-DXX 5362-XXX	5360-X2X 5381-XXX 5832-XXX (Magazine Drive)	5525-02X 5525-03X 5525-04X
DISK/TREND GROUP	13	13	13	13	13
MARKET	Captive	Captive	Captive	Captive	Captive
MEDIA: Generic type	8" -- 2/77	8" -- 1/77	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	F: .492544 or F: .568320 or F: .606208	F: .242944	F: 1.212416	F: .985088 or F: 1.212416	F: 1.212416
Total capacity (Mbytes)	F: 3,328/3,840/ 4,096	F: 3,328	F: 8,192	F: 6,656/8,192	F: 8,192
Capacity per track (Bytes)	2	1	2	2	2
Data surfaces per spindle	74/3	74/3	74/3	74/3	74/3
Tracks per surface	48	48	48	48	48
Track density (TPI)	3408	3268	6816	3408/6816	6816
Maximum linear density (BPI)	360	360	360	360	360
Rotational speed (RPM)	Band, Stepping Motor	Lead Screw, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor
PERFORMANCE	5	50	5	5	5
Actuator type	35	20	35	35	35
POSITIONING:Track to track(msec)		80	--		
Settling time (msec)	83.3	83.3	83.3	41.7	83.3
Head load time(msec)	31.25	31.25	62.5	31.25/62.5	62.5
Average rotational delay (msec)	--	--	--	--	--
Data transfer rate (KBytes/sec)	11/76	--	--	1/79 (S/34)	2/80
SIZE (Inches: H x W x D)	--	--	--	--	--
FIRST CUSTOMER SHIPMENT	--	--	--	--	--
U.S. OEM PRICE FOR 500 UNITS	Similar drive included with some 4962 models Series/1	5230 data collection system	System/36	Capacity is 2 10-diskette magazines and 3 diskettes System/36 & /38	5520 administrative system
COMMENTS					

MANUFACTURER	IBM	IBM	IBM	INSITE PERIPHERALS	INSITE PERIPHERALS
DRIVE	5525-05X (Magazine Drive)	8101-A20 8101-A23/25	8130 Series 8150 Series	I325	I325VM
DISK/TREND GROUP	13	13	13	16	16
MARKET	Captive	Captive	Captive	OEM	OEM
MEDIA: Generic type	8" -- 2/77	8" -- 2/77	8" -- 2/77	3.5" -- Special	3.5" -- Special
Nominal disk diameter	8"	8"	8"	3.5"	3.5"
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Barium Ferrite	Barium Ferrite
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: 1.212416	F: .492544 or F: .985088	F: .492544 or F: .985088	F: 20.8	F: 20.8
Capacity per track (Bytes)	F: 8,192	F: 3,328/6,656	F: 3,328/6,656	F: 13,824	F: 13,824
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	74/3	74/3	74/3	755	755
Track density (TPI)	48	48	48	1250	1250
Maximum linear density (BPI)	6816	3408/6816	3408/6816	23980 BPI* 17985 FCI	23980 BPI* 17985 FCI
Rotational speed (RPM)	720	360	360	720	720
PERFORMANCE					
Actuator type	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Crs:Step. Motor Fine:Voice Coil	Crs:Step. Motor Fine:Voice Coil
POSITIONING:Track to track(msec)	5	5	5	1	1
Settling time (msec)	35	35	35	15	15
Head load time(msec)				Continuous Contact 41.6	Continuous Contact 41.6
Average rotational delay (msec)	41.7	83.3	83.3		
Data transfer rate (KBytes/sec)	125	31.25/62.5	31.25/62.5	200	200
SIZE (Inches: H x W x D)	--	--	--	1.625 x 4.0 x 5.9	1.625 x 4.0 x 5.9
FIRST CUSTOMER SHIPMENT	11/80	1980	1980	1Q89	1990
U.S. OEM PRICE FOR 500 UNITS	--	--	--	\$250 (5000)	--
COMMENTS	5520 administrative system	8100 system	8100 system	*1,7 RLL Code 65 msec average positioning time Optical servo track system SCSI interface	*1,7 RLL Code 65 msec average position. time Optical servo track system. SCSI interface Downward comp. with 1 & 2 MB

1989 DISK/TREND REPORT

MANUFACTURER	IOMEGA	IOMEGA	IOMEGA	IOMEGA	IOMEGA
DRIVE	A110H Bernoulli Box	A120H Bernoulli Box	Alpha-10H	Alpha-20H	B120/B220 Bernoulli Box II
DISK/TREND GROUP	16	16	16	16	16
MARKET	PCM	PCM	PCM, OEM	PCM, OEM	PCM
MEDIA: Generic type	Alpha-10 Cartridge 8"	Alpha-20 Cartridge 8"	Alpha-10 Cartridge 8"	Alpha-20 Cartridge 8"	Bernoulli II Cartridge 5.25"
Nominal disk diameter					
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: 10.0	F: 21.4	F: 10.027 or 10.497	F: 21.4	F: 21.4
Capacity per track (Bytes)	F: 32,768	F: 32,768	F: 32,768 or 34,304	F: 32,768	F: 16,128
Data surfaces per spindle	1	1	1	1	2
Tracks per surface	306	654	306	654	677
Track density (TPI)	300	641	300	641	570
Maximum linear density (BPI)	24000 BPI 18000 FCI	24000 BPI 18000 FCI	24000 BPI 18000 FCI	24000 BPI 18000 FCI	23511 BPI* 17633 FCI
Rotational speed (RPM)	1500	1500	1500	1500	1845.7
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Linear, Voice Coil
POSITIONING:Track to track(msec)	10 (including settling)	10 (including settling)	10 (including settling)	10 (including settling)	6.2 (including settling)
Settling time (msec)	--	--	--	--	--
Head load time(msec)	Continuous Contact 20	Continuous Contact 20	Continuous Contact 20	Continuous Contact 20	Continuous Contact 16.25
Average rotational delay (msec)					
Data transfer rate (KBytes/sec)	1130	1130	1130	1130	666
SIZE (Inches: H x W x D)	6.32 x 12.5 x 15.25	6.32 x 12.5 x 15.25	2.32 x 8.54 x 12.0	2.32 x 8.54 x 12.0	1.625 x 5.75 x 8.0
FIRST CUSTOMER SHIPMENT	8/85	10/85	4Q84	3Q85	9/87
U.S. OEM PRICE FOR 500 UNITS	\$1,299 (List)	\$1,799 (List)	See below	See below	\$1,100 (List)
COMMENTS	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	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

MANUFACTURER	IOMEGA	IOMEGA	KONICA	MAGYAR OPTIKAI MUVEK	MAGYAR OPTIKAI MUVEK
DRIVE	B144/B244 Bernoulli Box II/44	Beta-20	KT-510	Momflex 6400	MF 54D
DISK/TREND GROUP	16	16	16	13	14
MARKET	PCM	OEM	OEM	OEM	OEM
MEDIA: Generic type	Bernoulli II Cartridge	Beta-20 Cartridge	5.25" -- 2/350	8" -- 1/77	5.25" -- 2/40
Nominal disk diameter	5.25"	5.25"	5.25"	8"	5.25"
Recording medium	Barium Ferrite	High Density Oxide Coated	High Density Oxide Coated	Oxide Coated	Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: 44.5	F: 21.4	F: 10.76	U: .4/.8	U: .5
Capacity per track (Bytes)	F: 20,480	F: 16,128	F: 15,360	U: 5,208/10,416	U: 6,250
Data surfaces per spindle	2	2	2	1	2
Tracks per surface	1088	677	350	77	40
Track density (TPI)	1095	570	480	48	48
Maximum linear density (BPI)	28541 BPI* 21405 FCI	23511 BPI* 17633 FCI	17827	3268/6536	5876
Rotational speed (RPM)	2027	1845.7	600	360	300
PERFORMANCE					
Actuator type	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil	Band, Stepping Motor	Band, Stepping Motor
POSITIONING:Track to track(msec)	3.7	6.2 (including settling)	20	4	3
Settling time (msec)	--	--	--	15	15
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	35	35
Average rotational delay (msec)	14.8	16.25	50	83.3	100
Data transfer rate (KBytes/sec)	692.5	666	200	31.25/62.5	31.25
SIZE (Inches: H x W x D)	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8	1.625 x 5.75 x 8.0	4.4 x 8.5 x 13.9	1.625 x 5.75 x 8.3
FIRST CUSTOMER SHIPMENT	2/89	3Q86	11/87	1980	1987
U.S. OEM PRICE FOR 500 UNITS	\$1,399 (List)	See below	--	--	--
COMMENTS	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	Embedded Servo 75 msec average positioning time SCSI, with 1200 KB/second transfer rate		

1989 DISK/TREND REPORT

MANUFACTURER	MAGYAR OPTIKAI MUVEK	MAGYAR OPTIKAI MUVEK	MAGYAR OPTIKAI MUVEK	MANTEC TECHNOLOGY	MANTEC TECHNOLOGY
DRIVE					
	MF 54S	MF 58D	MF 58S	MTL-FD102E/C	MTL-FD128
DISK/TREND GROUP	14	14	14	14	14
MARKET	OEM	OEM	OEM	PCM	PCM
MEDIA: Generic type	5.25" -- 1/40	5.25" -- 2/80	5.25" -- 1/80	5.25" -- 1/40	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	Oxide Coated	Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: .250	U: 1.0	U: .5	U: .125/.250	U: .5
Capacity per track (Bytes)	U: 6,250	U: 6,250	U: 6,250	U: 3,125/6,250	U: 6,250
Data surfaces per spindle	1	2	1	1	2
Tracks per surface	40	80	80	40	40
Track density (TPI)	48	96	96	48	48
Maximum linear density (BPI)	5536	5922	5576	2768/5536	5876
Rotational speed (RPM)	300	300	300	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	16	16
Head load time(msec)	35	35	35	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	15.63/31.25	31.25
SIZE (Inches: H x W x D)	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
FIRST CUSTOMER SHIPMENT	1987	1987	1987	1987	1987
U.S. OEM PRICE FOR 500 UNITS	--	--	--	--	--
COMMENTS				For use with Apple IIC and Apple IIE	

MANUFACTURER	MANTEC TECHNOLOGY	MATSUSHITA COMMUNICATION INDUSTRIAL	MATSUSHITA COMMUNICATION INDUSTRIAL	MATSUSHITA COMMUNICATION INDUSTRIAL	MATSUSHITA COMMUNICATION INDUSTRIAL
DRIVE	MTL-FD228	JA-751	JU-455 JA-551*	JU-465 JU-466 JA-561*	JU-475 JU-595*
DISK/TREND GROUP	14	13	14	14	14
MARKET	PCM	OEM	OEM	OEM	OEM
MEDIA: Generic type	5.25" - 2/40 HD	8" -- 2/77	5.25" -- 2/40	5.25" -- 2/80	5.25" -- 2/80
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					U: .5/1.0 or U: .8/1.6
Total capacity (Mbytes)	U: 1.6	U: .8/1.6	U: .5	U: 1.0	
Capacity per track (Bytes)	U: 10,416	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	77	77	40	80	77/80
Track density (TPI)	96	48	48	96	96
Maximum linear density (BPI)	9646	3408/6816	5876	5876	5922/9646
Rotational speed (RPM)	360	360	300	300	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	4	3	3
Settling time (msec)	16	25	15	15	15
Head load time(msec)	Continuous Contact	50	Continuous Contact	Continuous Contact	Continous Contact
Average rotational delay (msec)	83.3	83.3	100	100	100/83.3
Data transfer rate (KBytes/sec)	31.25	31.25/62.5	31.25	31.25	31.25/62.5
SIZE (Inches: H x W x D)	1.625 x 5.75 x 8.0	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
FIRST CUSTOMER SHIPMENT	6/88	1987	1982	1982	1983
U.S. OEM PRICE FOR 500 UNITS	--	--	--	--	--
COMMENTS			*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-585*	JU-202	JU-243A*	JU-252	JU-252A
DISK/TREND GROUP	14	15	15	15	15
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	5.25" -- 2/77	2.0" -- 2/80 HD	3.5" -- 2/80	3.5" -- 1/80	3.5" -- 1/80
Nominal disk diameter	5.25"	2.0"	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	U: .5	U: .5
Capacity per track (Bytes)	U: 10,416	U: 6,250	U: 6,250	U: 6,250	U: 6,250
Data surfaces per spindle	2	2	2	1	1
Tracks per surface	77	80	80	80	80
Track density (TPI)	96	254	135	135	135
Maximum linear density (BPI)	9870	14000	8717	8186	8186
Rotational speed (RPM)	360	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)	3	6	6	3	6
Settling time (msec)	15	15	15	15	15
Head load time(msec)	50	Continuous Contact 100	Continuous Contact 100	Continuous Contact 100	Continuous Contact 100
Average rotational delay (msec)	83.3				
Data transfer rate (KBytes/sec)	62.5	31.25	31.25	31.25	31.25
SIZE (Inches: H x W x D)	1.625 x 5.75 x 8.0	.79 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
FIRST CUSTOMER SHIPMENT	1983	1989	1987	1987	1986
U.S. OEM PRICE FOR 500 UNITS	--	--	--	--	--
COMMENTS	*Sold only in Japan		*Sold only in Japan		

1989 DISK/TREND REPORT

MANUFACTURER	MATSUSHITA COMMUNICATION INDUSTRIAL	MATSUSHITA COMMUNICATION INDUSTRIAL	MATSUSHITA COMMUNICATION INDUSTRIAL	MATSUSHITA COMMUNICATION INDUSTRIAL	MATSUSHITA COMMUNICATION INDUSTRIAL
DRIVE					
	JU-253	JU-253A	JU-255	JU-255A	JU-257
DISK/TREND GROUP	15	15	15	15	15
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: 1.0	U: 1.0	U: 1.0/1.6	U: 1.0/1.6	U: 1.0/2.0
Capacity per track (Bytes)	U: 6,250	U: 6,250	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	80/77	80/77	80
Track density (TPI)	135	135	135	135	135
Maximum linear density (BPI)	8717	8717	8717/14184	8717/14184	8717/17434
Rotational speed (RPM)	300	300	300/360	300/360	300
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING:Track to track(msec)	3	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	100/83.3	100/83.3	100
Data transfer rate (KBytes/sec)	31.25	31.25	31.25/37.5/62.5	31.25/37.5/62.5	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	1987	1986	1987	1987	1987
U.S. OEM PRICE FOR 500 UNITS	--	--	--	--	--
COMMENTS					

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

MATSUSHITA COMMUNICATION INDUSTRIAL	MATSUSHITA COMMUNICATION INDUSTRIAL	MATSUSHITA COMMUNICATION INDUSTRIAL	MATSUSHITA COMMUNICATION INDUSTRIAL	MATSUSHITA ELECTRONIC COMPONENTS
JU-257A	JU-263A*	JU-363 JU-363A JU-364	JU-3511	EME-156
15	15	15	16	15
OEM	OEM	OEM	OEM	OEM
3.5" -- 2/80 HD	3.5" -- 2/80	3.5" -- 2/80	3.5"-2/320 Met.	3.0" -- 1/40
3.5"	3.5"	3.5"	3.5"	3"
High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	Iron Metallic	High Density Oxide Coated
U: 1.0/2.0	U: 1.0	U: .5/1.0	U: 16.0	U: .250
U: 6,250/12,500	U: 6,250	U: 3,125/6,250	U: 25,000	U: 6,250
2	2	2	2	1
80	80	80	320	40
135	135	135	542	100
8717/17434	8717	4359/8717	35100	8946
300	300	300	600	300
Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Lead Screw, Stepping Motor
3	6	3	20	12
15	15	15		15
Continuous Contact 100	Continuous Contact 100	Continuous Contact 100	Continuous Contact 50	Continuous Contact 100
31.25/62.5	31.25	15.63/31.25	2000 Max.	31.25
1.0 x 4.0 x 5.9	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
1987	1987	1984	1990	1987
--	--	--	--	--
5V (single)	*Sold only in Japan		Drive writes embedded servo 60 msec average head positioning SCSI interface	Replaces EME-155

MANUFACTURER	MATSUSHITA ELECTRONIC COMPONENTS	MATSUSHITA ELECTRONIC COMPONENTS	MATSUSHITA ELECTRONIC COMPONENTS	MATSUSHITA ELECTRONIC COMPONENTS	MILTOPE
DRIVE	EME-232	EME-112	EME-212	EME-213 EME-214	DD 400
DISK/TREND GROUP	15	15	15	15	13
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	3.0" -- 2/80	3.5" -- 1/80	3.5" -- 2/80	3.5" -- 2/80	8" -- 1/77
Nominal disk diameter	3"	3.5"	3.5"	3.5"	8"
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: .5	U: 1.0	U: 1.0	U: .401/.802
Capacity per track (Bytes)	U: 6,250	U: 6,250	U: 6,250	U: 6,250	U: 5,208/10,416
Data surfaces per spindle	2	1	2	2	1
Tracks per surface	80	80	80	80	77
Track density (TPI)	200	135	135	135	48
Maximum linear density (BPI)	9891	8187	8717	8717	3268/6536
Rotational speed (RPM)	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)	12	3	6	3/6	6
Settling time (msec)	15	15	15	15	10
Head load time(msec)	Continuous Contact 100	Continuous Contact 100	Continuous Contact 100	Continuous Contact 100	16
Average rotational delay (msec)	100	100	100	100	83.3
Data transfer rate (KBytes/sec)	31.25	31.25	31.25	31.25	31.25/62.5
SIZE (Inches: H x W x D)	1.5 x 3.5 x 5.9	1.0 x 3.8 x 5.9	1.0 x 3.8 x 5.9	1.0 x 3.8 x 5.75	5.44 x 8.44 x 18.0
FIRST CUSTOMER SHIPMENT	1987	3/87	3/87	1989	1977
U.S. OEM PRICE FOR 500 UNITS	--	--	--	--	\$4,950
COMMENTS	Replaces EME-231				Sold as militarized subsystem

1989 DISK/TREND REPORT

MANUFACTURER	MILTOPE	MITSUBISHI ELECTRIC CORPORATION	MITSUBISHI ELECTRIC CORPORATION	MITSUBISHI ELECTRIC CORPORATION	MITSUBISHI ELECTRIC CORPORATION
DRIVE					
	DD 450	M2896-63	MF 501B	MF 501C	MF 504B
DISK/TREND GROUP	13	13	14	14	14
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	8" -- 2/77	8" -- 2/77	5.25" -- 2/40	5.25" -- 2/40	5.25" - 2/80 HD
Nominal disk diameter	8"	8"	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: .8/1.6	U: 1.6	U: .5	U: .5	U: 1.0/1.6
Capacity per track (Bytes)	U: 5,208/10,416	U: 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	77	77	40	40	80/77
Track density (TPI)	48	48	48	48	96
Maximum linear density (BPI)	3408/6816	6816	5877	5877	5922/9870
Rotational speed (RPM)	360	360	300	300	300/360
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)	5	3	6	6	3
Settling time (msec)	10	15	15	15	15
Head load time(msec)	16	35	Continuous Contact 100	Continuous Contact 100	Continuous Contact 100/83.3
Average rotational delay (msec)	83.3	83.3	100	100	100/83.3
Data transfer rate (KBytes/sec)	31.25/62.5	62.5	31.25	31.25	31.25/62.5
SIZE (Inches: H x W x D)	5.44 x 8.44 x 18.0	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
FIRST CUSTOMER SHIPMENT	1980	1982	4Q85	2Q88	4Q85
U.S. OEM PRICE FOR 500 UNITS	\$5,400	--	--	--	--
COMMENTS	Sold as militarized subsystem				

MANUFACTURER	MITSUBISHI ELECTRIC CORPORATION	MITSUBISHI ELECTRIC CORPORATION	MITSUBISHI ELECTRIC CORPORATION	MITSUBISHI ELECTRIC CORPORATION	MITSUBISHI ELECTRIC CORPORATION
DRIVE					
	MF 504C	MF 353BA	MF 353C	MF 354C	MF 355BA
DISK/TREND GROUP	14	15	15	15	15
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: 1.0/2.0
Capacity per track (Bytes)	U: 6,250/10,416	U: 6,250	U: 6,250	U: 6,250/10,416	U: 6,250/12,500
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80/77	80	80	80/77	80
Track density (TPI)	96	135	135	135	135
Maximum linear density (BPI)	5922/9870	8717	8717	8717/14184	8717/17434
Rotational speed (RPM)	300/360	300	300	300/360	300
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING:Track to track(msec)	3	3	3	3	3
Settling time (msec)	15	15	15	15	15
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
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	1.0 x 4.0 x 5.9	1.26 x 4.0 x 5.9
FIRST CUSTOMER SHIPMENT	2Q88	4Q85	2Q87	2Q87	4Q86
U.S. OEM PRICE FOR 500 UNITS	--	--	--	--	--
COMMENTS					

MANUFACTURER	MITSUBISHI ELECTRIC CORPORATION	MITSUMI ELECTRIC	MITSUMI ELECTRIC	MITSUMI ELECTRIC	MITSUMI ELECTRIC
DRIVE					
	MF 355C	D 503V	D 503V2	D 509V	D 509V2
DISK/TREND GROUP	15	14	14	14	14
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	3.5" -- 2/80 HD	5.25" -- 2/40	5.25" -- 2/40	5.25" - 2/80 HD	5.25" - 2/80 HD
Nominal disk diameter	3.5"	5.25"	5.25"	5.25"	5.25"
Recording medium	High Density Oxide Coated	Oxide Coated	Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: 1.0/2.0	U: .500	U: .500	U: 1.0/1.6	U: 1.0/1.6
Capacity per track (Bytes)	U: 6,250/12,500	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	40	40	80	80
Track density (TPI)	135	48	48	96	96
Maximum linear density (BPI)	8717/17434	5876	5876	5922/9646	5922/9646
Rotational speed (RPM)	300	300	300	360	360
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Band, Stepping Motor	Lead Screw, Stepping Motor	Band, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING:Track to track(msec)	3	6	6	3/5	3/5
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 83.3
Average rotational delay (msec)	100				
Data transfer rate (KBytes/sec)	31.25/62.5	31.25	31.25	37.5/62.5	37.5/62.5
SIZE (Inches: H x W x D)	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	1.625 x 5.75 x 7.4
FIRST CUSTOMER SHIPMENT	2Q87	3/85	4Q88	1987	4Q88
U.S. OEM PRICE FOR 500 UNITS	--	--	--	--	--
COMMENTS					

1989 DISK/TREND REPORT

MANUFACTURER	MITSUMI ELECTRIC	MITSUMI ELECTRIC	MITSUMI ELECTRIC	MITSUMI ELECTRIC	MITSUMI ELECTRIC
DRIVE					
	D 201	D 357B D 357T	D 357C	D 357T2	D 359C
DISK/TREND GROUP	15	15	15	15	15
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	2.0" Data Disk	3.5" -- 2/80	3.5" -- 2/80	3.5" -- 2/80	3.5" -- 2/80 HD
Nominal disk diameter	2.0"	3.5"	3.5"	3.5"	3.5"
Recording medium	Metal Powder	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: 1.0	U: 2.0
Capacity per track (Bytes)	U: 20,000	U: 6,250	U: 6,250	U: 6,250	U: 12,500
Data surfaces per spindle	1	2	2	2	2
Tracks per surface	50	80	80	80	80
Track density (TPI)	254	135	135	135	135
Maximum linear density (BPI)	51200	8717	8717	8717	17434
Rotational speed (RPM)	3600	300	300	300	300
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Band, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING:Track to track(msec)	4	6	6	6	6
Settling time (msec)	--	15	15	15	15
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	8.3	100	100	100	100
Data transfer rate (KBytes/sec)	1787.5	31.25	31.25	31.25	62.5
SIZE (Inches: H x W x D)	1.0 x 2.5 x 3.4	1.0 x 4.0 x 6.1	.75 x 4.0 x 6.1	1.0 x 4.0 x 6.1	.75 x 4.0 x 6.1
FIRST CUSTOMER SHIPMENT	2Q90	4/87	1Q90	4Q88	1Q90
U.S. OEM PRICE FOR 500 UNITS	--	--	--	--	--
COMMENTS	Compatible with Sony 2.0" FDD				

1989 DISK/TREND REPORT

MANUFACTURER	MITSUMI ELECTRIC	MITSUMI ELECTRIC	MITSUMI ELECTRIC	MULTIDIGIT	MULTIDIGIT
DRIVE	D 359T D 359T2	D 35XT	D 281 D 284 D 286	DF0211	DF0511
DISK/TREND GROUP	15	15	17	14	14
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	3.5" -- 2/80 HD	3.5" -- 2/80 BF	Maxell QD-2	5.25" -- 1/40	5.25" -- 2/40
Nominal disk diameter	3.5"	3.5"	72 mm	5.25"	5.25"
Recording medium	High Density Oxide Coated	Barium Ferrite	Oxide Coated	Oxide Coated	Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: 2.0	U: 4.0	U: .064	U: .218	U: .5
Capacity per track (Bytes)	U: 12,500	U: 25,000	U: 64,000	U: 6,250	U: 6,250
Data surfaces per spindle	2	2	1	1	2
Tracks per surface	80	80	1	35	40
Track density (TPI)	135	135	59	48	48
Maximum linear density (BPI)	17434	34768	4410	5536	5877
Rotational speed (RPM)	300	300	423	300	300
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	N/A	Band, Stepping Motor	Band, Stepping Motor
POSITIONING:Track to track(msec)	6	3	N/A	6	6
Settling time (msec)	15	15	N/A	15	25
Head load time(msec)	Continuous Contact	Continuous Contact	N/A	Continuous Contact	50
Average rotational delay (msec)	100	100	N/A	100	100
Data transfer rate (KBytes/sec)	62.5	125	12.63	31.25	31.25
SIZE (Inches: H x W x D)	1.0 x 4.0 x 6.1	1.0 x 4.0 x 6.1	1.73 x 4.6 x 4.1	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0
FIRST CUSTOMER SHIPMENT	4Q88	2Q90	2/86	1986	1985
U.S. OEM PRICE FOR 500 UNITS	--	--	--	--	--
COMMENTS			64,000 bytes in single spiral track Front loading QDM-02 is MSX subsystem		

MANUFACTURER	MULTIDIGIT	MULTIDIGIT	MULTIDIGIT	NEC	NEC
DRIVE					
	DF1011	DF1611 DF1622	DF2011	FD 1165	FD 1054
DISK/TREND GROUP	14	14	14	13	14
MARKET	OEM	OEM	OEM	Captive, OEM	Captive, OEM
MEDIA: Generic type	5.25" -- 2/80	5.25" - 2/80 HD	5.25" - 2/80 HD	8" -- 2/77	5.25" -- 2/40
Nominal disk diameter	5.25"	5.25"	5.25"	8"	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: 1.6	U: 2.0	U: .8/1.6	U: .5
Capacity per track (Bytes)	U: 6,250	U: 10,416	U: 12,500	U: 5,208/10,416	U: 6,250
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80	77	80	77	40
Track density (TPI)	96	96	96	48	48
Maximum linear density (BPI)	5922	9646	11844	3408/6816	5876
Rotational speed (RPM)	300	360	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	3	3	3	6
Settling time (msec)	15	15	15	15	15
Head load time(msec)	50	50	50	50	35
Average rotational delay (msec)	100	83.3	100	83.3	100
Data transfer rate (KBytes/sec)	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	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0	2.28 x 8.54 x 12.7	1.625 x 5.75 x 8.0
FIRST CUSTOMER SHIPMENT	1985	1986	1986	4Q81	1987
U.S. OEM PRICE FOR 500 UNITS	--	--	--	\$280 (1000)	--
COMMENTS					

MANUFACTURER	NEC	NEC	NEC	NEC	NEC
DRIVE					
	FD 1057	FD 1157C	FD 1157D	FD 1035	FD 1037A
DISK/TREND GROUP	14	14	14	15	15
MARKET	Captive, OEM	Captive, OEM	Captive, OEM	Captive, OEM	Captive, 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: 1.0	U: 1.0/1.6	U: 1.0/1.6	U: .5/1.0	U: .5/1.0
Capacity per track (Bytes)	U: 6,250	U: 6,250/10,416	U: 6,250/10,416	U: 3,125/6,250	U: 3,125/6,250
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80	80	80	80	80
Track density (TPI)	96	96	96	135	135
Maximum linear density (BPI)	5922	5922/9870	5922/9870	4359/8717	4359/8717
Rotational speed (RPM)	300	360	360	300	300
PERFORMANCE					
Actuator type	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Band, 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	35	35	35	Continuous Contact 100
Average rotational delay (msec)	100	83.3	83.3	100	100
Data transfer rate (KBytes/sec)	31.25	37.5/62.5	37.5/62.5	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	1.614 x 4.0 x 5.2	1.0 x 4.0 x 5.1
FIRST CUSTOMER SHIPMENT	1987	1987	1987	11/84	1987
U.S. OEM PRICE FOR 500 UNITS	--	--	--	\$105 (1000)	--
COMMENTS			With VFO		

MANUFACTURER	NEC	NEC	NEC	NEC	NEC
DRIVE					
	FD 1038A	FD 1135C	FD 1135D	FD 1136C	FD 1137C
DISK/TREND GROUP	15	15	15	15	15
MARKET	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	U: 1.0/1.6	U: 1.0/1.6	U: 1.0/1.6	U: 1.0/1.6
Capacity per track (Bytes)	U: 6,250	U: 6,250/10,416	U: 6,250/10,416	U: 6,250/10,416	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)	135	135	135	135	135
Maximum linear density (BPI)	8717	8717/14528	8717/14528	8717/14528	8717/14528
Rotational speed (RPM)	300	300/360	300/360	300/360	300/360
PERFORMANCE					
Actuator type	Linear, Pulse Motor	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Linear, Stepping Motor
POSITIONING:Track to track(msec)	2	3	3	3	3
Settling time (msec)	15	15	15	15	15
Head load time(msec)	Continuous Contact	35	35	Continuous Contact	Continuous Contact
Average rotational delay (msec)	100	100/83.3	100/83.3	100/83.3	100/83.3
Data transfer rate (KBytes/sec)	31.25	37.5/62.5	37.5/62.5	37.5/62.5	37.5/62.5
SIZE (Inches: H x W x D)	.75 x 4.0 x 5.12	1.625 x 4.0 x 5.3	1.625 x 4.0 x 5.3	1.18 x 4.0 x 5.75	1.0 x 4.0 x 5.1
FIRST CUSTOMER SHIPMENT	1Q90	11/85	1/86	6/86	1987
U.S. OEM PRICE FOR 500 UNITS	--	--	--	--	--
COMMENTS					

1989 DISK/TREND REPORT

MANUFACTURER	NEC	NEC	NEC	NEC	OCEANIC
DRIVE					
	FD 1137D	FD 1137H	FD 1138H	FD 1331	Master 5A
DISK/TREND GROUP	15	15	15	16	14
MARKET	Captive, OEM	Captive, OEM	OEM	Captive, OEM	PCM
MEDIA: Generic type	3.5" -- 2/80 HD	3.5" -- 2/80 HD	3.5" -- 2/80 HD	3.5"-2/240 Met.	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	Metal Powder	Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: 1.0/1.6	U: 1.0/2.0	U: 2.0	F: 9.4	U: .5
Capacity per track (Bytes)	U: 6,250/10,416	U: 6,250/12,500	U: 12,500	F: 19,456	U: 6,250
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80	80	80	240	40
Track density (TPI)	135	135	135	406	48
Maximum linear density (BPI)	8717/14528	8717/17434	17434	36518	5536
Rotational speed (RPM)	300/360	300	300	360	300
PERFORMANCE					
Actuator type	Linear, Stepping Motor	Linear, Stepping Motor	Linear, Pulse Motor	Linear, Stepping Motor	Band, Stepping Motor
POSITIONING:Track to track(msec)	3	3	2	3	5
Settling time (msec)	15	15	15	15	20
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	100/83.3	100	100	83.3	100
Data transfer rate (KBytes/sec)	37.5/62.5	37.5/62.5	62.5	1250	31.25
SIZE (Inches: H x W x D)	1.0 x 4.0 x 5.1	1.0 x 4.0 x 5.1	.75 x 4.0 x 5.12	1.26 x 4.0 x 5.75	1.57 x 5.67 x 7.95
FIRST CUSTOMER SHIPMENT	1987	1987	1Q90	8/88	1988
U.S. OEM PRICE FOR 500 UNITS	--	--	--	--	--
COMMENTS	With VFO			Embedded Servo Reads 1.0 and 2.0 MB diskettes ST412 and SCSI interfaces	External mount for Amiga

MANUFACTURER	OCEANIC	OCEANIC	OCEANIC	ORIENTAL PRECISION	ORIENTAL PRECISION
DRIVE					
	OB-1	OC-118 OC-118N	OH-2	OFD-506R	OFD-516R
DISK/TREND GROUP	14	14	14	14	14
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	Captive, OEM	Captive, OEM
MEDIA: Generic type	5.25" -- 2/40	5.25" -- 1/40	5.25" -- 1/40	5.25" - 2/80 HD	5.25" -- 2/80
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	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: .5	U: .174	U: .143	U: 1.0/1.6	U: 1.6
Capacity per track (Bytes)	U: 6,250	U: 4,833	U: 3,972	U: 6,250/10,416	U: 10,416
Data surfaces per spindle	2	1	1	2	2
Tracks per surface	40	36	36	77/80	77
Track density (TPI)	48	48	48	96	96
Maximum linear density (BPI)	5536	2768/5536	2768/5536	5922/9870	9646
Rotational speed (RPM)	300	300	300	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)	4	6	4	3	3
Settling time (msec)	20	15	15	15	15
Head load time(msec)	Continuous Contact	35	35	Continuous Contact	Continuous Contact
Average rotational delay (msec)	100	100	100	100/83.3	83.3
Data transfer rate (KBytes/sec)	31.25	15.63	15.63	62.5/37.5	62.5
SIZE (Inches: H x W x D)	1.57 x 5.67 x 7.95	1.57 x 5.67 x 7.95	1.65 x 5.75 x 7.05	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0
FIRST CUSTOMER SHIPMENT	9/86	--	--	6/89	6/89
U.S. OEM PRICE FOR 500 UNITS	\$62	\$86	\$55	--	--
COMMENTS		For Commodore	For Apple II		

1989 DISK/TREND REPORT

MANUFACTURER	ORIENTAL PRECISION	ORIENTAL PRECISION	PERIPHERAL DATA SYSTEMS	PERIPHERAL DATA SYSTEMS	PERIPHERAL DATA SYSTEMS
DRIVE					
	OFD-546R	OFD-596R	BD-101	BD-120	MFDD-110
DISK/TREND GROUP	14	14	14	14	14
MARKET	Captive, OEM	Captive, OEM	Captive, OEM	Captive, OEM	Captive, OEM
MEDIA: Generic type	5.25" -- 2/40	5.25" -- 2/80	5.25" -- 2/40	5.25" -- 2/40	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: .250/.5	U: .5/1.0	U: .250/.5	U: .250/.5	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	2	2	2	2	1
Tracks per surface	40	80	40	40	40
Track density (TPI)	48	96	48	48	48
Maximum linear density (BPI)	2938/5876	2961/5922	2938/5876	2938/5876	2788/5576
Rotational speed (RPM)	300	300	300	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	5	5	5
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)	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	3.25 x 5.75 x 8.0	1.625 x 5.75 x 8.0	2.2 x 5.86 x 9.68
FIRST CUSTOMER SHIPMENT	1983	1983	1986	1987	4Q86
U.S. OEM PRICE FOR 500 UNITS	--	--	--	--	--
COMMENTS	Licensed by TEAC	Licensed by TEAC			Subsystem for Apple II system

MANUFACTURER	QUME	QUME	ROBOTRON	ROBOTRON	ROCTEC
DRIVE					
	HF12	HF24	K 5600.10	K 5600.20	RF501A
DISK/TREND GROUP	16	16	14	14	14
MARKET	OEM	OEM	Captive, OEM	Captive, OEM	OEM
MEDIA: Generic type	5.25" Cartridge	5.25" Cartridge	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	High Density Oxide Coated	Barium Ferrite	Oxide Coated	Oxide Coated	Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: 10.0	F: 20.2	U: .125/.250	U: .250/.5	U: .250
Capacity per track (Bytes)	F: 19,968	F: 19,968	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	301	506	40	80	40
Track density (TPI)	333	666	48	96	48
Maximum linear density (BPI)	21640	24000	2768/5536	2788/5576	5576
Rotational speed (RPM)	600	720	300	300	300
PERFORMANCE					
Actuator type	Voice Coil	Voice Coil	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Band, Stepping Motor
POSITIONING:Track to track(msec)	25	25	10	8	6
Settling time (msec)	N/A	N/A	12	10	20
Head load time(msec)	Continuous Contact	Continuous Contact	40	40	Continuous Contact
Average rotational delay (msec)	50	42	100	100	100
Data transfer rate (KBytes/sec)	275	330	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	10/86	8/88	1984	1984	4Q87
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			For Apple II

1989 DISK/TREND REPORT

MANUFACTURER	ROCTEC	ROCTEC	ROCTEC	SAMSUNG ELECTRONICS	SAMSUNG ELECTRONICS
DRIVE					
	RF501R	RF502B RF542	RF512B RF552	SFD-500V	SFD-560D SFD-560K
DISK/TREND GROUP	14	14	14	14	14
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" -- 2/80	5.25" - 2/80 HD
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	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: .250	U: .5	U: 1.6	U: .5	U: 1.6
Capacity per track (Bytes)	U: 6,250	U: 6,250	U: 10,416	U: 6,250	U: 10,416
Data surfaces per spindle	1	2	2	2	2
Tracks per surface	40	40	77	40	80/77
Track density (TPI)	48	48	96	48	96
Maximum linear density (BPI)	5576	5876	9646	5876	9870/9642
Rotational speed (RPM)	300	300	360	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)	6	6	3	6	3
Settling time (msec)	20	20	20	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
Data transfer rate (KBytes/sec)	31.25	31.25	62.5	31.25	62.5
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	3Q88	4Q87
U.S. OEM PRICE FOR 500 UNITS	--	--	--	--	--
COMMENTS	External drive for Atari systems	External models BA Amstrad C Commodore BS IBM BR Toshiba BZ Zenith BQ Compaq	External models BA Amstrad C Commodore BS IBM		

MANUFACTURER	SAMSUNG ELECTRONICS	SANKYO SEIKI	SANKYO SEIKI	SANKYO SEIKI	SANKYO SEIKI
DRIVE					
	SFD-321K	FDU-370 FDU-380	FDU-480	FDU-580	FDU-583
DISK/TREND GROUP	15	15	15	15	15
MARKET	Captive, OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	3.5" - 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	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	U: 1.0/1.6	U: 1.0/2.0	U: 2.0
Capacity per track (Bytes)	U: 6,250/12,500	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	80	80/77	80	80
Track density (TPI)	135	135	135	135	135
Maximum linear density (BPI)	8717/17434	8717	8717/14184	8717/17434	17434
Rotational speed (RPM)	300	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)	Continuous Contact 100	Continuous Contact 100	Continuous Contact 100/83.3	Continuous Contact 100	Continuous Contact 100
Average rotational delay (msec)	31.25/62.5	31.25	31.25/62.5	31.25/62.5	62.5
Data transfer rate (KBytes/sec)					
SIZE (Inches: H x W x D)	1.0 x 4.0 x 5.9	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	2Q89	12/86	2Q87	2Q87	3Q87
U.S. OEM PRICE FOR 500 UNITS	--	--	--	--	--
COMMENTS					

1989 DISK/TREND REPORT

MANUFACTURER	SEIKO EPSON	SEIKO EPSON	SEIKO EPSON	SEIKO EPSON	SEIKO EPSON
DRIVE					
	SD-621L	SD-680L	SD-340	SMD-1040	SMD-240
DISK/TREND GROUP	14	14	15	15	15
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 HD	3.5" -- 2/80 HD
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: 2.0	U: 1.0/2.0	U: 1.0/2.0
Capacity per track (Bytes)	U: 6,250	U: 6,250/10,416	U: 12,500	U: 6,250/12,500	U: 6,250/12,500
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	17434	8717/17434	8717/17434
Rotational speed (RPM)	300	300/360	300	300	300
PERFORMANCE					
Actuator type	Rack & Pinion, Stepping Motor	Rack & Pinion, Stepping Motor	Rack & Pinion, 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 100	35	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	37.5/62.5	62.5	31.25/62.5	31.25/62.5
SIZE (Inches: H x W x D)	1.625 x 5.75 x 7.7	1.625 x 5.75 x 7.7	1.0 x 4.0 x 5.75	.71 x 4.0 x 5.1	1.0/1.1 x 4.0 x 5.87
FIRST CUSTOMER SHIPMENT	2Q86	3Q86	--	1Q90	1Q86
U.S. OEM PRICE FOR 500 UNITS	\$63 (1000)	\$74 (1000)	--	--	\$90 (1000)
COMMENTS					

MANUFACTURER	SEIKO EPSON	SEIKO EPSON	SEIKO EPSON	SEIKO EPSON	SEIKO EPSON
DRIVE					
	SMD-280H	SMD-280L	SMD-320	SMD-340	SMD-380
DISK/TREND GROUP	15	15	15	15	15
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
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: 1.0/1.6	U: 1.0/2.0	U: 1.0
Capacity per track (Bytes)	U: 6,250	U: 6,250	U: 6,250/10,416	U: 6,250/12,500	U: 6,250
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	8717/14528	8717/17434	8717
Rotational speed (RPM)	300	300	300/360	300	300
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Rack & Pinion, Stepping Motor	Rack & Pinion, Stepping Motor	Rack & Pinion, 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	100/83.3	100	100
Data transfer rate (KBytes/sec)	31.25	31.25	37.5/62.5	31.25/62.5	31.25
SIZE (Inches: H x W x D)	1.1 x 4.0 x 5.87	1.0 x 4.0 x 5.87	1.0 x 4.0 x 5.75	1.0 x 4.0 x 5.75	1.0 x 4.0 x 5.75
FIRST CUSTOMER SHIPMENT	1986	9/85	1/89	1/89	1/89
U.S. OEM PRICE FOR 500 UNITS	\$75 (1000)	\$80 (1000)	--	--	--
COMMENTS					

1989 DISK/TREND REPORT

MANUFACTURER	SEIKO EPSON	SEIKO EPSON	SHUGART	SHUGART	SHUGART
DRIVE					
	SMD-440	SMD-480	801	848-2	851
DISK/TREND GROUP	15	15	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" -- 2/77	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: .8/1.6	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	2	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	3406/6816	3408/6816
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	Continuous Contact	35	Continuous Contact	50
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	4.62 x 8.55 x 14.25
FIRST CUSTOMER SHIPMENT	11/87	4Q86	9/75	4/81	6/77
U.S. OEM PRICE FOR 500 UNITS	--	\$65 (1000)	--	--	--
COMMENTS					

MANUFACTURER	SONY	SONY	SONY	SONY	SONY
DRIVE					
	MP-F11W	MP-F17W	MP-F52W	MP-F53W MP-F53W-00D	MP-F63W-00D MP-F63W-01D
DISK/TREND GROUP	15	15	15	15	15
MARKET	Captive, OEM	Captive, OEM	Captive, OEM	Captive, OEM	OEM
MEDIA: Generic type	3.5" -- 2/80 HD	3.5" -- 2/80 HD	3.5" -- 2/80	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	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: 1.0/2.0	U: .5/1.0	U: .5/1.0	U: 1.0
Capacity per track (Bytes)	U: 6,250	U: 6,250/12,500	U: 3,125/6,250	U: 3,125/6,250	U: 6,250
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	8717/17434	4359/8717	4359/8717	8717
Rotational speed (RPM)	300	300	600	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	6	6	3
Settling time (msec)	15	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)	31.25	31.25/62.5	31.25/62.5	15.63/31.25	31.25
Data transfer rate (KBytes/sec)					
SIZE (Inches: H x W x D)	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	1.18 x 4.0 x 5.9
FIRST CUSTOMER SHIPMENT	2Q87	2Q87	2Q85	3Q85	1Q86
U.S. OEM PRICE FOR 500 UNITS	\$93	\$120	\$93	\$93	\$100
COMMENTS					

1989 DISK/TREND REPORT

MANUFACTURER	SONY	SONY	SONY	TEAC	TEAC
DRIVE					
	MP-F73W-00D MP-F73W-01D	PDD-100 PDD-150	PDD-110	FD-55BR	FD-55FR
DISK/TREND GROUP	15	15	15	14	14
MARKET	OEM	Captive, OEM	Captive, OEM	OEM	OEM
MEDIA: Generic type	3.5" -- 2/80 HD	2.0" Data Disk	2.0" Data Disk	5.25" -- 2/40	5.25" -- 2/80
Nominal disk diameter	3.5"	2.0"	2.0"	5.25"	5.25"
Recording medium	High Density Oxide Coated	Metal Powder	Metal Powder	Oxide Coated	Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: 1.0/2.0	U: 1.0	U: 1.0	U: .5	U: 1.0
Capacity per track (Bytes)	U: 6,250/12,500	U: 20,000	U: 20,000	U: 6,250	U: 6,250
Data surfaces per spindle	2	1	1	2	2
Tracks per surface	80	50	50	40	80
Track density (TPI)	135	254	254	48	96
Maximum linear density (BPI)	8717/17434	51200	51200	5876	5922
Rotational speed (RPM)	300	3600	3600	300	300
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Stepping Motor	Stepping Motor	Band, Stepping Motor	Band, Stepping Motor
POSITIONING:Track to track(msec)	3	16	4	4/6	3
Settling time (msec)	15	12		10/15	15
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	50	50
Average rotational delay (msec)	100	8.3	8.3	100	100
Data transfer rate (KBytes/sec)	31.25/62.5	1787.5	1787.5	31.25	31.25
SIZE (Inches: H x W x D)	1.18 x 4.0 x 5.9	1.0 x 2.6 x 3.5	.79 x 2.5 x 3.5	1.625 x 5.75 x 8.0	1.625 x 5.75 x 8.0
FIRST CUSTOMER SHIPMENT	1Q86	4Q87	3Q88	1987	1987
U.S. OEM PRICE FOR 500 UNITS	\$120	--	--	\$55 (1000)	\$86 (1000)
COMMENTS		Data version of 2" still video disk	Data version of 2" still video disk		

1989 DISK/TREND REPORT

MANUFACTURER	TEAC	TEAC	TEAC	TEAC	TEAC
DRIVE					
	FD-55GFR	FD-55GR	FD-235F	FD-235G	FD-235GF
DISK/TREND GROUP	14	14	15	15	15
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				

1989 DISK/TREND REPORT

MANUFACTURER	TEAC	TEAC	TEAC	TEAC	TEAC
DRIVE					
	FD-235HF	FD-235J	FD-334F	FD-334G	FD-334GF
DISK/TREND GROUP	15	15	15	15	15
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	3.5" -- 2/80 HD	3.5" -- 2/80 BF	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	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: 1.0	U: 1.666	U: 1.0/1.6
Capacity per track (Bytes)	U: 6,250/12,500	U: 6,250/25,000	U: 6,250	U: 10,416	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)	135	135	135	135	135
Maximum linear density (BPI)	8717/17434	8717/34868	8717	14528	8717/14528
Rotational speed (RPM)	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	100	100	83.3	100/83.3
Data transfer rate (KBytes/sec)	31.25/62.5	31.25/62.5/125	31.25	62.5	31.25/62.5
SIZE (Inches: H x W x D)	1.0 x 4.0 x 5.71	1.0 x 4.0 x 5.71	.75 x 4.0 x 5.32	.75 x 4.0 x 5.32	.75 x 4.0 x 5.32
FIRST CUSTOMER SHIPMENT	2Q88	1989	1Q90	1Q90	1Q90
U.S. OEM PRICE FOR 500 UNITS	\$61 (1000)	\$90 (1000)	--	\$60 (1000)	\$60 (1000)
COMMENTS					

1989 DISK/TREND REPORT

MANUFACTURER	TEAC	TEAC	TEAC	TEAC	TEAC
DRIVE					
	FD-334HF	FD-35EN	FD-35FN	FD-35FN-18	FD-35FN-23
DISK/TREND GROUP	15	15	15	15	15
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	3.5" -- 2/80 HD	3.5" -- 1/80	3.5" -- 2/80	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	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: .5	U: 1.0	U: .5/1.0	U: 1.0
Capacity per track (Bytes)	U: 6,250/12,500	U: 6,250	U: 6,250	U: 3,125/6,250	U: 6,250
Data surfaces per spindle	2	1	2	2	2
Tracks per surface	80	80	80	80	80
Track density (TPI)	135	135	135	135	135
Maximum linear density (BPI)	8717/17434	8187	8717	4359/8717	8717
Rotational speed (RPM)	300	300	300	600	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	3	3	1.5	3
Settling time (msec)	15	15	15	15	15
Head load time(msec)	Continuous Contact 100	Continuous Contact 100	Continuous Contact 100	Continuous Contact 50	Continuous Contact 100
Average rotational delay (msec)	31.25/62.5	31.25	31.25	15.63/31.25	31.25
Data transfer rate (KBytes/sec)	31.25/62.5	31.25	31.25	15.63/31.25	31.25
SIZE (Inches: H x W x D)	.75 x 4.0 x 5.32	1.57 x 4.0 x 5.3	1.57 x 4.0 x 5.3	1.57 x 4.0 x 5.3	1.625 x 5.75 x 8.0
FIRST CUSTOMER SHIPMENT	1Q90	2Q84	2Q84	1986	1986
U.S. OEM PRICE FOR 500 UNITS	\$60 (1000)	\$68 (1000)	\$80 (1000)	\$80 (1000)	\$87 (1000)
COMMENTS					3.5" drive in 5.25" form factor

MANUFACTURER	TEAC	TEAC	TEAC	TEAC	TEAC
DRIVE					
	FD-35GFN	FD-35GN	FD-35HFN	FD-135FN	FD-135HFN
DISK/TREND GROUP	15	15	15	15	15
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 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: 1.6	U: 1.0/2.0	U: 1.0	U: 1.0/2.0
Capacity per track (Bytes)	U: 6,250/10,416	U: 10,416	U: 6,250/12,500	U: 6,250	U: 6,250/12,500
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80/77	80	80	80	80
Track density (TPI)	135	135	135	135	135
Maximum linear density (BPI)	14528/14184	14528	8717/17434	8717	8717/17434
Rotational speed (RPM)	300/360	360	300	300	300
PERFORMANCE					
Actuator type	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Lead Screw, 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)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	100/83.3	83.3	100	100	100
Data transfer rate (KBytes/sec)	31.25/62.5	62.5	31.25/62.5	31.25	31.25/62.5
SIZE (Inches: H x W x D)	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	1.0 x 4.0 x 5.9
FIRST CUSTOMER SHIPMENT	1986	1986	1986	7/85	1987
U.S. OEM PRICE FOR 500 UNITS	--	--	\$95 (1000)	\$79 (1000)	\$90 (1000)
COMMENTS					

1989 DISK/TREND REPORT

MANUFACTURER	TEAC	TECMATE	TECMATE	TECMATE	TECMATE
DRIVE	FD-135JFN	MT-501A NPH-501A NPH-501AC	MT-502 NPH-502A	MT-504 NPH-504A	MT-302 NPH-302
DISK/TREND GROUP	15	14	14	14	15
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	3.5" -- 2/80 BF	5.25" -- 1/40	5.25" -- 2/40	5.25" -- 2/80	3.5" -- 2/80
Nominal disk diameter	3.5"	5.25"	5.25"	5.25"	3.5"
Recording medium	Barium Ferrite	Oxide Coated	Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: 4.0	U: .218	U: .500	U: 1.6	U: 1.0
Capacity per track (Bytes)	U: 25,000	U: 3,125	U: 6,250	U: 10,416	U: 6,250
Data surfaces per spindle	2	1	2	2	2
Tracks per surface	80	35	40	80	80
Track density (TPI)	135	48	48	96	135
Maximum linear density (BPI)	34868	5162	5876	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)	3	6	6	3	6
Settling time (msec)	15	15	10	10	15
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	100	100	100	83.3	100
Data transfer rate (KBytes/sec)	125	31.25	31.25	62.5	31.25
SIZE (Inches: H x W x D)	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	1.625 x 4.0 x 6.0
FIRST CUSTOMER SHIPMENT	1989	1983	8/86	9/86	1986
U.S. OEM PRICE FOR 500 UNITS	\$150 (1000)	\$55	\$52	\$70	\$80
COMMENTS		Apple compatible			

1989 DISK/TREND REPORT

MANUFACTURER	TECMATE	TECMATE	TOSHIBA	TOSHIBA	TOSHIBA
DRIVE					
	NPH-304	NPH-312	ND-0401 ND-04DT-A	ND-0801 ND-08DE-A	ND-3521 ND-352SH/TH-A
DISK/TREND GROUP	15	15	14	14	15
MARKET	OEM	OEM	Captive, OEM	Captive, OEM	Captive, OEM
MEDIA: Generic type	3.5" -- 2/80 HD	3.5" -- 2/80	5.25" -- 2/40	5.25" - 2/80 HD	3.5" -- 2/80
Nominal disk diameter	3.5"	3.5"	5.25"	5.25"	3.5"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: 1.0/2.0	U: 1.0	U: .5	U: 1.0/1.6	U: .5/1.0
Capacity per track (Bytes)	U: 6,250/12,500	U: 6,250	U: 6,250	U: 6,250/10,416	U: 6,250
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80	80	40	80/77	80
Track density (TPI)	135	135	48	96	135
Maximum linear density (BPI)	8717/17434	8717	5876	5922/9646	8717
Rotational speed (RPM)	300	300	300	360	300
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING:Track to track(msec)	6	3	6	3	3
Settling time (msec)	15	15	15	15	15
Head load time(msec)	Continuous Contact	Continuous Contact	Continous Contact	Continous Contact	Continuous Contact
Average rotational delay (msec)	100	100	100	100/83.3	100
Data transfer rate (KBytes/sec)	31.25/62.5	31.25	31.25	31.25/62.5	31.25
SIZE (Inches: H x W x D)	1.0 x 4.0 x 5.9	1.2 x 4.0 x 5.9	1.6 x 5.7 x 8.2	1.6 x 5.7 x 8.2	1.0 x 4.0 x 5.9
FIRST CUSTOMER SHIPMENT	3/88	11/87	1Q88	1Q88	1Q88
U.S. OEM PRICE FOR 500 UNITS	--	--	\$55 (1000)	\$70 (1000)	\$60 (1000)
COMMENTS					

1989 DISK/TREND REPORT

MANUFACTURER	TOSHIBA	TOSHIBA	TOSHIBA	TOSHIBA	Y-E DATA
DRIVE	ND-3551 ND-355S/T-A	ND-3561 ND-356S/T-A	PD-211	PD-401	YD-180
DISK/TREND GROUP	15	15	15	16	13
MARKET	Captive, OEM	Captive, OEM	OEM	OEM	OEM
MEDIA: Generic type	3.5" -- 2/80 HD	3.5" -- 2/80 HD	3.5" -- 2/80 BF	3.5" - 2/320 BF	8" -- 2/77
Nominal disk diameter	3.5"	3.5"	3.5"	3.5"	8"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	Barium Ferrite	Barium Ferrite	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: 16.0	U: .8/1.6
Capacity per track (Bytes)	U: 6,250/10,416	U: 12,500	U: 6,250/25,000	U:	U: 5,208/10,416
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80/77	80	80	320	77
Track density (TPI)	135	135	135	542	48
Maximum linear density (BPI)	8717/14184	8717/17434	8717/34768	35080	3408/6816
Rotational speed (RPM)	300/360	300	300	1500	360
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Band, Stepping Motor	Linear, Voice Coil	Band, Stepping Motor
POSITIONING:Track to track(msec)	3	3	3		3
Settling time (msec)	15	15	15		15
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact		50
Average rotational delay (msec)	100/83.3	100	100	20	83.3
Data transfer rate (KBytes/sec)	31.25/62.5	31.25/62.5	31.25/62.5/125	625	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 6.3	1.625 x 4.0 x 5.6	1.26 x 4.0 x 5.9	2.25 x 8.55 x 12.6
FIRST CUSTOMER SHIPMENT	1Q88	1Q88	1988		9/81
U.S. OEM PRICE FOR 500 UNITS	--	\$70 (1000)	\$125 (1000)		--
COMMENTS				50 msec average head positioning Embedded Servo	

1989 DISK/TREND REPORT

MANUFACTURER	Y-E DATA	Y-E DATA	Y-E DATA	Y-E DATA	Y-E DATA
DRIVE					
	YD-380-1710	YD-380-1714	YD-380B-1710B	YD-380B-1711B	YD-380B-1714B
DISK/TREND GROUP	14	14	14	14	14
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 HD	5.25" - 2/80 HD
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	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: .8/1.6	U: .5/1.0 or U: .8/1.6	U: 1.6	U: 1.0/1.6	U: 1.0/1.6
Capacity per track (Bytes)	U: 5,208/10,416	U: 6,250/10,416	U: 10,416	U: 6,250/10,416	U: 6,250/10,416
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	77	80/77	77	80	80/77
Track density (TPI)	96	96	96	96	96
Maximum linear density (BPI)	4823/9646	5922/9646	9646	5922/9870	5922/9646
Rotational speed (RPM)	360	300/360	360	360	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	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	83.3	100/83.3
Data transfer rate (KBytes/sec)	31.25/62.5	31.25/62.5	62.5	37.5/62.5	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 5.75 x 8.0	1.625 x 5.75 x 8.0
FIRST CUSTOMER SHIPMENT	2/82	1984	4/86	4/86	4/86
U.S. OEM PRICE FOR 500 UNITS	--	--	--	--	--
COMMENTS					

MANUFACTURER	Y-E DATA	Y-E DATA	Y-E DATA	Y-E DATA	Y-E DATA
DRIVE					
	YD-380B-1736B	YD-580B-1354B YD-580B-1355B	YD-580B-1376B	YD-801 YD-802	YD-645C YD-646C
DISK/TREND GROUP	14	14	14	14	15
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Generic type	5.25" - 2/80 HD	5.25" -- 2/40	5.25" -- 2/40	5.25" - 2/80XHD	3.5" -- 2/80
Nominal disk diameter	5.25"	5.25"	5.25"	5.25"	3.5"
Recording medium	High Density Oxide Coated	Oxide Coated	Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: 1.0/1.6	U: .5	U: .5	U: 3.333	U: .5/1.0
Capacity per track (Bytes)	U: 6,250/10,416	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	80	40	40	80	80
Track density (TPI)	96	48	48	96	135
Maximum linear density (BPI)	5922/9870	5876	5876	19740	4358/8717
Rotational speed (RPM)	360	300	300	180	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	5	5	3	6
Settling time (msec)	15	15	15	15	15
Head load time(msec)	50	50	50	50	Continuous Contact 100
Average rotational delay (msec)	83.3	100	100	166.7	100
Data transfer rate (KBytes/sec)	37.5/62.5	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	1.0 x 4.0 x 5.9
FIRST CUSTOMER SHIPMENT	2Q87	4/86	2Q87	1Q87	1986
U.S. OEM PRICE FOR 500 UNITS	--	--	--	--	--
COMMENTS	Also sold as YD-380B-PC		Also sold as YD-580B-PC	Compatible with 1.0 and 1.6 MB formats	

MANUFACTURER	Y-E DATA	Y-E DATA	Y-E DATA	Y-E DATA	
DRIVE					
	YD-665C	YD-686C	YD-701 YD-702	YD-740	
DISK/TREND GROUP	15	15	15	15	
MARKET	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 HD	
Nominal disk diameter	3.5"	3.5"	3.5"	3.5"	
Recording medium	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	Cobalt Modified Oxide Coated	
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	U: 1.6	U: 1.0/1.6	U: 1.0/2.0	U: 1.0/2.0/4.0	
Capacity per track (Bytes)	U: 10,416	U: 6,250/10,416	U: 6,250/12,500	U: 6,250/25,000	
Data surfaces per spindle	2	2	2	2	
Tracks per surface	77	80/77	80	80	
Track density (TPI)	135	135	135	135	
Maximum linear density (BPI)	14184	8717/14184	8717/17434	8717/34868	
Rotational speed (RPM)	360	300/360	300	300/150	
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	
POSITIONING:Track to track(msec)	3	3	3	3	
Settling time (msec)	15	15	15	15	
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	
Average rotational delay (msec)	83.3	100/83.3	100	100/200	
Data transfer rate (KBytes/sec)	62.5	31.25/62.5	31.25/62.5	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	1.0 x 4.0 x 5.9	1.0 x 4.0 x 5.9	
FIRST CUSTOMER SHIPMENT	1986	1Q87	1Q87	3Q88	
U.S. OEM PRICE FOR 500 UNITS	--	--	--	--	
COMMENTS					

MANUFACTURER PROFILES

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 "1988 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. "1988 total net sales" covers the fiscal year ending in 1988 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, 1988, 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 1988 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	7.81
India	Rupee	13.9
Japan	Yen	128.00
South Korea	Won	735.00
Taiwan	Dollar	26.6

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 to develop high capacity 3.5 inch floppy disk drives. The initial product was a 21.4 megabyte drive scheduled for 1989 shipment with a 43.2 megabyte version announced later, for delivery in 1990. Both models employ embedded servo, using preformatted diskettes with barium ferrite media. 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. Limited shipments of the 21.4 megabyte drive began in late 1989, with full production scheduled for the first part of 1990. Brier has licensed Irwin Magnetics, since purchased by Cipher, as a second manufacturing source.

DATA TECHNOLOGY CORPORATION (See Qume Corporation)

DIGITAL EQUIPMENT CORPORATION
146 Main Street
Maynard, MA 01754

1988 total net sales: \$11,475,400,000	Net income: \$1,305,633,000
(FY ending 6/30/88)	

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. Shipments have been declining over the last several years.

EASTMAN KODAK COMPANY
343 State Street
Rochester, NY 14650

1988 total net sales: \$13,305,000,000	Net income: \$1,178,000,000
--	-----------------------------

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
14930 Alondra Boulevard
La Mirada, CA 90638

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.

INSITE PERIPHERALS, INC.
4433 Fortran Drive
San Jose, CA 95134-2302

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 visible servo tracks on the surface of 3.5 inch barium ferrite media. A version that is downward compatible with standard 3.5 inch 1 and 2 megabyte drives in both read and write mode was announced at the 1989 Fall Comdex show. Insite is attempting to achieve mainstream status for the "floptical" through licensing of established drive and media manufacturers, with Iomega as the first announced licensee, and is aggressively seeking additional strategic relationships. Internal manufacturing will start in late 1989.

INTERNATIONAL BUSINESS MACHINES CORPORATION
Route 22
Armonk, NY 10504

1988 FDD sales: \$20,200,000

1988 total net sales: \$59,681,000,000

Net income: \$5,806,000,000

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 a mainstream minifloppy configuration. More recently, the IBM blessing was given to 1.6 megabyte 5.25 inch drives and to 3.5 inch microfloppies, and these configurations are now industry standards. The 1987 introduction of the PS/2 series of personal computers using both 1 and 2 megabyte microfloppies reinforced the 3.5 inch trend and gave the 2 megabyte format a major boost. It is now expected that IBM will use the 4 megabyte barium ferrite 3.5 inch drives pioneered by Toshiba for applications to be introduced in 1990, and IBM's preparations for this move have already prompted many Japanese floppy drive manufacturers to prepare for production of 4 megabyte barium ferrite drives. 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 has continued in order to support older product families, but is now at a low level.

IOMEGA CORPORATION
1821 West 4000 South
Roy, UT 84067

1988 FDD sales: \$64,500,000

1988 total net sales: \$111,501,000

Net income: \$8,566,000

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. The 5.25 inch product line includes drives offering 21.4 megabytes capacity and a 44.5 megabyte model added in mid-1989. Iomega has licensed the Insite Peripherals 'floptical' drive, but has not yet announced a production start-up date.

MILTOPE CORPORATION
1770 Walt Whitman Road
Melville, NY 11747

1988 total net sales: \$668,336,000

Net income: \$1,569,000

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

1988 total net sales: \$183,162,000 Net income: \$5,036,000
(FY ending 2/29/89)

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, and 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 in which Qume has a 24.05% interest.

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 Associates in bad shape when confronted by increasing competition. In the end, Xerox management decided to stop the bleeding, and most Shugart Associates 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 continued to manufacture the 8 inch product line until 1989, along with additional models acquired from Control Data and Tandon. When inventories are exhausted, which may take a year or two, the firm plans to discontinue floppy drive sales operations. Shugart Corporation also makes tape drives (acquired from Kennedy) and terminals (acquired from TEC).

Asian Manufacturers

(All fiscal years for Japanese companies end in March, 1988, unless otherwise noted.)

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

1988 FDD sales: \$171,600,000

1988 total net sales: \$2,894,328,000

Net income: \$64,664,000

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. Printers and floppy disk drives together account for approximately 21% of Alps revenues.

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. 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 in Garden Grove, California. In 1989, Alps announced a 2 inch floppy drive for use with video camera systems, but has not announced a similar product for use as a computer peripheral.

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

1988 total net sales: \$1,601,031,000

(FY ending 11/30/88)

Net income: \$47,063,000

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. The firm was unable to achieve a high enough production volume to remain competitive in the OEM market, and at the present time, Brother's floppy disk drive production is dedicated to use in Brother products.

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

1988 FDD sales:	\$59,600,000	
1988 total net sales:	\$8,640,703,000	Net income: \$289,844,000
	(FY ending 12/31/88)	

Canon Electronics produces electronic subassemblies for Canon cameras, as well as other electronic components and systems. Floppy disk drives represent 14% of Canon Electronics revenues, down from 27% in 1987. One and two sided 5.25 inch floppy drives have been in production since 1979, originally under a BASF license for one third high drives. Canon also developed its own unique microfloppy using a 97 mm disk, but these drives were dropped, and the firm began shipments of 3.5 inch microflopsies in late 1984. Floppy drives are produced for both captive applications and for sale to the OEM market, both domestic and export. One inch high 3.5 inch drives began production in mid-1986, and in 1988 Canon commenced production of a 2 megabyte 3.5 inch drive.

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

1988 FDD sales:	\$72,500,000	
1987 total net sales:	\$375,117,000	Net income: \$9,008,000
	(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. 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 microflopsies. In 1984, data products accounted for less than 10% of company revenues, but grew to 35% in 1989, with a major proportion contributed by floppy drive shipments.

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

1988 FDD sales: \$58,500,000
1988 total net sales: \$2,096,305,000 Net income: \$40,789,000

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 60% of sales, machine tools hold 11% and electronic equipment the balance. 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. In 1989, Citizen again led the industry in drive packaging, this time with the first introduction of 3/4 inch high 1 and 2 megabyte 3.5 inch floppy disk drives.

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

1988 total net sales: \$510,047,000 Net income: (\$10,109,000)

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 32% of revenues in 1988. 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.

EASTERN PERIPHERALS PVT. LTD.
72, S. D. F. III
Seepz, Andheri (E)
Bombay, 400 096
India

Eastern Peripherals was originally established to make 5.25 inch floppy disk drives and components for Tandon Corporation, and is owned by members of the Tandon family. With Tandon Corporation's departure from the disk drive business in 1987, Eastern Peripherals has continued as an OEM floppy drive manufacturer, using models developed by Tandon, and also produces heads, stepping motors, and other electronic products.

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

1988 FDD sales: \$49,000,000
1988 total net sales: \$15,990,641,000 Net income: \$329,023,000

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 Europe added later. 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-1980s, was later sold to Hyundai.

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

1988 total net sales: \$222,527,000 Net income: (\$5,388,000)

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

1988 total net sales: \$38,868,016,000

Net income: \$1,068,797,000

Hitachi is Japan's largest electric and electronics manufacturer, with about 44% 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.

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

1988 total net sales: \$3,574,445,000 Net income: \$14,125,000
(FY ending 4/30/88)

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 pre-written servo tracks and is downward compatible with standard 48 TPI and 96 TPI formats. Citizen also has rights to manufacture the drive, but only Konica had an active program in 1989.

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

Established in 1973, Lung Hwa for several years offered 2/3 high 5.25 inch floppy disk drives. Most were shipped to the U.S. add-on market for use with home computers, but production ceased in 1988 due to declining demand.

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

1988 FDD sales: \$240,900,000
1988 total net sales: \$2,633,336,000 Net income: \$64,633,000

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 has a joint venture with a manufacturer in the Philippines, Precision Electronics Corporation, to manufacture 5.25 inch floppy disk drives and other computer components.

The firm's product line includes a 1 megabyte 2 inch floppy drive that was adopted by Zenith in 1989 for use in a notebook computer. 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 has also announced a 16 megabyte 3.5 inch drive using metal particle media.

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

1988 FDD sales: \$64,700,000

1988 total net sales: \$37,648,531,000

Net income: \$1,272,141,000

Matsushita's Panasonic, National, Technics and Quasar brand names 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. In addition, production of one inch high 3.5 inch microflopies began in 1987.

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

1988 FDD sales: \$257,500,000

1988 total net sales: \$18,502,180,000

Net income: \$1,272,141,000

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 as early as 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. Production of one inch high 3.5 inch drives at Koriyama began in 1987, and Mitsubishi has become a major supplier of flexible disk drives to IBM.

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

1988 FDD sales:	\$55,000,000	
1988 total net sales:	\$1,026,578,000	Net income: \$289,000
	(FY ending 1/31/88)	

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 went into production in 1987, and at the 1989 Comdex conference Mitsumi displayed a 3.5 inch floppy drive with 3/4 inch height, a 4 megabyte drive 3.5 inch drive, and a 2 inch Sony compatible drive. Mitsumi has established a manufacturing facility in Malaysia for floppy disk drives.

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

1988 FDD sales:	\$550,900,000	
1988 total net sales:	\$21,208,875,000	Net income: \$198,148,000

About 46% of NEC's revenues are generated by computer mainframes, small business systems, minicomputers and desktop systems -- and the firm remains 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. In 1989, NEC announced that it was establishing a subsidiary in Hong Kong to oversee procurement and manufacturing in southeast Asia, including production of floppy disk drives in the Philippines.

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, Toranomon
Minato-ku, Tokyo 105, Japan

1988 total net sales: \$3,526,203,000 Net income: \$27,297,000

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 1/3 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

1988 total net sales: \$136,344,000 Net income: \$612,000

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

1988 total net sales: \$5,267,328,000 Net income: \$132,938,000

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 which now accounts for about 30% of Ricoh sales. 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. All of Ricoh's floppy drives are made by Ricoh Elemex, a subsidiary.

ROCTEC ELECTRONICS LTD.
Subsidiary of Roctec Enterprises
Union Industrial Building
18 Lee Chung Street
Chai Wan
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. Roctec is emphasizing externally mounted diskette add-on products for various personal computers including Apple, Commodore, Compaq, IBM, and Toshiba

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

1988 total net sales: \$4,120,072,000

Net income: \$138,537,000

Samsung Electronics is the leading manufacturer of consumer electronics and appliances in Korea. About two thirds 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. Production of 3.5 inch 2 megabyte 1 inch high drives began in 1989.

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

1988 total net sales: \$694,352,000

Net income: \$6,352,000

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. The firm received a major investment in 1988 from Nippon Steel as part of that firm's diversification program into technology industries. 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

1988 FDD sales: \$156,800,000

Seiko Epson is owned by the privately held Suwa Seikosha/Epson group held 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. As of 1989, the product line included half high 5.25 inch drives and 1 inch and 3/4 inch 3.5 inch drives.

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

1988 FDD sales: \$308,300,000

1988 total net sales: \$11,381,828,000
(FY ending 10/31/88)

Net income: \$286,984,000

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. About 21% of sales are now in non-

consumer products. Included are word processing and personal computer equipment -- both of which use the Sony 3.5 inch microfloppy which has been shipping since late 1981.

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 micro-floppy 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 responded to the growing industry support for one inch high 3.5 inch drives by introducing its own model. The firm has been pioneering the sub-microfloppy field with 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 has also entered the 3.5 inch rigid disk drive market as a supplier to Apple.

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

1988 FDD sales:	\$184,600,000	
1988 total net sales:	\$356,195,000	Net income: \$4,477,000
	(FY ending 9/30/88)	

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 made Teac the leader in 1986 worldwide OEM floppy drive revenues. Major products today are half high 5.25 inch drives and microfloppy drives. In 1985, Teac announced its line of 3.5 inch drives, including a 2.0 megabyte model and subsequently added one inch high models. The firm joined Toshiba in 1987 in announcing 4 megabyte 3.5 inch floppy drives using barium ferrite media. 1 megabyte and 2 megabyte 3/4 inch high 3.5 inch drives were introduced at the Fall 1989 Comdex.

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 5.25 inch models.

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. TECO was unable to establish adequate production volume for floppy drives and ceased manufacturing in 1988.

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

1988 FDD sales: \$207,400,000
1988 total net sales: \$27,909,648,000 Net income: \$474,305,000

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 developed by the firm for 4 megabyte 3.5 inch floppies, with initial production of drives and media underway in 1988. Several other firms have licensed the drive and media. Toshiba is also working on 3.5 inch drives with 15-20 megabyte capacity, and displayed a 16 megabyte 3.5 inch drive using barium ferrite media at the Japan Business Show in May, 1989.

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 made half high 5.25 inch floppy drives which were marketed as OEM and add-on drives in the personal computer market, but ceased production in 1988.

WELTEC DIGITAL, INC.

Subsidiary of Wearnes Brothers
 3002 Dow Avenue
 Tustin, CA 92680

The Remex flexible disk drive operation was sold to a group controlled by Wearnes Brothers, Singapore manufacturers of electronics products, in mid-1984. Manufacturing in recent years was in China, with marketing responsibility still maintained in California, for drives used primarily in other products. Weltec's floppy drive manufacturing was discontinued in 1989.

Y-E DATA, INC.

60, 1-1, Higashi-Ikebukuro 3-chome
 Toshima-ku, Tokyo 170
 Japan

1988 FDD sales: \$142,600,000

1988 total net sales: \$184,398,000

Net income: (\$242,000)

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. Disk drives represent about two thirds of current sales. 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 using cobalt modified oxide media was introduced in 1988 in an unsuccessful attempt to develop an industry standard, and a preliminary announcement of a 27.8 megabyte drive using metal particle media was made in 1989.

European Manufacturers

DZU
6000 Stara Zagora
Bulgaria

DZU is the new name for the Bulgarian organization known for many years as ISOT, following a series of reorganizations during the past year of the governmental structure which manages technology industries in Bulgaria. DZU produces flexible and rigid disk drives, as well as most of the components needed for disk drive fabrication, plus many other electrical and electronic devices. Isotimpex is the foreign trade organization for Bulgarian computer equipment and other electronic products. Disk drives manufactured by DZU 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 since the 1960s, later joined by 8 inch and 5.25 inch floppy drives.

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. 1988 production was impacted by a shortage of suitable heads, but a product redesign has enabled Elcomatic to resume production.

ISOT (See DZU)

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, but manufacturing of floppy drives was discontinued in the last year.

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

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 electronic 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 Guarany, 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 1989 DISK/TREND Report as a separately purchased option to subscribers to the corresponding 1989 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 RT10.89R is 1989 Rigid Disk Drive Report Table 10
 File FT2.89F is 1989 Flexible Disk Drive Report Table 2
 File OT1.89O is 1989 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, 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

	REVENUE SUMMARY					
	1988		1989		1990	
	-----Revenues-----					
	U.S.	WW	U.S.	WW	U.S.	WW
	-----	-----	-----	-----	-----	-----
U.S. Manufacturers						

L>>>>>>>>>>>>>>>>>>>>>>>>>>>>> *V>>>>>>>> *V>>>>>>>> *V>>>>>>>> *V>>>>>>>> *V>>>>>>>> *V>>>>>>>>						
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 1989 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:

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 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.

Example: FS189 Flexible disk specification table

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

Using the specification data base

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

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

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

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.

If you are interested in only a subset of product groups, use the FILE EXTRACT and FILE COMBINE commands to move these records to another file and then use the second file for analysis. The smaller file will take less time to process.

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.

