1985 CONTROLLER CONCEPTS

VOLUME 1

SASI/SCSI
Imbedded Controllers
IBM-PC/XT/AT
Host Adapters
LSI Devices
Chip Sets

Peripheral Concepts

1985 CONTROLLER CONCEPTS

VOLUME I

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FOREWORD

The 1985 peripheral controller market has expanded into new areas, and so has this year's edition of Controller Concepts. New sections included this year cover SCSI Host Adapters and Imbedded controllers.

The Host Adapter market is certainly going through a metamorphosis. As higher performance SCSI controllers and disk drives are coming of age, Host Adapters are no longer restricted to a simple "hardware conversion". By the end of next year, we will likely see a totally new (and rapid growing) Host Adapter marketplace.

Imbedded controllers, or the use of controller chips in disk drives, made their debut in 1985. A lot of changes will occur as this new market begins to structure itself. The development of new controller chips specifically designed for drive use will be one of its segments. As these products become available, we will expand and structure Controller Concepts in tune with changing market conditions.

We are grateful for the many suggestions we received concerning last year's report (our first edition) and have incorporated most of them in this year's report. As we neared completion, we realized that the book had to be split into two volumes. Rather than splitting it by "Low-end vs. High-end" or "Micro vs. Mini", we looked at all of the suppliers and their product lines and essentially followed the same division as the industry. Volume two contains coverage of the DEC-Compatible, Multibus I/II, VMEbus, and other minicomputer busses.

We have changed some of our forecasting categories this year. For example, SASI/SCSI is now forecasted by interface type (XSASI, Full SCSI, etc.) rather than the "old" method of winchester, tape, and multifunction. We have also added additional breakdowns of the forecasts, specifically by drive interface in the SCSI section((i.e., forecasts of ST506/412, ESDI, SMD) and in the IBM-PC section (OEM vs. Captive vs. IBM shipments).

Please give us a call if you have any suggestions, questions, or need additional information. We can also provide "custom" reports or do further investigation into a particular niche market.

Joe Jaworski

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SEMICONDUCTOR CONTROLLERS

IMBEDDED CONTROLLERS

PRODUCT MATRIX

IBM, IBM-PC, PC/XT, and PC AT are trademarks of International Business Machines Corporation.

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INTRODUCTION

How the Report is Organized

Controller Concepts is partitioned by host interface. All controllers, regardless of the type of peripherals they control (i.e., Winchester, Floppy, Tape, etc.) are grouped within a section by the type of computer or host interface they support. Each chapter also presents its data independently, so you can skip around or start at any chapter without missing any pertinent information on the interface of interest. The Total Forecast section contains a numerical and analytical summary of all the chapters. Also included in this section are the total market numbers from Controller Concepts Volume 2, which contains Multibus, Multibus II, VMEbus, Qbus, Unibus, and other minicomputer controllers. In this way, the reader can get an idea of the total controller market as well as the impact of the individual markets listed in this volume.

The host interfaces covered in Controller Concepts (Vol 1) are:

SASI/SCSI- These peripheral controllers are board-level products which support the "older" SASI, XSASI, and SA1403 interfaces, as well as SCSI products adhering to various levels of the SCSI specification developed by the ANSI X3T9 subcommittee. Controller Concepts partitions SCSI products into three types: 1) XSASI/SASI 2)Basic SCSI and 3) Full SCSI (This partitioning method is described on page SCSI-6).

IBM-PC/XT/AT- These peripheral controllers are board-level products which support IBM's line of personal computers. Since IBM continues to buy controllers as an OEM, these shipments are included along with other OEM purchases.

Host Adapters- These board-level products convert a computer specific host interface (IBM-PC, Apple II, Multibus, VMEbus, etc.) into a SASI/SCSI interface. Although host adapters are not technically controllers, they are an essential part of the integration of SCSI to many computer systems. This chapter contains host adapters for both microcomputer and minicomputer systems.

Semiconductor Controllers- These controllers consist of single-chip, chip-sets, and support devices sold on an OEM basis for developing peripheral controller board-level products.

Imbedded Controllers- This new chapter of Controller Concepts addresses semiconductors products intended for use within the peripheral and are typically sold directly to the peripheral vendor for use in manufacturing intelligent drives. Today's controller chips used on board-level products are also used for imbedding. Forecasts for this section includes conventional and unique controller chips used for this purpose.

Most sections are then further divided into the types of peripherals that the controller supports:

Winchester- Controller products supporting one or more winchester or rigid disk drives of various form factors.

Floppy- Controller products which support only floppy disk interfaces of various capacities and form factors.

Tape- Controller products which support 1/4 inch, 1/2 inch, data cassette, or any other sequential access streaming or start/stop tape drive.

Multifunction- Controller products which support more than one type of peripheral such as Floppy/Winchester, Winchester/ Tape, and Winchester/Floppy/Tape controllers.

Some sections have further breakdowns unique to that interface. These breakdowns are described in the associated chapters.

There are also two other sections:

Product Matrix- A detailed list of all controller products in production or scheduled for production by the first quarter of 1986. The products are again grouped by host interface.

Manufacturers' Profiles- A brief description of each supplier and the product lines manufactured.

A Guide to Interpreting the Numbers

To save time in analyzing revenue and shipment numbers, keep the following points in mind:

Constant Dollars- All revenues are listed in 1985 Dollars with no discount rates applied.

Calendar Years- All revenues/shipments are reported in calendar years, not fiscal years. Make appropriate adjustments to your situation.

Manufacturers- All revenues/shipments represent products manufactured by U.S. companies for world-wide consumption, regardless of the physical location of the manufacturing facility. Included are imports by overseas manufacturers intended for U.S. consumption. In other words, the destination of product is always the U.S.

Market Shares- All market share data is listed in revenues for calendar year 1984.

Captive Products- Captive products listed are those controllers used in other products manufactured by the same supplier for internal consumption. For example, a board-level controller supplier who also manufactures subsystems, will ship some of their board-level production "buried" in the subsystems. Likewise, an OEM semiconductor supplier who also sells board-level products will ship some devices captively, or on their own board-level products.

Market Trends

Peripheral Concepts estimates the total controller market/all categories to be:

	1984	1985	1986	1987	1988
REVENUES ($)	512.4M	581.9M	693.1M	826.3M	979.2M
SHIPMENTS	12.1M	15.2M	18.6M	22.0M	26.1M

Revenues of the peripheral controller market are expected to produce a compound annual growth of 17.6% from 1984 to 1988. From 1984 to 1985, revenue growth was 13.6%, down significantly from the 1983-84 period. The sluggish growth experienced in the computer industry certainly affected the overall controller market growth, but their was also a lag of 6-9 months before most suppliers experienced a downturn in new and existing orders. With few exceptions, the second quarter of 1985 revealed the strongest decline. Flat growth is now occuring during the third quarter, so it is likely that the worst is over.

A moderate recovery is expected during the second and third quarters of 1986, with an estimated 19.1% annual growth rate from 1985 levels. Year-to-year revenue growth is expected to stabilize within the 19.0% to 19.5% range through 1987. Unit shipments are a different story. An impressive 22.8% increase over 1984 levels are projected for 1985, increasing to 36.4% annually by 1988. The main driving factor is the introduction of many new semiconductor controller products, both in OEM and imbedded controller segments. Compound unit growth rate for

the forecast period is estimated at 19.4% for chips, 29.6% for board-level products. By 1989, total revenues for all controller products will break the Billion Dollar mark.

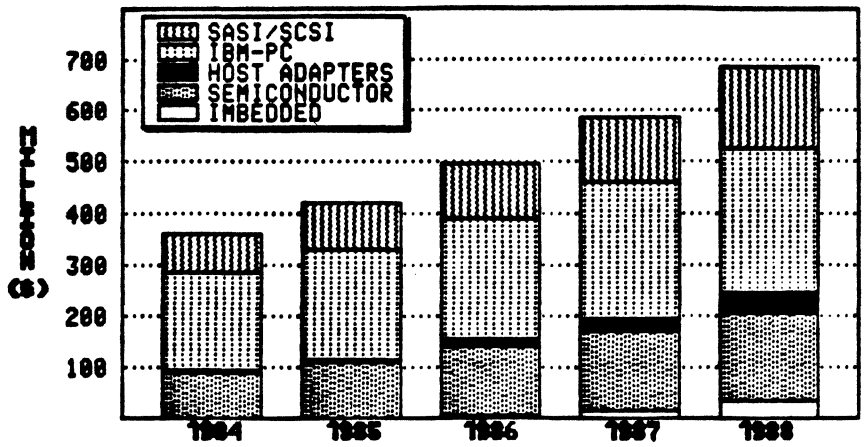
The IBM-PC controller segment will account for 37.1% of all revenues generated in 1985, or roughly $216.1 Million. The second strongest market is expected to be semiconductors at 18.9%, with revenues of $109.9 Million. In third place is the SASI/SCSI board-level market, which will actually decline in overall revenue share from 1984 to 1985, from 15.0% to 14.4%. The strong growth of IBM shipments and semiconductors will account for SCSI's loss of share. But actual revenues for this market will increase from $76.7 Million to $83.7 Million during this period.

The two significant growth markets over the forecast (1984 to 1988) are Host Adapters and SASI/SCSI controllers. Host Adapters will experience a strong compound annual growth in revenues of 69.2%, but the total market is relatively small; remaining below the $50 Million mark in 1988. SASI/SCSI products will grow at a compound rate of 20.8%, from 1984 revenues of $76.7 Million to 1988's projected $163.1 Million. Semiconductor peripheral controllers are becoming more of an OEM product rather than mostly captive (shipped on board-level controllers), as traditional microprocessor and merchant-market suppliers introduced new products during 1985. There is also some indication that the "build vs buy" decision is reverting back to a "build" status (over the last three years, this market has seen many OEMs specifying complete board products instead of purchasing

controller chips). However, a strong shift from captive to OEM will not occur until late 1986, when volume production and second-sources are established for these new suppliers. The compound growth rate for all semiconductors over the forecast period is expected to be 17.0%, from $89.7 Million in 1984 to $168.1 Million in 1988. Approximately 62.6% of 1984's chip revenues came from shipments of floppy controller devices. By 1988, only 51.7% of revenues will be derived from this source, indicating almost a double growth rate for LSI winchester controllers. Nevertheless, over 11 million floppy controller chips will ship in 1985.

The imbedded controller market is a new segment for the industry. This market, with virtually no shipments in 1984, is expected to increase to 817,000 units by 1988. Revenues (which are on an "if-sold" basis, since product is really shipped within a disk or tape drive) are expected to be $33.2 Million by 1988, primarily coming from purchases by drive manufacturers.

Finally, the markets covered in this volume (SASI/SCSI, IBM-PC, Host Adapters, Semiconductor, and Imbedded) will account for 70.3% of the controller market in 1985, or $360.26 Million. the remaining 29.7% ($152.14 Million) is shared among the DEC-compatible, Multibus, VMEbus, Data General NOVA, Perkin-Elmer, and Texas Instruments minicomputer controller markets. And like most other markets in the electronics industry, IBM will remain the largest customer in the foreseeable future.



TOTAL CONTROLLERS -ALL CATEGORIES

REVENUE SUMMARY

	<——— REVENUES BY PRODUCT TYPE ($000) ———>										
	ACTUAL		<——— FORECAST ———>								
	1984		1985		1986		1987		1988		1984-88
CONTROLLER TYPE:											CAGR:
	REV($K)	(%)	REV($K)	(%)	REV($K)	(%)	REV($K)	(%)	REV($K)	(%)	
SASI/SCSI	76,689	15.0	83,714	14.4	108,613	15.7	139,984	16.9	163,076	16.7	20.8%
IBM-PC	188,720	36.8	216,170	37.1	234,570	33.8	255,350	30.9	279,900	28.6	10.4%
HOST ADAPTERS	5,151	1.0	7,027	1.2	13,080	1.9	24,280	2.9	42,250	4.3	69.2%
SEMICONDUCTOR [1]	89,704	17.5	109,998	18.9	135,800	19.6	153,984	18.6	168,055	17.2	17.0%
IMBEDDED	0	0.0	937	.2	3,425	.5	12,910	1.6	33,180	3.4	—
OTHER [2]	152,141	29.7	164,086	28.2	197,569	28.5	239,840	29.0	292,716	29.9	17.8%
TOTAL REVENUES ($000)	$512,405	100%	$581,932	100%	$693,057	100%	$826,348	100%	$979,177	100%	17.6%
ANNUAL GROWTH RATE		—		13.6%		19.1%		19.2%		18.5%	

SOURCE: PERIPHERAL CONCEPTS, INC.

[1] Revenues from non-captive shipments.

[2] Multibus, DEC-compatible, VMEbus, and other Minicomputers (Vol II).

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TOTAL CONTROLLERS -ALL CATEGORIES

SHIPMENT SUMMARY

	<——SHIPMENTS BY PRODUCT TYPE (000)——>										
	ACTUAL		<—— FORECAST ——>								
	1984		1985		1986		1987		1988		1984-88
BOARD-LEVEL PRODUCTS:											CAGR:
	UNITS(K)	(%)	UNITS(K)	(%)	UNITS(K)	(%)	UNITS(K)	(%)	UNITS(K)	(%)	
SASI/SCSI	338.7	18.9	404.8	18.6	579.4	21.4	834.2	24.4	1,107.5	26.1	34.5%
IBM-PC	1,325.2	74.0	1,625.5	74.6	1,910.8	70.6	2,241.2	65.6	2,577.6	60.8	18.1%
HOST ADAPTERS	22.4	1.3	29.4	1.3	64.2	2.4	141.2	4.1	295.4	7.0	90.6%
OTHER [2]	105.2	5.9	119.6	5.5	152.4	5.6	199.6	5.8	259.0	6.1	25.3%
TOTAL SHIPMENTS (000)	1,791.5	100%	2,179.3	100%	2,706.8	100%	3,416.2	100%	4,239.5	100%	24.0%
ANNUAL GROWTH RATE		—		21.6%		24.2%		26.2%		24.1%	

SEMICONDUCTOR PRODUCTS:											
	UNITS(K)	(%)	UNITS(K)	(%)	UNITS(K)	(%)	UNITS(K)	(%)	UNITS(K)	(%)	CAGR:
CHIPS/CHIP SETS	10,339.1	100.0	13,006.0	99.8	15,740.7	99.5	18,271.7	98.4	21,014.3	96.3	19.4%
IMBEDDED	0.0	0.0	19.8	.2	71.7	.5	290.9	1.6	817.5	3.7	—
TOTAL SHIPMENTS (000)	10,339.1	100%	13,025.8	100%	15,812.4	100%	18,562.6	100%	21,831.8	100%	20.5%
ANNUAL GROWTH RATE		—		26.0%		21.4%		17.4%		17.6%	

ALL PRODUCTS:											
	UNITS(K)	(%)	UNITS(K)	(%)	UNITS(K)	(%)	UNITS(K)	(%)	UNITS(K)	(%)	CAGR:
SEMICONDUCTOR	10,339.1	85.2	13,025.8	85.7	15,812.4	85.4	18,562.6	84.5	21,831.8	83.7	20.5%
BOARD-LEVEL	1,791.5	14.8	2,179.3	14.3	2,706.8	14.6	3,416.2	15.5	4,239.5	16.3	24.0%
TOTAL MARKET (000)	12,130.6	100%	15,205.1	100%	18,519.2	100%	21,978.8	100%	26,071.3	100%	21.1%
ANNUAL GROWTH RATE		—		25.3%		21.8%		18.7%		18.6%	

[1] Non-Captive shipments.

[2] Multibus, DEC-compatible, VMEbus, and other Minicomputers (Vol II).

SOURCE: PERIPHERAL CONCEPTS, INC.

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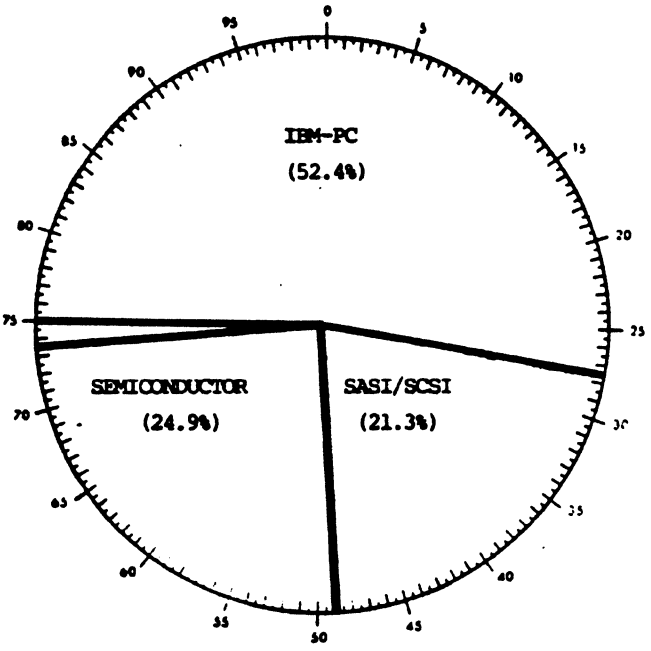
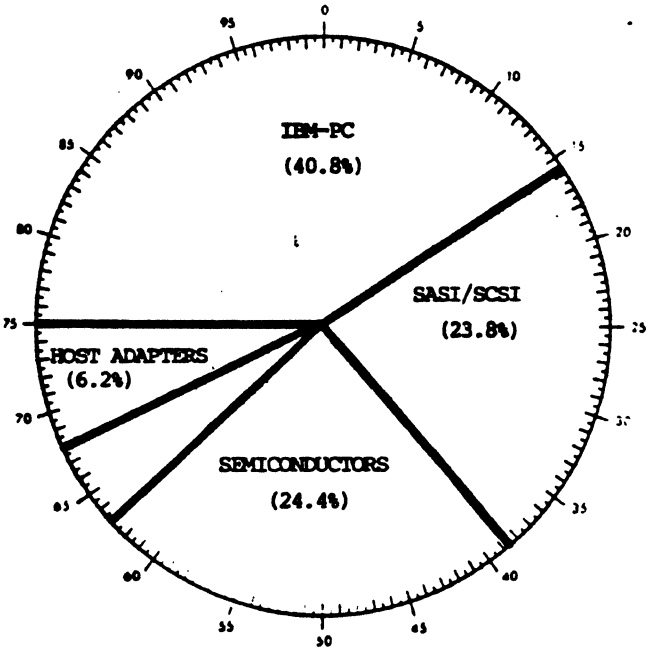


1984 Market Share
Total Revenues: $360.3M



IMBEDDED
(4.8%)

1984-88 CAGR:
17.5%

1988 Market Share
Total Revenues: $686.5M

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THE SASI/SCSI INTERFACE

Introduction

The SCSI (Small Computer Systems Interface) is an attempt to standardize a generic, dedicated I/O (Input/Output) bus for small systems.

The concept of the I/O bus is not new. Minicomputer and mainframe manufacturers have been using I/O busses for at least ten years. The most prominent example is the IBM I/O Channel, which is really where SCSI got its start.

The need for I/O busses stems from the unique characteristics of peripherals. Minicomputer and mainframe manufacturers, long-time users of I/O busses, realized long ago that large peripherals (such as an SMD disk drive or a reel-to-reel tape unit) have unique operating requirements relative to the other CPU oriented system functions. The internal host busses of these larger computers were designed for use by memory boards, DMA controllers, co-processors, etc. They did not operate efficiently with the serial, sector block protocols of peripherals. The high-end manufacturer found that by creating a separate I/O bus, based upon the requirements of these peripherals, data transfers between computer and peripheral could be done more efficiently. As an added bonus, future systems (which normally used an advanced but incompatible CPU bus) could still use the same peripherals as its previous model, saving development time. Even

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today, the most costly and time consuming development phase of a new computer design remains in peripheral support and efficient I/O handling.

SCSI goes one step further than the older I/O bus designs. On larger systems, the I/O bus was captive (i.e., the computer manufacturer developed the bus for use only on their own machines). SCSI is an I/O bus that is designed to be generic. That is, it operates in the same manner independent of the type of computer or host connected to it. Although SCSI certainly enjoys the benefits of I/O bus efficiencies, this was not the motive for its creation.

SCSI was originally developed by peripheral and controller manufacturers, not by any one computer maker. Even in its early days, the goal of SCSI was to ultimately use it as a disk drive bus. These "intelligent" or SCSI bus peripherals would be sold directly to the computer manufacturer on an OEM basis. However, this assumes that computer manufacturers will adopt and implement SCSI, regardless of the make or model of computer. Such universal standards do exist today, like the RS-232 interface. However, so far, SCSI has not been widely accepted by the major computer OEMs. Until it does, SCSI will be limited to the systems integrator and the add-on market. But there is "evaluation" activity occuring at many computer OEMs including Apple, AT&T, Data General, Datapoint, Digital Equipment, NCR, Sperry, and Texas Instruments.

Obviously, many factors will determine the long-range success of SCSI. Probably the most important is the availability of controller products which meet the ANSI specification for SCSI. Odd as it may seem, the majority of products shipped today (called "XSASI" or "SASI") are not SCSI at all. While it is true that these products represent a detriment to the growth of SCSI, they are also the cause of standardization efforts by ANSI and the industry. Most controller companies now have "SCSI-compliant" products available, which now offer a better price/performance than the older XSASI/SASI controllers.

Historical Background

The original SCSI, called SASI (Shugart Associates Systems Interface) was developed as a way to interface winchester disk drives (of varying device-level interfaces) to computers. In a sense, SASI was intended as a "cushion" to the rapid changes expected in winchester disk technology. In particular, changes in data transfer rates.

In 1979, floppy disk manufacturer Shugart Associates, in conjunction with controller manufacturer Data Technology Corporation, developed the first SASI product. This effort was prompted by Shugart's entry into the small winchester business. The interface requirements for Shugart's new winchester drive, the model SA1000, could not be satisfied by using the standard 8-inch floppy interface (from a technical standpoint), and the traditional SMD interface was considered too costly. Follow-on products would also feature significant increases in capacity (the original SA1000 offered five megabytes, unformatted). A new interface was developed for the SA1000, which was a modification of the existing 8-inch floppy protocol. Data Technology had already developed an I/O channel interface similar to SASI, and could manufacture controllers for use with the SA1000. Without controllers, potential customers for the drive could not even perform the simplest evaluation. Hence, the SASI interface was born. A year later, the SA1000 interface was slightly modified by Seagate Technology to form the now popular ST506 interface.

During 1980 and 1981, NCR Corporation had developed a proprietary I/O interface called the Byte Serial Interface (BSI) for use on their next generation machines. The BSI had many of the characteristics of SASI, but of course, since the two interfaces were developed independently, they were incompatible. NCR's desire to use an industry-standard interface resulted in a joint effort with Shugart Associates to produce an enhanced version of SASI called SASI-B or SASI-II. To help further promote the market for SASI, both Shugart and NCR brought the SASI-B specification to the American National Standards Institute (ANSI) for approval. ANSI formed the task group ANSC X3T9.2 to develop the specification. The ANSC group would not allow a vendors name in the title of the document, and changed the title from SASI to SCSI (Small Computer Systems Interface). Many new additions, including a general expansion of the spec (to include other devices besides winchesters and floppies), were incorporated into the document.

SASI vs. SCSI

From 1980 through the early part of 1983, there were no single chip controllers available for SCSI, SA1000, or even ST506. As a result, winchester controllers were implemented as add-on board-level products. Consisting of semi-custom chip sets and off-the-shelf devices, these controllers either mounted inside the computers' chassis or on the drive itself. The most popular winchester controller board became Xebec Corporations's S1410, a SASI to ST506 controller designed to mount on a 5 1/4 inch winchester drive. Many systems

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houses used the S1410 to evaluate and integrate their first winchesters into new systems. Unfortunately, the S1410 implemented the original SASI specifications with some minor differences in command and status protocols. The controller product inherently became non-compliant with the ANSC-revised SCSI specification.

These differences have caused the industry to split into two camps: one being S1410-compatible, and the other being SCSI-compatible. The S1410-compatible controllers are called "XSASI" or SASI, while the others use the SCSI name. Without a clear nomenclature established, many manufacturers are now referring to their ANSC-compatible SCSI products as being "Basic-SCSI" or "Full-SCSI". Although these descriptions are somewhat nebulous, "Full-SCSI" usually means that the product implements the reconnect/disconnect and arbitration protocol options in the SCSI spec. The "Basic-SCSI" products are compliant with SCSI, but do not implement reconnect/disconnect or arbitration options. Because of industry acceptance of these terms, forecasts and trends in this chapter will be referenced by Basic SCSI, Full SCSI, and XSASI/SASI.

The main difference between the older XSASI and the newer SCSI controllers is that XSASI typically operates with only one controller or device on the bus, while SCSI has the option to work with multiple devices and/or multiple computers. The key word in the previous sentence is "option". A manufacturer can correctly call a product SCSI-compatible, even though it delivers the same (or even less) performance than an older XSASI/SASI controller. Hence, the terms

Basic SCSI and Full SCSI say little about the performance of a particular product.

Because of the momentum of the installed base of XSASI controllers, they still represent a significant portion of 1984's shipments. But things have changed. Many controller manufacturers have been working on SCSI gate-array/ semi-custom devices for the past 18 months. Many of these devices are now appearing on new products. Full-SCSI controllers are available which fit in the 5 1/4 inch form factor, and soon, 3 1/2 inch SCSI controllers will be commonplace. These products will continue to put tremendous pressure on XSASI/SASI controllers. Revenues for this class of products have declined 17.0% in the past year, from $33.9 Million in 1984 to an estimated $28.1 Million in 1985. By the end of 1986, XSASI/SASI controllers will yield only $21.6 Million in revenues, representing an annual (1985-86) decline of 23.4%. There is little, if any, new designs specifying the older SASI or XSASI controller products.

Technical Background

The move from XSASI to SCSI is more than economic. The growing popularity of SCSI can also be attributed to its "device independence". There are basically two types of interfaces used on storage devices, 1) device-level and 2) intelligent. Device-level interfaces consist of many signal lines, each dedicated to perform a single, somewhat primitive function. A controller is installed between the computer and peripheral to convert the device-level signals to

computer-compatible (serial) data and control. The controller must apply different types of signals to these lines, sometimes in sequence, to instruct the peripheral to perform a task. For example, to instruct a disk drive to read a desired file, the controller must first seek the head to the appropriate cylinder. This function alone requires many separate electrical pulses. The controller must then find the desired data within the current cylinder, extract the applicable sectors which make up the file, check for errors (sometimes correct them and/or retry), convert the serial data from the disk into parallel form, then give the data to the computer for further processing.

It sounds complicated, and it is, but a device-level interface is still the most cost-effective way to integrate a winchester disk drive into a system. Some of the more popular device-level interfaces are ST506/412, SMD, and most recently, ESDI. These types of winchester drives are price competitive, multi-sourced, and available in a wide variety of capacities and performance levels. But they all share two major problems: 1) The computer must know where each sector of data is located as well as how many there are, and 2) The controller must know the electrical parameters (in great detail) of each signal line. As winchester technology continues to change, so will these parameters. The computer OEM or system integrator cannot take advantage of a new, higher performance disk drive without rewriting software and/or changing the hardware when a more efficient device-level interface is available. Similarly, the peripheral

manufacturer cannot offer better performance or higher capacities in the new drive under the constraints of the current interface. This situation has probably been the biggest detriment to the introduction of high capacity, high performance winchesters.

On the other hand, an "intelligent" interface such as SCSI, solves these two problems. SCSI contains a standard set of commands, each performing a complex function. In the above example, in order to read a file via SCSI, the computer simply sends the address of the data and issues a "Read" command to the SCSI bus. The SCSI controller (or SCSI-based peripheral) finds the data and presents it on the bus, ready to be received by the computer in parallel form. Aside from the simplicity, the significant advantage here is that the computer specifies a "logical" block as an address of the data, rather than a "physical" sector and cylinder location. Problem 1 above is solved: the disk capacity and its organization of sectors/cylinders can change with little or no impact on software.

Rather than being composed of individual signal lines, SCSI uses a common 8-bit bus (with optional Parity) for data, commands, and status. Problem 2 is solved: The data rate or functionality of individual control lines can change without any effect on the SCSI bus. In fact, the computer does not even know such a device-level bus exists, since all communications are handled via the SCSI protocol.

Figure 1 illustrates the two popular ways that SCSI is used. Both configurations use a "host adapter" or a computer-specific board which

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converts the system's internal bus into an SCSI I/O bus. There are also various levels of sophistication that a host adapter may employ (see the section on host adapters for a detailed discussion). In Figure 1, the bottom configuration shows an SCSI peripheral communicating directly to the bus, while at the top, an SCSI add-on controller (typically mounted on the disk drive) is shown between the peripherals and the SCSI bus. These controllers can be considered "protocol converters", converting the SCSI interface to a device-level peripheral bus.

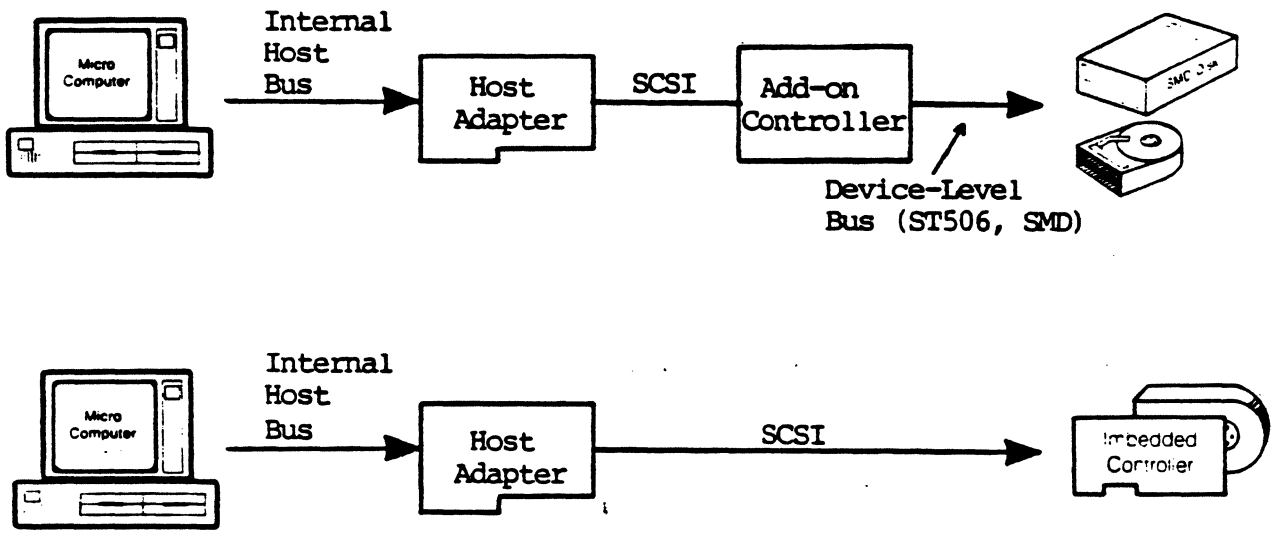

Figure 1.
Typical SCSI Implementations

The lack of SCSI peripherals, winchester or otherwise, keeps the independent controller/peripheral configuration the most popular in use today. Even as SCSI peripherals become widely available, separate

controllers will continue to be popular. The low cost of device-level winchester drives, the ability to "mix and match" controller and peripheral, the availability of multifunction controllers (i.e., tape and winchester controller on a single board), and the higher level of sophistication available in dedicated controllers will all contribute to the long-term board-level controller market. In other words, at any given point in time, it is likely that there will be a controller with more performance/sophistication than can fit "imbedded" in the disk drive. There will always be two co-existing applications: High performance and low cost.

The cost of the host adapter keeps the SCSI system (host adapter/controller/drive) at a price disadvantage when compared to other alternatives such as a bus-specific controller. But that additional cost buys expansion capability. As these systems truly implement multiple peripherals on the SCSI bus (a situation that is virtually non-existent today), the price of the host adapter can also be amortized over the number of peripherals, reducing the total system cost. But host adapters which support multiple peripherals (or "targets" as the ANSC spec calls them) will require increased functionality and hence, increased cost. Semiconductors for SCSI become the critical path for the future success of this interface, as these chips can be used in host adapter, drive, and controller.

SCSI's multiple peripheral/multiple host capability is its most attractive feature. As the office systems market continues to mature, many new and older machines are being adapted for networking. SCSI is

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well suited for this application, either as a file server or a local shared resource.

A Changing Market

As mentioned earlier, the cost of an SCSI system today is more expensive than traditional alternatives. The price of the the host adapter, controller, or SCSI peripheral is more costly than a dedicated bus-specific controller coupled to a device-level winchester disk drive. This alternative does not support the expansion capabilities of SCSI, but in some applications, particularly a single-user personal computer market, cost outweighs these expansion benefits. Add-on board products available for these computers now perform multiple functions, thereby preserving the available number of slots for system expansion.

XSASI and host-specific controllers which feature multiple peripheral support (winchester/tape, winchester/floppy, etc.) compete with SCSI implementations in the single host/multiple peripheral configuration. Many of these products perform peripheral-to-peripheral communications internally, keeping the bus free. Unfortunately, it is at this level that most computer OEM's and system integrators begin to see the benefits of SCSI.

An SCSI floppy disk drive or an SCSI floppy controller has an extremely limited market. Today's pricing of floppy disk drives and LSI floppy controllers enable the computer OEM to integrate a floppy

into the base system at very low cost (in some cases, for less than $50). One must question the advantage of a second floppy disk drive on the SCSI bus, even if supported by a multifunction controller. In fact, the low recurring costs of a floppy controller/drive has made this peripheral "standard" on all but the lower-end home machines, a market that is clearly not SCSI territory.

SCSI peripherals, or those peripherals containing an imbedded SCSI controller, will compete with the SCSI controller board-level market. But most peripheral manufacturers will initially purchase standard and custom controller chips for integration into their drives, at least until in-house controller expertise is developed. A controller company which supplies both chips and board-level products can take advantage of this new market. By 1988, over 30% of all winchester controller chips will be sold via this channel. In the short term, many SCSI buyers will continue to prefer separate controller and drive procurement to retain maximum price and performance flexibility.

The majority of SCSI devices available today have been limited to winchester and tape peripherals simply because it was these manufacturers who were responsible for the development and promotion of SCSI. Both the printer and communications market has not experienced much interest. The popular Centronics-parallel and RS-232 interfaces are low in cost, supported by virtually all computer manufacturers, and present stiff competition on a price-basis with SCSI. The communications market generally finds SCSI quite limited, particularly in terms of its data rate and contention protocol when

compared with traditional data communications alternatives. Both these markets will grow, but not until a major computer OEM chooses SCSI as a "standard" port on the back of the system. There is much speculation this year of such an event happening at IBM, Digital Equipment, AT&T, and Apple. We believe Apple will be the first major user, followed closely by AT&T. Don't expect too much activity before the second quarter of '86. DEC's renewed interest in QBUS may have positive connotations for SCSI, but not in the near term. In the case of IBM, the use of a generic interface doesn't make sense. Despite strong speculation, any company with the clout to set industry standards has little to gain by adopting an interface used by its much smaller competitors.

The "vendor unique" and "optional" commands in the SCSI specification has caused many of today's products to be software-incompatible. There are no guidelines or levels of SCSI supported in the ANSC specification. The "mandatory" command set, which all devices must recognize, is too limited to allow even the simplest firmware or host adapter to support only those commands. The end result is the SCSI designer must modify firmware and/or driver routines each time a different vendors' product is qualified. This problem continues to slow the growth of SCSI. A low cost, high-volume controller chip for SCSI may stabilize these command choices in the future, but these devices will probably be available from a variety of vendors with slightly different command support, or simply allow any command to be passed along the bus. Another possibility, and one that holds the most

promise, may be a de facto solution. One manufacturer becomes a dominant supplier of SCSI controllers, forcing all others to manufacture command-compatible products. This would not be the first (or last) time that an industry standard became established in this way.

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Product Definition

Products and forecasts within this group refer to XSASI/SASI, Basic SCSI (non-arbitrating) and Full SCSI (reconnect-disconnect) board-level controllers of various form factors. These controllers interface to a variety of peripherals including winchesters, tapes, and floppies. During Calendar year 1984, there were 11 manufacturers shipping 54 products. Examples of products and manufacturers in this group are:

Adaptec, Inc.	ACB-4000 ACB-5500
Adaptive Data Systems, Inc.	PYTHON-II COMBO-I
Data Technology Corporation	802C 510D
Emulex Corporation	MEDALIST MD01 TITLEIST MT02
NCR Corporation	ADP-41-04 ADP-44-02
Scientific Micro Systems	FWD5001 5100
Sysgen Corporation.	SC3000 SI536
Western Digital Corporation	WD1002-SHD WD1036R-SHD
Xebec Corporation	S1410A S1420

Market Trends

Peripheral Concepts estimates the total SASI/SCSI market to be:

	1984	1985	1986	1987	1988
REVENUES ($)	76,689K	83,714K	108,613K	139,984K	163,076K
SHIPMENTS	338.7K	404.8K	579.4K	834.2K	1107.5K

Revenues for this market are expected to produce a compound annual growth rate of 20.8% from 1984 through 1988. Revenues from 1984 to 1985 will experience a growth of 9.2%, while shipments for the same period will increase 19.5% from 338,600 to 404,700 units. The slower short-term growth in the computer industry is partly responsible for this near term slowdown, which is expected to recover during the second half of 1986.

The shift from XSASI to SCSI is occuring ahead of our 1984 predictions. It is evident now that 17% of the XSASI business will give way to SCSI before the end of 1985. A proliferation of semiconductor products for SCSI (Both custom and semi-custom) will allow Basic and Full SCSI controllers to compete on a price and form factor basis with XSASI. Over the 5-year period from 1984 to 1988, XSASI/SASI will experience a negative compound annual growth rate of -26.0% in revenues.

Part of the SCSI controller board-level business is also shifting to imbedded controllers and intelligent drives. This new market is almost

exclusively chips and chip-sets sold directly to peripheral vendors. It is estimated that the SCSI board-level controller market will lose 12-15% share to imbedded controllers by 1986. However, a growing need for higher performance controllers (especially in the Basic SCSI configuration) will prevent this share from increasing substantially in future years. The lower performance level SCSI controllers and SASI type controllers will be the first markets to deteriorate, being displaced by imbedded controllers.

Optical disk drives represent a prime candidate for SCSI, more so than ESDI. The characteristics of optical data storage are different than winchesters. SCSI can "hide" these differences from existing operating systems and applications software. The first products will likely be board-level controllers, particularly multifunction units capable of controlling both optical and winchester disk drives on the same board.

It is expected that by the end of 1986, major OEM commitments will materialize for SCSI. This boost to the market will result in a "second-wind" for SCSI, causing a much sharper growth rate towards the end of 1986 and beyond. This demand should also diversify SCSI into non-storage related products.

Technology Trends

The SCSI controller market has been primarily dominated by winchester-only controllers, representing 73.3% of revenues, or $56.2 Million in 1984. Multifunction products accounted for only $13.5

Million or 17.6% of 1984's market. We expect a definite shift to multifunction controllers over the next several years, particularly in the Tape/Winchester combination. The need for back-up of higher capacity winchesters coupled with the wide acceptance of the QIC-36 tape interface will allow multifunction controllers to reach 27% revenue share or $44.0 Million by 1988.

The QIC-02 interface, dominating tape-only and multifunction revenues by 61.7% or $12.5 Million in 1984, will dwindle down to approximately 10.1% by 1988. The higher price tag of QIC-02 drives as well as the "duplication" of intelligence in both the drive and controller, is sharply increasing the use of the QIC-36 tape interface in new applications. By the end of 1986, over half of all the tape/multifunction controllers shipped (62.1%) will use the QIC-36 interface. The only event which could cause a contingency to QIC-36's dominance, is the acceptance of the IBM 3480 tape cartridge for use in microcomputer systems. We believe the 3480 will eventually penetrate this market, but not until late 1987-88, and will most likely utilize the SCSI interface rather than a "native" environment such as QIC-36.

The traditional ST506/412 controller, though not declining on an absolute revenue basis, will make way for ESDI products. Less than .2% revenue share in 1984, ESDI controllers will account for 19.6% of all winchester controllers shipped in 1988, representing $19.8 Million in revenues. The ST506/412 controller will still retain 80.2% revenue share in 1988, down slightly from the 93.9% share or $52.8 Million in 1984. ESDI products will have the most effect on SMD winchester-only

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controllers, declining from its 5.9% share in 1984 to less than .2% by 1988.

The Basic SCSI configuration will continue in a strong growth mode as the need for Full SCSI is circumvented by the growth in multifunction controllers. Likewise, new designs will continue to find the higher performance, Basic SCSI controllers more than adequate to meet design goals. Basic SCSI, which represents 34.9% of the 1984 market, will grow to 52.0% by 1988. But by 1987, it is expected that Full SCSI will begin to gain a foothold, capturing 25% of the 1988 marketplace.

Imbedded controllers and chips will present significant competition to the overall SCSI board-level controller market. These drives will at least be equal in price to discrete controller and drive purchases. Likewise, the price differential between the older SASI controllers and most basic SCSI products will be less than 10% by the end of 1985.

Controller products will have to rely on higher performance and advanced functions to maintain market share. Basic SCSI interfaces will be available on many disk drives in the near future. But advanced controller features such as caching, synchronous transfers, advanced error correction, file-serving, etc., will remain in the controller.

An often overlooked characteristic of SCSI is its performance range. A computer system costing $2500 and one costing $25,000 can both use SCSI effectively because of its wide range of performance options. Personal computers, Supermicro's, low-end CAD/CAM, and engineering workstations are all excellent markets for SCSI. Some limitations do

exist at the very high-end of the market (i.e., Unibus and other minicomputer interfaces) when SCSI is used in an emulating environment. Performance degradation occurs when several levels of protocol conversions have to be made from SCSI to the host bus.

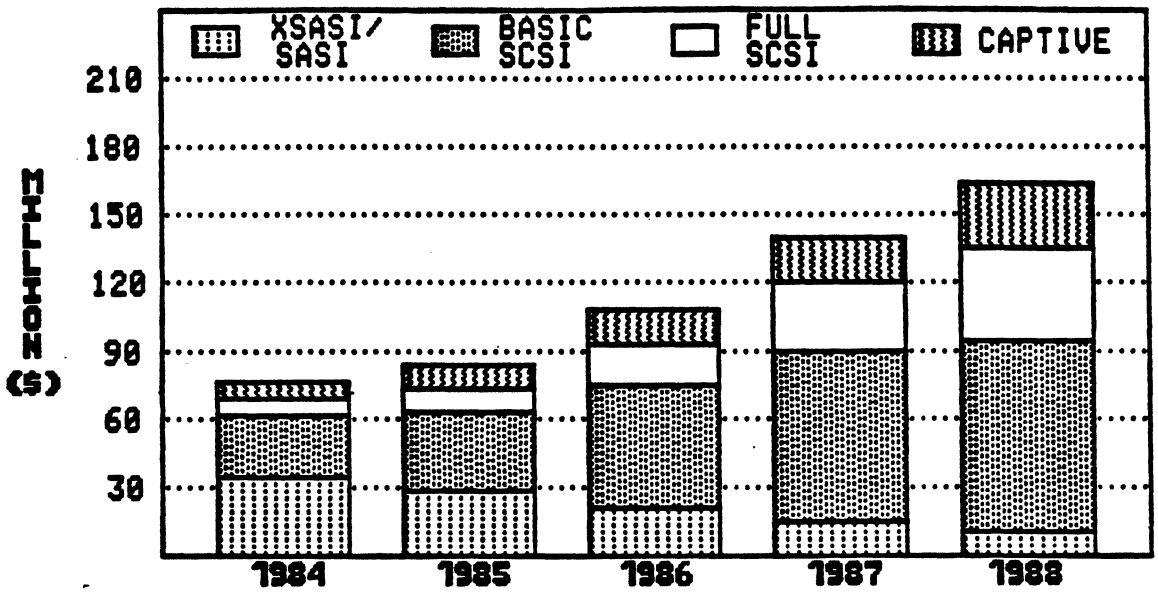
The potential number of SCSI "sockets" has yet to influence the true merchant semiconductor suppliers to develop dedicated silicon for SCSI. In fact, microprocessor suppliers are just now beginning to ship ST506/412 winchester controller chips, usually as part of their microprocessor family of support devices. If the same were done for SCSI, every microprocessor design would have the potential to contain an SCSI port, and that would have a very positive impact on the size of this market.

Key Assumptions

- XSASI/SASI controllers will continue to lose market share to Basic and Full SCSI products.
- Major OEM commitments will be made towards SCSI in the second half of 1986.
- Multifunction controllers (Winchester/Tape) will gain significant acceptance and boost the Basic SCSI configuration.
- SCSI is a strong contender for optical disk drives, both in the imbedded and board-level marketplace.
- Higher performance Basic SCSI products will be adequate for most applications, slowing the short-term growth of Full SCSI.

CALENDAR 1984 MARKET SHARES
REVENUES BY MANUFACTURER

Xebec Corporation	26.5%
Western Digital	18.0%
Adaptec, Inc.	13.8%
Scientific Micro Systems	13.6%
Data Technology Corporation	9.8%
Adaptive Data Systems	5.9%
Sysgen Corporation	4.4%
Other	8.0%
	100.0%



SASI/SCSI CONTROLLERS

REVENUE SUMMARY

	<——REVENUES BY PRODUCT TYPE ($000)——>										
	ACTUAL		<—— FORECAST——>								
	1984		1985		1986		1987		1988		1984-88
CONTROLLER TYPE											CAGR:
	REV($K)	(%)	REV($K)	(%)	REV($K)	(%)	REV($K)	(%)	REV($K)	(%)	
XSASI/SASI	33,950	44.3	28,182	33.7	21,600	19.9	14,308	10.2	10,154	6.2	-26.0%
BASIC SCSI	26,790	34.9	34,920	41.7	54,083	49.8	75,179	53.7	84,866	52.0	33.4%
FULL SCSI	7,435	9.7	11,164	13.3	18,536	17.1	30,114	21.5	40,820	25.0	53.1%
CAPTIVE	8,514	11.1	9,448	11.3	14,394	13.3	20,383	14.6	27,236	16.7	33.7%
TOTAL REVENUES ($000)	$76,689	100%	$83,714	100%	$108,613	100%	$139,984	100%	$163,076	100%	20.8%
ANNUAL GROWTH RATE		—		9.2%		29.7%		28.9%		16.5%	

SOURCE: PERIPHERAL CONCEPTS, INC.

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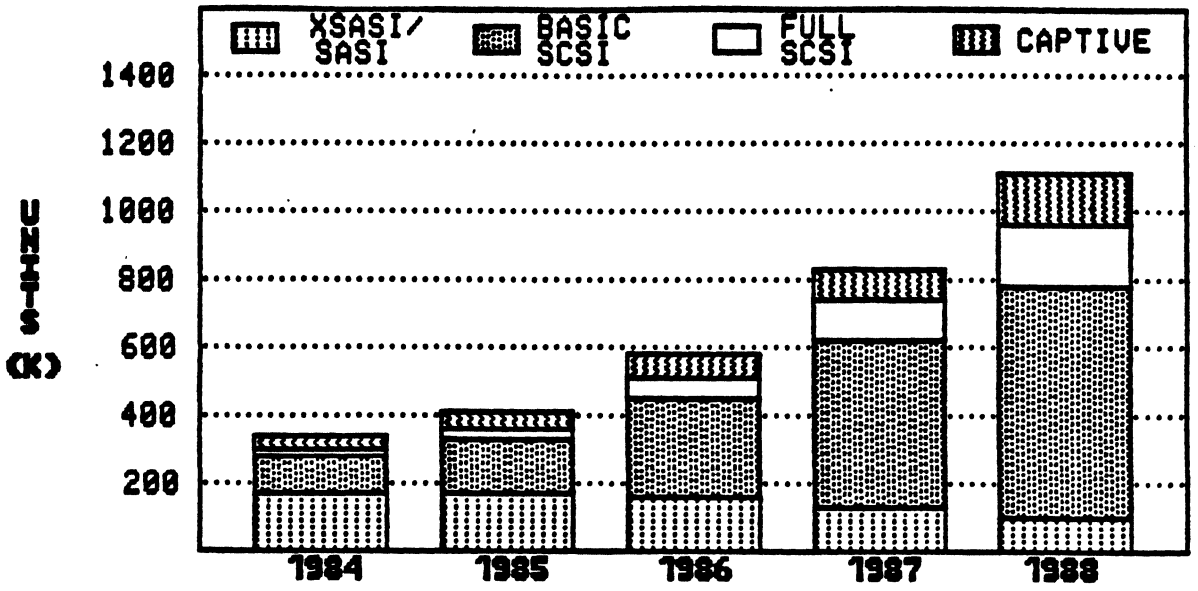

SASI/SCSI CONTROLLERS

SHIPMENT SUMMARY

	<——SHIPMENTS BY PRODUCT TYPE (000)——>										
	ACTUAL		<—— FORECAST——>								
	1984		1985		1986		1987		1988		1984-88
CONTROLLER TYPE											CAGR:
	UNITS(K)	(%)	UNITS(K)	(%)	UNITS(K)	(%)	UNITS(K)	(%)	UNITS(K)	(%)	
XSASI/SASI	173.9	51.3	170.8	42.2	160.0	27.6	128.9	15.5	96.7	8.7	-13.6%
BASIC SCSI	114.2	33.7	165.5	40.9	298.8	51.6	494.6	59.3	684.4	61.8	56.5%
FULL SCSI	20.3	6.0	32.8	8.1	61.9	10.7	118.1	14.2	183.1	16.5	73.3%
CAPTIVE	30.3	8.9	35.7	8.8	58.7	10.1	92.6	11.1	143.3	12.9	47.5%
TOTAL SHIPMENTS (000)	338.7	100%	404.8	100%	579.4	100%	834.2	100%	1,107.5	100%	34.5%
ANNUAL GROWTH RATE		—		19.5%		43.1%		44.0%		32.8%	

AKP

+ 226.42

147.25

SOURCE: PERIPHERAL CONCEPTS, INC.

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SASI/SCSI CONTROLLERS

REVENUE SUMMARY

BREAKDOWN BY FUNCTIONAL TYPE

	<——— REVENUES BY PRODUCT TYPE ($000) ———>										
	ACTUAL		<——— FORECAST ———								
	1984		1985		1986		1987		1988		1984–88
CONTROLLER TYPE											CAGR:
	REV($K)	(%)	REV($K)	(%)	REV($K)	(%)	REV($K)	(%)	REV($K)	(%)	
Winchester	56,213	73.3	59,270	70.8	75,051	61.6	93,090	66.5	100,781	61.8	15.7%
Tape	6,749	8.8	8,120	9.7	12,056	9.9	16,518	11.8	18,264	11.2	28.3%
Floppy	230	.3	84	.1	16,518	13.6	0	0.0	0	0.0	—
Multifunction	13,497	17.6	16,241	19.4	18,264	15.0	30,377	21.7	44,030	27.0	34.4%
TOTAL REVENUES ($000)	$76,689	100%	$83,715	100%	$121,889	100%	$139,985	100%	$163,075	100%	20.8%
ANNUAL GROWTH RATE		—		9.2%		45.6%		14.8%		16.5%	

REVENUES BREAKDOWN BY DRIVE INTERFACE

INTERFACE TYPE											
Winchester Only:	REV($K)	(%)	REV($K)	(%)	REV($K)	(%)	REV($K)	(%)	REV($K)	(%)	
ST506/412	52,784	93.9	55,477	93.6	69,197	92.2	81,081	87.1	80,826	80.2	11.2%
ESDI	112	.2	356	.6	3,377	4.5	10,333	11.1	19,753	19.6	264.4%
SMD	3,317	5.9	3,438	5.8	2,477	3.3	1,676	1.8	202	.2	—
TOTAL REVENUES ($000)	$56,213	100%	$59,271	100%	$75,051	100%	$93,090	100%	$100,781	100%	15.7%
ANNUAL GROWTH RATE		—		5.4%		26.6%		24.0%		8.3%	
Tape Only/Multifunction:	REV($K)	(%)	REV($K)	(%)	REV($K)	(%)	REV($K)	(%)	REV($K)	(%)	
QIC-02	12,492	61.7	13,057	53.6	12,653	37.7	10,458	22.3	6,292	10.1	142.5%
QIC-36	7,572	37.4	11,206	46.0	20,842	62.1	36,390	77.6	56,003	89.9	318.8%
Pertec	182	.9	97	.4	67	.2	47	.1	0	0.0	—
TOTAL REVENUES ($000)	$20,246	100%	$24,360	100%	$33,562	100%	$46,895	100%	$62,295	100%	32.4%
ANNUAL GROWTH RATE		—		20.3%		37.8%		39.7%		32.8%	

SOURCE: PERIPHERAL CONCEPTS, INC.

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THE IBM PC/XT/AT INTERFACE

Introduction

When IBM first introduced its Personal Computer, many industry observers doubted IBM's ability to penetrate an unfamiliar market. It was questionable whether IBM could gain a strong foothold against the established players such as Apple, Tandy, and Commodore. There are no more doubts. No other company or product, in the history of the computer industry, has started from zero and captured the majority of market share as fast as IBM and their personal computer product has done.

The minicomputer/mainframe-dominated office, especially the Fortune 500 corporations, thought little of personal computers before the IBM-PC. These companies typically used two classes of machines. A mainframe or high-end minicomputer, supplying processing power to a limited number of users (mainly clerical and order entry), and stand-alone dedicated word processing computers used within individual departments for secretarial services. Other levels within the organization, particularly the middle manager, had little or no access to computers. IBM's personal computer not only legitimized this class of machine as an office tool, but was marketed to fill this middle manager void without affecting their strongest business: the mainframe market. The recent introduction of the 3270 SNA adapters for the IBM-PC further enforces the mainframe/personal computer synergy and IBM's overall market strategy.

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Recent estimates show that the IBM-PC and compatible machines now account for 70% to 85% of all computers sold in the $2,000 to $5,000 price range. There are over 1,300 companies supplying add-on products for these machines. There is more add-on hardware available for the IBM-PC than all other computers combined. In terms of software, there are over 2,500 applications programs available, taking second place only to Apple Computer's "Apple II" series.

Historical Background

This phenomenal four-year growth was not achieved using standard IBM methods. In 1981, IBM formed the Entry Systems Division in Boca Raton, Florida, which became a dedicated, separate marketing and manufacturing (or at least systems assembly) facility for the IBM personal computer series. This concept is not new within IBM, as a decentralizing strategy for new product lines has been a trend within the company for the past several years. The ESD group also operated differently than other IBM facilities, particularly in terms of procurement and material qualification.

Non-standard IBM methods are not solely responsible for the success of their personal computer. Much of the initial software was obtained from outside sources. The popular CP/M operating system was chosen for the machine in its 16-bit version, called CP/M-86. Also supplied was another operating system called MSDOS, developed by Microsoft Corporation (the IBM version is called PCDOS). The majority of third

party applications software available today runs under PCDOS, as this third party software played a major role in the success of the IBM-PC.

Likewise, the hardware of the machine was marketed as having an "open architecture". The basic PC's five expansion slots and the XT's eight expansion slots presented opportunity to new and existing add-on suppliers, while at the same time, further insured the success of the machine through third party suppliers. It was somewhat risky though, developing a whole new bus specification instead of using an existing standard (S-100 was most dominant at the time). But IBM's willingness to make technical specifications available to the public far outweighed this disadvantage.

There were also factors that put the new product at a disadvantage relative to gaining acceptance. The IBM-PC is a very conservative design. It did not offer any technological or superior features compared to similar priced machines already on the market. In fact, on a feature-by-feature basis, it was more expensive than any of its competitors. But the IBM name, reputation for support, substantial advertising dollars, and established service/distribution facilities, were all part of a complex marketing strategy that transformed the machine into an overnight success.

PRODUCT EVOLUTION

The entire IBM-PC continues to be purchased outside as sub-assemblies, with only final test and assembly performed. We believe IBM will

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eventually take PC manufacturing captive to maintain market share, reduce costs, and support future price reductions. From a management standpoint, the company has already brought the ESD group back under the corporate umbrella. This is a sure sign that IBM corporate views the PC product line as a maturing business.

IBM is now building their own 5 1/4" winchester disk drives. Drives for the AT model are being built in Rochester, Minnesota and XT drives in Fujisawa, Japan. The company also has additional disk drive manufacturing capability in Havant, England and Boulder, Colorado. Producing the remaining printed circuit boards and associated hardware is a relatively simple task when compared to disk drive manufacturing. The company has secured second-source and/or manufacturing rights on all custom and semi-custom components used within the PC from their vendors.

Since the introduction of the original IBM-PC in 1981, many different versions were introduced. The current product line and their memory/mass storage configurations are as follows:

IBM-PC: 64 Kilobytes or 256 Kilobytes of RAM, No Floppy drive, or 1 single-sided drive, or two double-sided Floppy drives.

IBM-PC/XT: 128 Kilobytes or 256 Kilobytes of RAM, 1 double-sided Floppy drive and 1 ten Megabyte Winchester drive.

IBM-PC/XT: 256 Kilobytes of RAM, 1 double-sided Floppy drive.

IBM-PC/XT: 256 Kilobytes of RAM, 2 double-sided Floppy drives.

IBM-PC Portable: 256 Kilobytes of RAM, 1 or 2 double-sided half-high Floppy drives.

IBM-PCjr (Entry): 64 Kilobytes of RAM.

IBM-PCjr (Enhanced): 128 Kilobytes of RAM, 1 double-sided half-high Floppy drive.

IBM-PC/AT (Base): 256 Kilobytes of RAM, 1 half-high 96 TPI Floppy drive.

IBM-PC/AT (Enhanced): 512 Kilobytes of Ram, 1 half-high 96 TPI Floppy drive and 1 twenty Megabyte Winchester drive.

Speculation/Strategies

The IBM-PCjr was discontinued early this year, as the company faced difficulties in penetrating the home market. The much rumored "PC2" machine, which was supposed to be introduced this year, has now been officially "delayed" by the company. We believe downward pricing pressures and the ever-narrowing performance differences between the XT and AT models (caused primarily by sophisticated XT applications software) was the cause of this move. It is also believed that many potential buyers were in a "wait and see" position, impacting sales of both XT and AT models. The PC2 was speculated to be positioned between the XT and AT in terms of capabilities, but it makes more sense for the company to bridge the gap between the AT and the System 36. Such a machine, expected to be introduced in late 1986, will likely use the Intel 80386 32-Bit micrprocessor.

Although all machines in the series have been designed to be compatible, many applications programs are specific on the model of machine that the package will run. Most incompatability problems occur between PC's manufacturered by IBM versus "clones" or

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hardware/software compatible units. A ROM, present in all machines, called the BIOS (Basic Input/Output System) is a key element which ties the operating system to I/O devices. 100% compatibility can only occur if this ROM is duplicated exactly within the "clone". Since this level of duplication results in copyright infringement, no compatible machine is fully IBM-PC compatible. The intent of the BIOS ROM was to give the system a "generic" I/O driver capability, and it does. But many applications programs bypass the standard entry points of the BIOS for improved speed and performance, accessing internal BIOS routines directly.

Market Overview

The total market for IBM-PC peripheral controllers is currently larger than any other segment of the industry, generating over $188 Million in revenues for calendar 1984. A significant portion of the market is attributed to IBM purchases. The company buys 100% of their controller needs from OEM suppliers. The two main suppliers, Xebec Corporation for the XT program and Western Digital for the AT, represent over 80% share of the 1984 market. If IBM takes PC manufacturing captive in the future, these suppliers will still enjoy significant sales of custom and semi-custom chips used on the products.

Most of the activity in OEM controller products continues to be the conversion of PC to XT via after-market controller and drive. In the case of the AT, every machine shipped by IBM, regardless if it comes with a winchester disk drive or not, contains a winchester controller.

Adding a winchester drive and changing the driver ROM will activate the rigid disk portion of this multifunction controller. Although voiding the warranty, this is the most inexpensive way to upgrade a floppy-only AT machine, and this is now occuring at some dealer-distribution points.

The after-market for AT winchester controllers is a questionable one. The add-on controller will have to provide something unique that the factory version does not provide, such as a higher performance interface (i.e., ESDI or SMD) or greatly improved performance.

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Product Definition

Products and forecasts within this category refer to board-level controllers which plug directly into an IBM-PC, XT, or AT bus and support a variety of storage peripherals. During calendar year 1984, there were 8 OEM manufacturers shipping 32 different products. Examples of products and manufacturers in this group are:

Adaptec, Inc.	ACB-2002A ACB-2010A
Data Technology Corporation	5051 5091
Interphase Corporation	PC-80
Scientific Micro Systems	5510 5710
Sigen Corporation	DC6 T-36
Western Digital Corporation	WD1002-WX2 WD1002-WA2
Xebec Corporation	S1210A S1220

Market Trends

Peripheral Concepts estimates the total IBM-PC/XT/AT controller market to be:

	1984	1985	1986	1987	1988
REVENUES ($)	188.72M	216.17M	234.58M	255.34M	279.90M
SHIPMENTS	1.33M	1.63M	1.91M	2.24M	2.58M

Revenues for this market are expected to produce a compound annual growth rate of 10.4% from 1984 through 1988, while shipments for the same period will produce a compound annual growth of 18.1%. Heavy price erosion in the winchester-only segment (averaging 8-12% annually through 1988) will result in a slight decline in revenues, though unit shipments will moderately increase. From 1984 to 1985, an annual negative growth rate of -10.8% revenues, -2.9% units is expected.

Multifunction products show the strongest growth rate, with a compound annual rate of revenues at 29.8% and a corresponding 37.9% in unit shipments. Combination Winchester/Tape and new multifunction controllers, including those for optical disk drives, will be responsible for this growth. Captive controllers, or those boards shipped by controller manufacturers in subsystems, shows a large unit growth of 71.3% compounded annually. But this market will remain relatively small, as 1988 unit shipments will be slightly less than 49,000 units, with an "if-sold" value of $6.3 Million. Independent

subsystems manufacturers will continue to control the lion's share of the subsystems market.

Clearly, IBM is the largest customer for these products. In 1984, IBM accounted for over 81% of sales, or $153.25 Million. Heavy purchases of AT controller boards in calendar 1985 increased revenues to $172.5 Million, but IBM's absolute share of 1985's revenues declined slightly by 1.4% to 79.8%, giving way to the rest of the OEM market which grew 18.3% from 1984 to 1985.

With one customer controlling such a large portion of the market, that customer's buying habits will substantially affect and set the trends for the remaining segments. We believe that IBM has "overbought" XT and AT controller products in 1984-1985. Our estimates show that the company's purchases for 1985 will be approximately 1,245,000 controllers. Optimistic projections for IBM computer shipments in the XT and AT product lines have been reported in the 700,000 to 800,000 range. We believe this excess inventory will be adjusted in 1986, resulting in a -4.5% revenue decline, or $164.6 Million in revenues. But by 1987, the successor to the AT will be in production, resulting in a 1987 increase of 5.1% or $173.1 Million, just slightly higher than the 1985 projection. Captive production of the original PC as well as the XT will occur at this time, keeping overall revenue growth at a modest increase.

The OEM or "non-IBM" market share will remain fairly constant over the next several years. As IBM introduces new models to the PC line, the

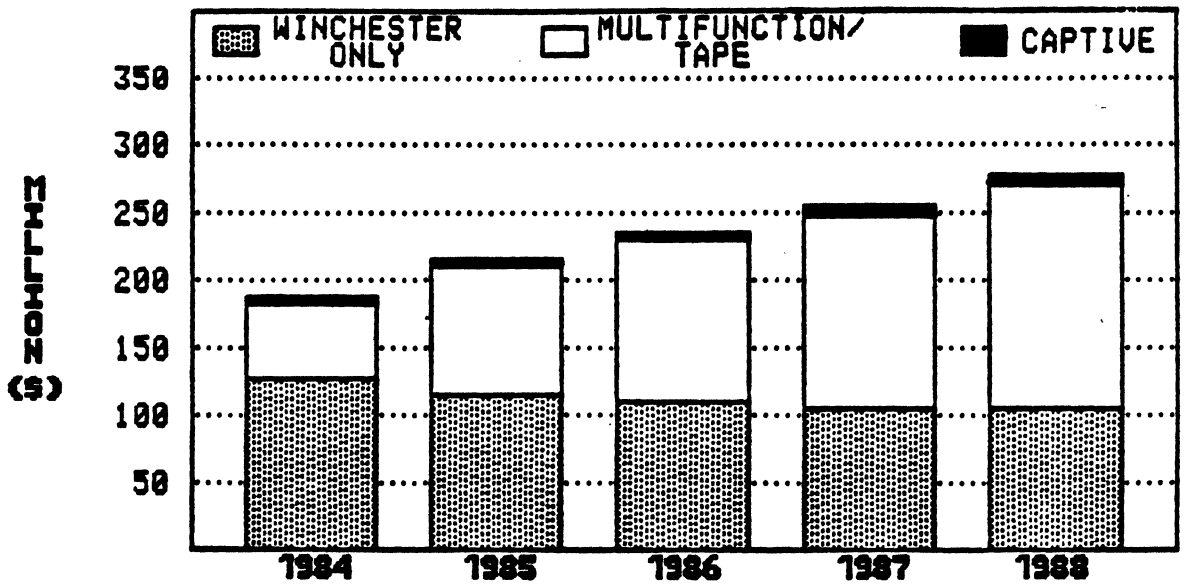
mand for after-market controllers will continue at a relative pace, regardless if the new machines are backward-compatible or not. From 1985 through 1988, market shares will remain at an average 30% OEM/ 70% IBM. The growth in "plug-and-play" or end-user installed subsystems will fuel this growth, as OEM controller manufacturers continue to ship product to the true add-on manufacturers.

Key Assumptions

- IBM will continue to be the largest OEM customer, purchasing approximately 70% of the industry's output.
- Multifunction controllers will experience the strongest growth over the next three years.
- IBM has "overbought" XT/AT controllers in 1985, which will result in a revenue decline during 1986 and early 1987.
- The next generation machine in the PC product line will be introduced in late 1986.

CALENDAR 1984 MARKET SHARES
REVENUES BY MANUFACTURER

Xebec Corporation	52.8%
Western Digital Corporation	32.3%
Data Technology Corporation	11.2%
OTHER	3.7%
	100.0%



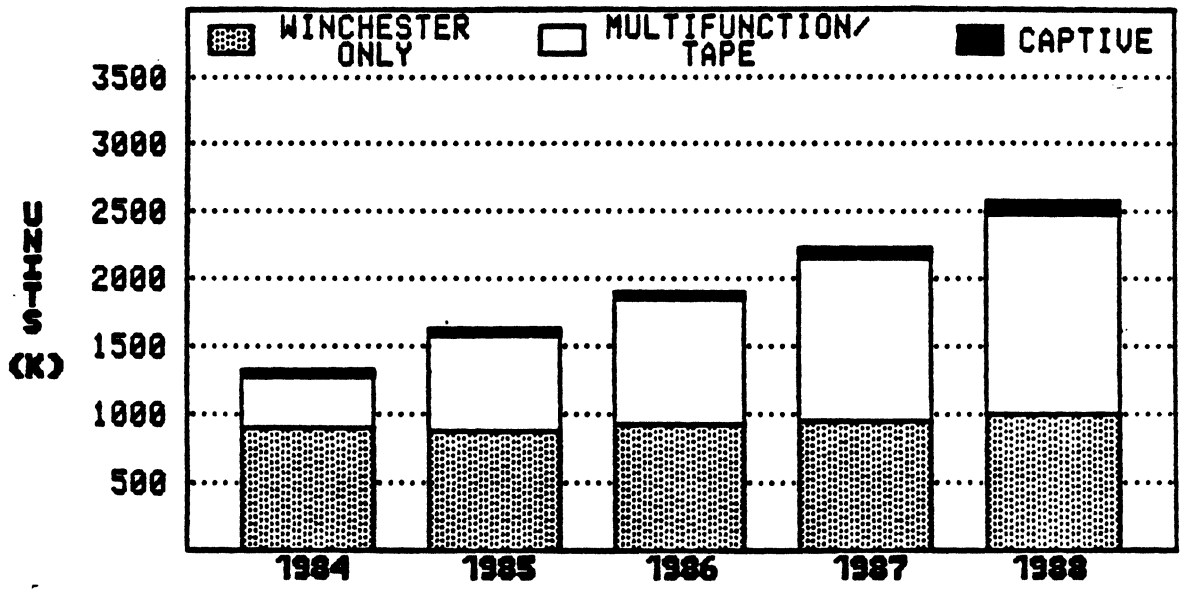
IBM-PC/XT/AT CONTROLLERS

REVENUE SUMMARY

	← REVENUES BY PRODUCT TYPE (MILLIONS) →										
	ACTUAL		← FORECAST →								
	1984		1985		1986		1987		1988		1984-88
CONTROLLER TYPE											CAGR:
	REV($M)	(%)	REV($M)	(%)	REV($M)	(%)	REV($M)	(%)	REV($M)	(%)	
Winchester	128.58	68.1	114.64	53.0	110.21	47.0	105.56	41.3	105.49	37.7	-4.8%
Multifunction/Tape	59.20	31.4	100,19	46.3	122.07	52.0	145.89	57.1	168.11	60.1	29.8%
Captive	.94	.5	1.34	.6	2.29	1.0	3.90	1.5	6.30	2.3	60.9%
TOTAL REVENUES ($M)	$188.72	100%	$216.17	100%	$234.57	100%	$255.35	100%	$279.90	100%	10.4%
ANNUAL GROWTH RATE		—		14.5%		8.5%		8.9%		9.6%	

SOURCE: PERIPHERAL CONCEPTS, INC.

Peripheral Concepts



IBM-PC/XT/AT CONTROLLERS

SHIPMENT SUMMARY

	← SHIPMENTS BY PRODUCT TYPE (~~MILLIONS~~ THOUSANDS) →										
	ACTUAL		← FORECAST →								
	1984		1985		1986		1987		1988		1984–88
CONTROLLER TYPE	UNITS(M)	(%)	UNITS(M)	(%)	UNITS(M)	(%)	UNITS(M)	(%)	UNITS(M)	(%)	CAGR:
Winchester	901.1	68.0	875.1	53.8	934.1	48.9	986.5	44.0	1,014.3	39.4	3.0%
Multifunction/Tape	418.4	31.6	742.1	45.7	961.2	50.3	1,226.0	54.7	1,514.5	58.8	37.9%
Captive	5.7	.4	8.3	.5	15.5	.8	28.7	1.3	48.8	1.9	71.1%
TOTAL SHIPMENTS (M)	1,325.2	100%	1,625.5	100%	1,910.8	100%	2,241.2	100%	2,577.6	100%	18.1%
ANNUAL GROWTH RATE		—		22.7%		17.6%		17.3%		15.0%	

SOURCE: PERIPHERAL CONCEPTS, INC.

IBM-PC/XT/AT CONTROLLERS

REVENUE SUMMARY

	<----------REVENUES BY DESTINATION ($000)---------->										
	ACTUAL		<---------- FORECAST---------->								
	1984		1985		1986		1987		1988		1984-88
CUSTOMER TYPE											CAGR:
	REV($K)	(%)	REV($K)	(%)	REV($K)	(%)	REV($K)	(%)	REV($K)	(%)	
IBM	153,246	81.2	172,502	79.8	164,671	70.2	173,122	67.8	191,734	68.5	5.8%
OEM	34,540	18.3	42,327	19.6	67,613	28.8	78,327	30.7	81,863	29.2	24.1%
Captive	941	.5	1,339	.6	2,290	1.0	3,893	1.5	6,307	2.3	60.9%
TOTAL REVENUES ($000)	$188,727	100%	$216,168	100%	$234,574	100%	$255,342	100%	$279,904	100%	10.4%
ANNUAL GROWTH RATE		—		14.5%		8.5%		8.9%		9.6%	

SOURCE: PERIPHERAL CONCEPTS, INC.

Peripheral Concepts

SCSI HOST ADAPTERS

Introduction

The Small Computer Systems Interface (SCSI) is a general purpose, input/output channel designed to be used on a wide variety of computer systems. But being "general purpose" means that different makes and models of computers must interface to SCSI via a specific piece of hardware and software. That interface equipment is called a host adapter.

The role of the host adapter has been a confusing one. Host adapters for SCSI have been around as long as SCSI itself, specifically, in the form of SASI and XSASI implementations. These early models were used to interface a SASI winchester controller to a host bus, and typically came with some software to "patch" the computers' operating system or install appropriate software driver routines. The hardware portion of the adapter provided nothing more than an electrical conversion from SASI to the host-specific bus.

As SASI has evolved to the higher performance SCSI, host adapters are also evolving to play a more significant role in the performance of the entire subsystem. In fact, SCSI does not seem to be limited to "small systems". The 1.5 Megabyte/second transfer rate (4.0 Megabytes/sec. in synchronous mode) is more than adequate for today's supermicros and some minicomputers. There are SCSI host adapters now available for the Qbus, Unibus, VMEbus, and soon, Multibus II.

Peripheral Concepts

It is generally less expensive today to interface a bus-specific controller and a device-level winchester disk drive to a popular model of computer, rather than using the SCSI bus via a host adapter and a winchester controller. For example, some winchester disk controllers for the IBM-PC currently sell for less than $200, approximately the same price as some SCSI winchester controllers. When the cost of the host adapter is added, the total system price is higher when using SCSI. But the configuration that is achieved is nothing more than an interface for a winchester disk drive. This is neither the goal of the host adapter or the concept of SCSI.

A system that contains an SCSI host adapter will have access to more than just winchesters. Other I/O devices such as communications channels, printers, optical disks, graphics devices, etc., will soon be available with SCSI. The cost of the host adapter can then be amortized over many peripherals. The host adapter can also solve another growing problem concerning those systems that are repackaged with "value-added" to vertical markets. Additional memory cards and I/O functions used by these systems often result in a shortage of slots or backplane access. These systems can benefit from using an SCSI host adapter by allowing multiple I/O capabilities through the use of only one backplane slot. Additional benefits can also be realized by minimizing software development; allowing the same I/O driver routines to access a wide variety of peripherals.

The market for host adapters has also been recognized by the semiconductor suppliers. Several merchant-market chip suppliers have recently added SCSI protocol devices to their product lines.

An Interim Market?

One of the most significant events that has happened in the SCSI market over the past year is the introduction of SCSI-based peripherals. Winchester disk and streaming tape suppliers are readying new storage products which will have an SCSI interface directly on the drive. If these products are sold on an OEM basis to computer manufacturers, then the computer makers will have to include an SCSI port or I/O connector to support this method of connecting peripherals. Such a scenario would eliminate the need for host adapters, as the OEM would be providing that function as part of every system.

The widespread acceptance of SCSI by the major computer manufacturers is an unlikely event. Although we believe that one or possibly two suppliers of microcomputers will adopt SCSI in the near term, the major player IBM, will not.

In the supermicro area, the Multibus interface is driven by a flourishing add-on market from many, many suppliers. There are no dominant market leaders as is the case of IBM in the microcomputer segment. The upcoming Multibus II and especially, the VMEbus will also follow the same structure.

Peripheral Concepts

In the minicomputer area, Digital Equipment is the primary supplier, but the hardware and software after-market for DEC systems is almost as big as the DEC market itself. Although SCSI already exists for this segment to a limited extent, it is unlikely that the SCSI host adapter market will develop significantly for DEC-compatible systems. The clearly defined Qbus and Unibus now enjoys a large variety of dedicated peripherals, controllers, and I/O accessories. Significant performance degradation occurs when SCSI is inserted in the chain between the disk drive and a device emulating controller.

The emergence of SCSI-based peripherals will fuel the host adapter market, not supress it. This growth will also change the product mix from lower performance host adapters to higher performance products.

Levels of Support

The level of support or amount of intelligence/performance that a host adapter can provide varies over a wide range. The most basic types of host adapters provide little more than an electrical conversion from the host bus to the SCSI bus. But this lower level of support may be adequate for many single-user systems tied to only one or two peripherals. It is expected that these products will constitute a smaller percentage of the future shipments of host adapters. As higher performance SCSI controllers and disk drives enter production, higher performance host adapters will quickly displace these products. Host adapters which support multi-user or concurrent operations will be those most likely to capture the majority of market share.

Host adapters which provide multi-tasking capabilities on single-user systems will enjoy a larger market than those for multi-user systems. Even the low-end microcomputer systems, such as the IBM-PC, are being aimed at low-end CAD/CAM and other applications requiring fast access to mass storage. Although IBM-PC systems used in a less-specific environment may see some host adapter activity, the use of SCSI on these systems will be limited to the niche markets of system integrators and value-added resellers. But the sheer size of the IBM-PC market makes even this "niche" a substantial piece of business.

Product Definition

Products and forecasts within this group refer to board-level products which adapt the SASI/SCSI interface to a variety of computer busses. These products plug directly into the backplane slot of the host bus, providing one or more SASI/SCSI ports for connection to internal and external devices. Examples of products and manufacturers in this group are:

Adaptive Data Systems, Inc.	PC-MASTER LINK
Data Technology Corporation	Model 10-1 Model 86-1
Emulex Corporation	UC03 UC13
Force Computers	SYS68K/SASI-1
Integrated Solutions, Inc.	VME-SCSI
Mizar, Incorporated	VME8500
NCR Corporation	ADP-31A-01 ADP-32-01
Plessey Microsystems	PME SASI-1
Scientific Micro Systems	510
Sigma Information Systems	SDC-RLV112

Market Trends

Peripheral Concepts estimates the total SCSI host adapter market to be:

	1984	1985	1986	1987	1988
REVENUES ($)	5,151K	7,027K	13,080K	24,280K	42,250K
SHIPMENTS	22.3K	29.4K	64.1K	114.1K	295.4K

Revenues for this market are expected to produce a compound annual growth rate of 69.2% from 1984 through 1988. Host adapter revenues for the microcomputer sector (IBM-PC, Apple II, S-100, and others) will produce a compound growth of 72.6% in revenues for the 1984-1988 period, while the minicomputer sector (Unibus, Qbus, VMEbus, Multibus I-II, and others) will experience a 61.9% compound growth in revenues.

In both the microcomputer and minicomputer sectors, the overall host adapter market is relatively new, as is the products they support- Basic SCSI and Full SCSI controllers and peripherals. There are currently over 25 manufacturers producing custom, OEM, and captive versions of host adapters for many different systems (the Product Matrix section lists most of the OEM suppliers and products). But much of the potential host adapter business remains captive, as most computer OEM's currently design and build their own adapters. Host adapters also represent the widest variance in average selling prices, from the $60-$90 range to over $1,200, depending upon performance and host bus.

The two strongest growth areas are the IBM-PC and the VMEbus. Host adapter revenues for the IBM-PC will grow an estimated 40.8% from 1984 to 1985, jumping to 114.7% from 1985 through 1986. Much of this growth is attributed to new evaluations/qualifications of SCSI disk drives in 1986, as well as the true systems integrators and VAR's who will begin to purchase both SCSI peripherals and high performance host adapters. The growth from 1986 through 1987 will decline slightly to 99.7%, but remain at this strong rate as new peripherals (in particular, optical disk drives) and other SCSI devices begin to enter production. Semiconductor suppliers will also enjoy a portion of these revenues, as many OEM's will begin to use SCSI protocol chips and purchase board-level products from third party suppliers.

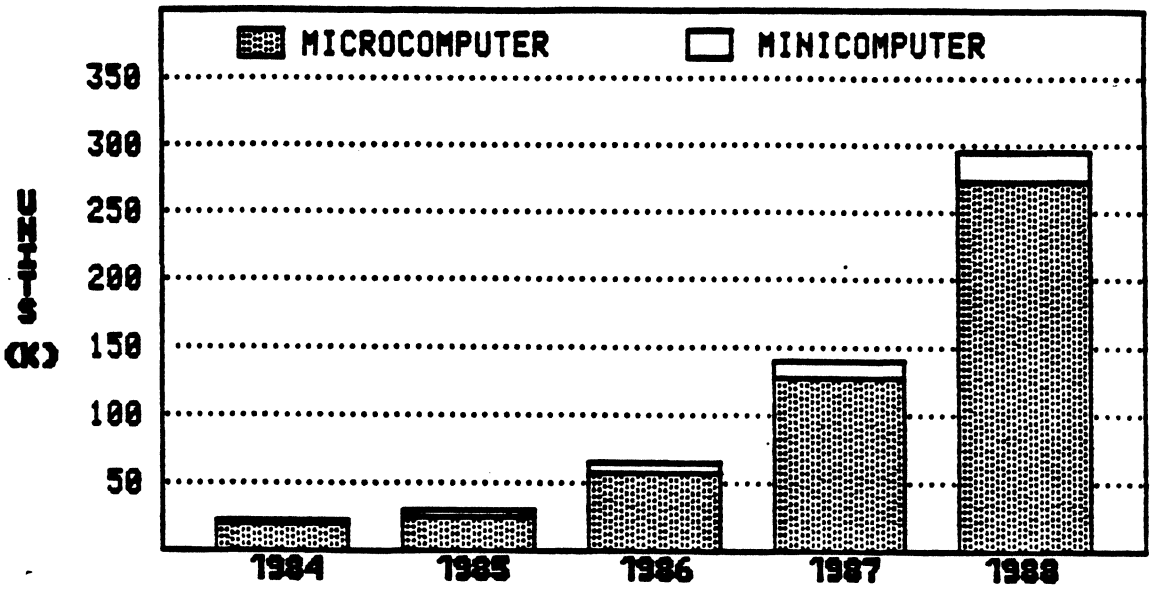
The opposite situation exists in today's market, where most OEM's design and manufacture their own host adapters. This structure will change as more choices of products with varying performance levels become available, and in particular, the SCSI specification options and sub-sets begin to mature through de facto methods. By 1988, IBM-PC host adapters will account for $27.42 Million in revenues out of the $30.4 Million for this market. Other sectors within the microcomputer market, particularly S-100 and the Apple II, will continue to play a declining role in this market. The S-100 will decline at a -47.6% compounded growth, as shipments of S-100 systems decline rapidly over the next several years. The Apple II series has had some activity with the older SASI host adapters, primarily in external subsystem support. But system integrators are no longer using the II-Plus or IIe machines

for vertical markets in favor of the IBM-PC. Most host adapters shipped in 1985 were done captively or in other words, within a disk drive subsystem. This trend will all but eliminate the OEM market for Apple host adapters within the next two years, though there will still be a small end-user demand.

The VMEbus will be particularly strong for SCSI. The VME controller market is currently fragmented among many suppliers, mostly "full-line" VME companies that also provide systems, SBC's, and other board-level products. The lack of product selection in SMD or ST506 controller products will fuel the short term growth. From 1985 through 1987, VMEbus host adapters will grow an average of 85.5% annually. Even after the establishment of controller products, the wide selection of SCSI peripherals will help contribute to a strong compound annual growth rate of 114.0% from 1984 through 1988.

Key Assumptions

- SCSI-based peripherals will become a strong market, fueling the growth of SCSI host adapters.
- The demand for intelligent multi-tasking host adapters will increase, displacing the older SASI-type adapters.
- The rapid growth of the VMEbus market, coupled with the lack of VME peripheral controllers, will increase the growth of VME-based host adapters.
- The growing use of IBM-PC's by system and vertical market integrators, will boost the acceptance of SCSI for these machines.

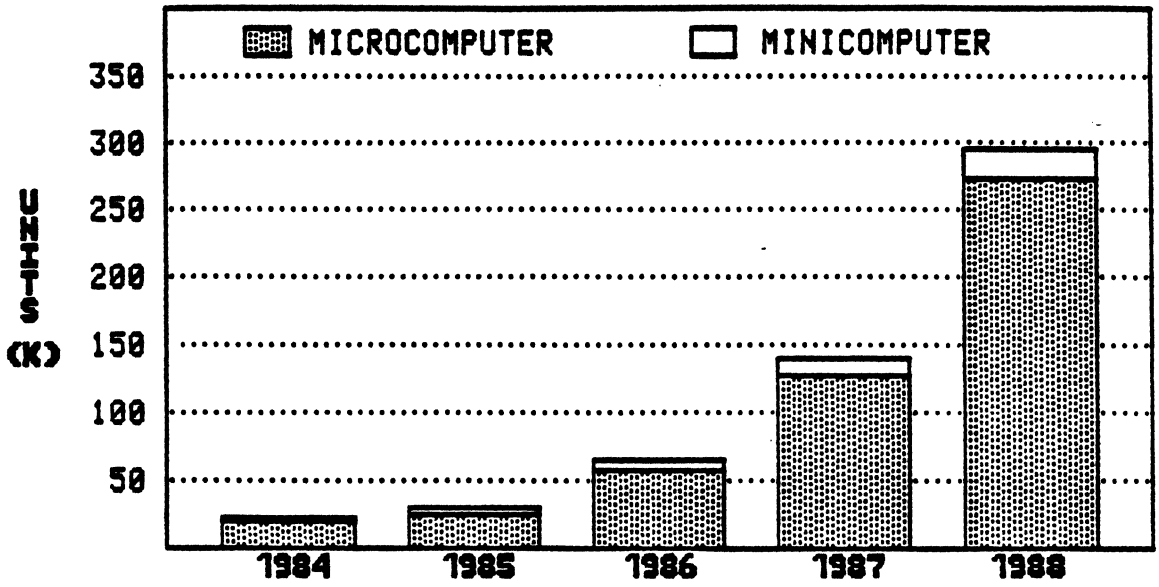


HOST ADAPTERS

REVENUE SUMMARY

	<——— REVENUES BY PRODUCT TYPE ($000) ———>										
	ACTUAL		<——— FORECAST ———								
	1984		1985		1986		1987		1988		1984-88
CONTROLLER TYPE											CAGR:
	REV($K)	(%)	REV($K)	(%)	REV($K)	(%)	REV($K)	(%)	REV($K)	(%)	
MICROCOMPUTER GROUP	3,426	66.5	4,550	64.8	9,150	70.0	17,800	73.3	30,400	72.0	72.6%
MINICOMPUTER GROUP	1,725	33.5	2,477	35.2	3,930	30.0	6,480	26.7	11,850	28.0	61.9%
TOTAL REVENUES ($000)	$5,151	100%	$7,027	100%	$13,080	100%	$24,280	100%	$42,250	100%	69.2%
ANNUAL GROWTH RATE		—		36.4%		86.1%		85.6%		74.0%	

SOURCE: PERIPHERAL CONCEPTS, INC.



HOST ADAPTERS

SHIPMENT SUMMARY

	ACTUAL		FORECAST								
	1984		1985		1986		1987		1988		1984-88
CONTROLLER TYPE											CAGR:
	UNITS(K)	(%)	UNITS(K)	(%)	UNITS(K)	(%)	UNITS(K)	(%)	UNITS(K)	(%)	
MICROCOMPUTER GROUP	19.1	85.3	24.5	83.3	56.6	88.2	129.0	91.4	273.9	92.7	94.6%
MINICOMPUTER GROUP	3.3	14.7	4.9	16.7	7.6	11.8	12.2	8.6	21.5	7.3	59.8%
TOTAL SHIPMENTS (000)	22.4	100%	29.4	100%	64.2	100%	141.2	100%	295.4	100%	90.6%
ANNUAL GROWTH RATE		—		31.2%		118.4%		119.9%		109.2%	

SOURCE: PERIPHERAL CONCEPTS, INC.

SCSI HOST ADAPTERS

REVENUE SUMMARY

	<——REVENUES BY INTERFACE TYPE ($00)——>										
	ACTUAL		<—— FORECAST ——>								
	1984		1985		1986		1987		1988		1984-88 CAGR:
MICROCOMPUTER GROUP:	REV($K)	(%)	REV($K)	(%)	REV($K)	(%)	REV($K)	(%)	REV($K)	(%)	
IBM-PC	2,624	50.9	3,695	52.6	7,933	60.6	15,842	65.2	27,421	64.9	79.8%
S100	202	3.9	173	2.5	82	.6	36	.1	15	.0	-47.8%
Other Micro	600	11.6	682	9.7	1,135	8.7	1,922	7.9	2,964	7.0	49.1%
TOTAL REVENUES ($000)	$3,426	67%	$4,550	65%	$9,150	70%	$17,800	73%	$30,400	72%	72.6%
ANNUAL GROWTH RATE		—		32.8%		101.1%		94.5%		70.8%	
MINICOMPUTER GROUP:	REV($K)	(%)	REV($K)	(%)	REV($K)	(%)	REV($K)	(%)	REV($K)	(%)	
Multibus	661	12.8	827	11.8	1,093	8.4	1,458	6.0	1,967	4.7	31.3%
VME	402	7.8	825	11.7	1,816	13.9	3,862	15.9	8,437	20.0	114.0%
DEC-Compatible	395	7.7	466	6.6	582	4.4	719	3.0	912	2.2	23.3%
Other Mini	267	5.2	359	5.1	440	3.4	441	1.8	533	1.3	18.9%
TOTAL REVENUES ($000)	$1,725	33%	$2,477	35%	$3,931	30%	$6,480	27%	$11,849	28%	61.9%
ANNUAL GROWTH RATE		—		43.6%		58.7%		64.8%		82.9%	
TOTAL MARKET ($000)	$5,151	100%	$7,027	100%	$13,081	100%	$24,280	100%	$42,249	100%	69.2%

SOURCE: PERIPHERAL CONCEPTS, INC.

SEMICONDUCTOR CONTROLLERS

Introduction

The development of "single-chip" or VLSI controllers began shortly after IBM's 1972 introduction of the Floppy Diskette Drive. This new peripheral, with its serial-encoded data and unique motor control signals, required a controller with well over a hundred SSI (Small Scale Integration) devices. The cost of these early controllers equalled that of the disk drive.

By the Mid-70's, the 8-inch Floppy was being manufactured by several companies for OEM distribution, expanding well beyond the traditional IBM plug-compatible business. Floppy drives became the primary storage device on other minicomputers, but also penetrated the emerging microcomputer market as well. As volume shipments of these drives began to occur, semiconductor manufacturers could justify the high development costs of dedicated, custom LSI circuits. Pioneering this field was Western Digital Corporation who, in 1976, began sampling the first LSI floppy disk controller, the FD1771. This device was the first of its kind to control both the data serialization/ de-serialization and motor control functions. Today, virtually all floppy disk controller designs are based around one of the many LSI controllers commonly available.

Peripheral Concepts

From its beginnings in the floppy market, semiconductor controllers have kept pace with the changes in the mass storage peripheral markets. Devices for winchester disks and streaming tape drives are now commonplace. But the continuous evolvement of winchester technology has segmented winchester chip products into various forms. Depending upon application, choices must be made between the "single-chip" or "chip-set" configurations. Each has their advantages and disadvantages.

The streaming tape market has been dominated by the 1/4 inch cartridge products. The emerging 1/2 inch market will surely have an impact on the future of LSI devices for tapes. But regardless of the form factor or interface specifics, semiconductor controller trends are clearly divided among floppy, winchester, and tape products.

Floppy Disk Controllers

The floppy disk controller chip has truly become a semiconductor commodity. Virtually all types and price ranges of computers, from home systems to minicomputers, are now shipped with a floppy disk drive as the standard configuration. These computer OEM's either place the floppy disk control logic directly on the motherboard, or include it on an auxiliary board with another peripheral controller, such as a winchester.

The amount of "glue" logic or extra circuitry needed to support an LSI floppy controller has decreased significantly over the past two years.

Functions such as data separation, write precompensation, and DMA (Direct Memory Access) are now common features of today's controllers. Many manufacturers offer support chips for use with older generation products, which further reduces the need for SSI-based support logic. The only remaining circuitry commonly implemented in discrete form are the I/O buffers and the host interface logic. Both of these functions will likely appear in new LSI controller products (and also as enhancements to existing products) within the next two years. The high-current, I/O buffer function can easily be handled with today's CMOS processes, and the standardization of low-end computer busses (i.e., IBM, SCSI, 80186, M68000, etc.) are now mature enough to dedicate much of this logic to silicon.

The popular configuration of combination winchester/floppy storage on today's computers has spurred the development of some "combo" winchester/floppy controller chips. Although these devices appear to satisfy a majority application, their acceptance so far has been poor, and will continue to be so in the near term. A certain amount of flexibility is usually sacrificed at the design-level when combining these functions. Products that have been previewed so far, require additional logic to "split" the signal lines for the two peripherals. Some do not allow concurrent operations, and others still require external logic, such as individual data separators. And like all new semiconductors, pricing is before the erosion curve, resulting in a higher selling price than the combined price of separate winchester and floppy controller chips. Today, about 1 out of every 5

microcomputers are shipped with both winchester and floppy. This indicates that the market still prefers the "add-on" approach to higher capacities, limiting the existing market for such a device.

It is likely that the "next generation" LSI floppy controller will not occur for several years. Many start-up companies have attempted to introduce high capacity floppy drives (3-10 Megabytes), but backward compatability issues, the use of special media, pre-formatting requirements, etc., has left the floppy market stalled at the 96 TPI level. There is little room for innovation in either drive or controller products. And with current floppy drive prices below $75 in many circumstances, this situation will not change in the near future. Until volume shipments of high capacity floppy drives occur, there is no incentive (and high risk) for a semiconductor supplier to invest LSI development dollars in new products. Likewise, existing controllers are adequate for today's products, including the newer 3-1/2 inch drives.

Winchester Controllers

Despite its similarities, the LSI winchester controller market is structured differently than the floppy market. For one thing, the "single-chip" winchester controllers that are now available are not intended as replacements for board-level winchester controllers. In fact, just the opposite is occuring. In many instances, LSI devices are developed exclusively for use on a winchester controller board.

The LSI winchester controller market can be divided into three classes of products. Although there is some overlap, these classes really define the marketing strategies and customer base for the various types of chips.

CHIP-SET CONTROLLERS- This product class typically consists of two to five devices. Each device performs a separate disk control function such as encode/decode, error correction, SERDES, etc. Chip-sets are now being called ASIC's (Application Specific Integrated Circuits), a term which has become popular in recent months. Manufacturers of chip sets usually produce board-level controllers as the main product line, using the chips on their own designs. Besides this captive use, some chip sets are sold to customers who buy the manufacturing rights of one or more board products. Depending upon the terms of the agreement, the buyer may manufacture all or part of his total consumption and in essence, becomes his own "second-source". Since many chip sets have been originally designed for use in a particular board-level controller, there is a tremendous difference in compatibility of chip sets from one controller supplier to the next. Not only are there incompatibilities in terms of pin-outs, but different partitioning results in completely different functionalities. These "hardware-specific" chips are often difficult to sell on a typical OEM basis.

SINGLE-CHIP CONTROLLERS- This product class includes devices normally having 40 or more pins which perform functions of motor control, data encoding/decoding, and sometimes error correction. They utilize a set of high-level commands similar to that of a microprocessor. In fact, many are just dedicated ROM versions of microprocessors. Single-chip winchester controllers are also generic. That is, they have not been designed to work with any particular hardware configuration. They may be used on a captive basis, but single-chip controller makers are typically merchant-market semiconductor manufacturers. Computer OEM's purchase single-chip controllers for use on an in-house disk controller design, just as they purchase microprocessors or other integrated circuits.

SUPPORT CHIPS- These devices are similar to floppy disk controller support chips, in that they are designed to be used with the manufacturers' single-chip controller. Their purpose is to reduce the amount of glue logic around the main controller chip. They too are sold on an OEM basis, and many controller manufacturers have "chip-set" pricing structures for the OEM who buys both single chip and support chips for a particular design.

Single-Chip vs Chip-Sets

Single-chip controllers are not meant as a replacement for chip sets. Both classes of products have a place in the market and satify

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different applications. The key advantage of chip sets is flexibility in design. A new interface or a custom controller may only require replacing/modifying one device in the set, or simply firmware changes on the board.

Single-chip controllers have far less flexibility. Even a moderate change can result in long development time and extensive layout changes. But these devices represent the lowest cost implementation. Obviously, they are designed to work with the more established winchester interfaces, such as the ST506/412.

During the past year, many microprocessor suppliers have announced single-chip winchester controllers. The common approach to marketing these devices is to include them as a "family component" or as a support device for a particular microprocessor. These family components typically include chips to perform DMA functions, Parallel or serial I/O, MMU (Memory Management Unit), and RAM/ROM. If their price/performance is competitive, many systems designers will choose the microprocessor supplier. The average OEM typically buys many support devices from their primary microprocessor supplier. The OEM will likely be able to negotiate better pricing from an existing supplier. There is also a better chance of having a viable second-source for the chips, since most microprocessor suppliers must provide second-sources in this highly competitive market. All of these factors will place strong competition on OEM chips from the independent winchester controller manufacturer.

The major chip-set suppliers will probably be the board manufacturing companies for the next several years. Many of these suppliers do not have distribution channels or staffing to support OEM semiconductor sales.

The market for support devices is limited. Almost all support devices sold today provide functions that will later be incorporated into a future version of the single-chip they support. Most suppliers (and their customers) view these devices as an interim product.

All single-chip controllers rely heavily upon mature, stable peripherals in particular, their interface specifications. At an average R & D expenditure of $400-800K and two years development time, the single-chip developer cannot rely on pure speculation in new product plans. However, the long lead time to product implies prudent forecasting of changing market conditions for at least 18-36 months out. Fortunately for the chip maker, the ST506 interface has remained as the major interface of choice for the last several years. Most suppliers do not see this changing in the near future. New winchester controller devices will likely be limited to enhancements of existing products in the near future. Additional functions to existing designs such as data separation, low-power CMOS versions, and integral sector buffering are the key technical areas being explored.

Tape Controllers

Semiconductor devices for streaming tape control have been limited to the chip-set configuration. These chip sets support either the QIC-36 or QIC-02 standards, and are primarily used on multifunction winchester/tape board controllers. The volume shipments to date for streaming tape drives have not been adequate to justify the development of single-chip controllers. However, expect some product announcement activity within the next six months. Many manufacturers believe that the availability of single-chip tape controllers will greatly influence the growth and size of the market.

Another factor which will affect market growth is the capacity of winchester disk drives. The majority of single-user systems today (and the bulk of drive shipments) are at the 20 Megabyte level or less. As this 20 Megabyte standard shifts to 50 Megabytes and beyond, using floppies for back-up purposes becomes impractical, even on a file-by-file basis. Future single-chip tape controllers may include multifunction capabilities, combining winchester and tape, as well as versions that are software and/or hardware compatible to their winchester counterparts.

Product Definition

Products and forecasts within this group refer to semiconductor devices used to control floppy, winchester, and tape drives, and are sold to OEMs either as standard products or through custom contracts. During calendar year 1984, there were 12 manufacturers shipping 61 different products. Examples of products and manufacturers in this group are:

Adaptec, Inc.	AIC-100 AIC-250
Data Technology Corporation	DTC1505 DTC1506
Hitachi, Ltd.	68463
Intel Corporation	8272A 82062-05
National Semiconductor Corp.	DP8451 DP8461
NCR Corporation	5380 5385E
NEC Electronics, USA	uPD765A uPD7261
Scientific Micro Systems	5050 5060
Standard Microsystems	FDC9266 HDC9224
Western Digital Corporation	WD1770-00 WD1010A-05

Market Trends

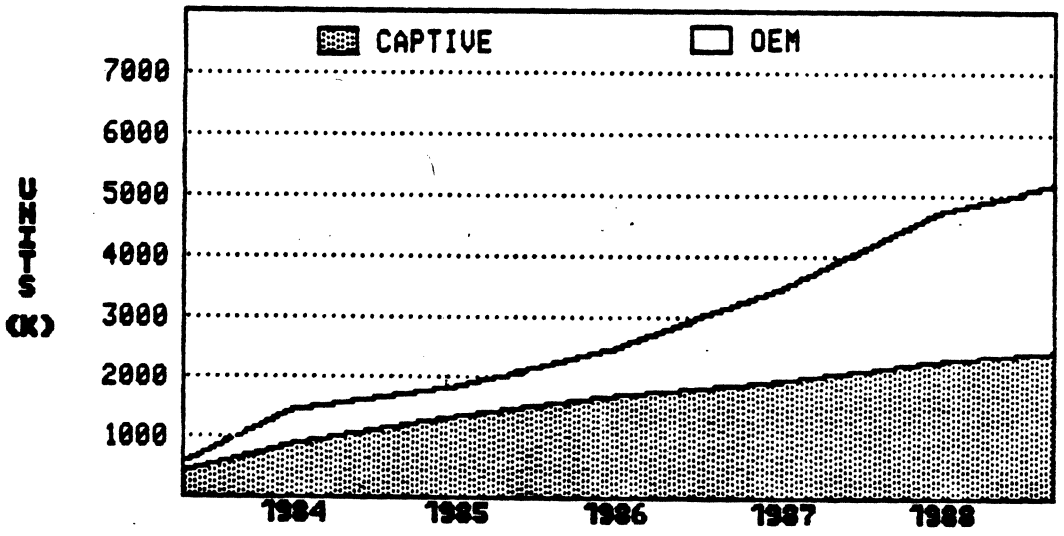
Peripheral Concepts estimates the total market to be:

	1984	1985	1986	1987	1988
REVENUES ($)	89.70M	109.99M	135.80M	153.98M	168.05M
SHIPMENTS	10.33M	13.01M	15.74M	18.27M	21.01M

Revenues for this market are expected to produce a compound annual growth rate of 17.0% from 1984 through 1988. The growth from 1984 to 1985 for winchester/tape controllers is estimated at 29.2% in revenues to $43.36 Million, up from 1984's $33.55 Million level. Unit shipments will grow slightly faster for the same period due to moderate price erosions; 1.80 Million units for 1985 versus 1.46 Million for 1984. However, many new product announcements during 1985 (especially from traditional semiconductor manufacturers), will actually increase the industry's overall ASP (Average Selling Price) by approximately 2.1%. As these new products enter volume production, normal price erosions will begin to occur again during 1987, yielding a -13.9% decline in overall ASP. For the same period, unit growth will reach 3.51 Million units (up 39.8% from 1986 levels), generating revenues of $74.14 Million. Finally, estimates show the winchester semiconductor market to reach close to 5 Million units or $81.17 Million in 1988, continuing at an average 35-39% year-to-year growth rate.

Semiconductor floppy controllers present a different scenario. The mature floppy controller market (dominated by the NEC765A and

compatibles), has reached 1984 levels of 8.87 Million units, growing at 26.2% from 1984 to 1985, to 11.19 Million in shipments for calendar 1985. Revenues for the same period are expected to grow 18.7%, from $56.15 Million to $66.64 Million. Although these products are mature, the price erosion curve has peaked out during 1982-1983, resulting in only a 5-7% annual erosion for the coming years, compared to the 20-25% peak experienced in 1983. Compound annual growth rate from 1984 through 1988 is estimated at 16.3% in units, 11.5% in revenues. A rather slow growth when compared to the winchester segment. Nevertheless, absolute unit shipments far exceed all other segments, with an estimated 16.24 Million units being shipped in 1988, generating $86.88 Million.



The most interesting shift in product mix over the next five years is the division between captive and OEM use. During 1985, approximately 76.4% of all winchester chips were used captively. That is, they were

included on board-level products shipped by board-level controller manufacturers. By 1988, it is estimated that captive consumption will drop to 47% of the total market. By this time period, many LSI devices will also rival the capabilities of today's lower-performance board products. Coupled with the declining prices of winchester drives, this peripheral will likely move into the basic configuration of many systems. But the majority of this shift is caused by a supplier mix to semiconductor-only manufacturers. Microprocessor-specific winchester controllers, especially those designed to interface to ST506 and ESDI, will constitute the majority of winchester controller chips by 1988.

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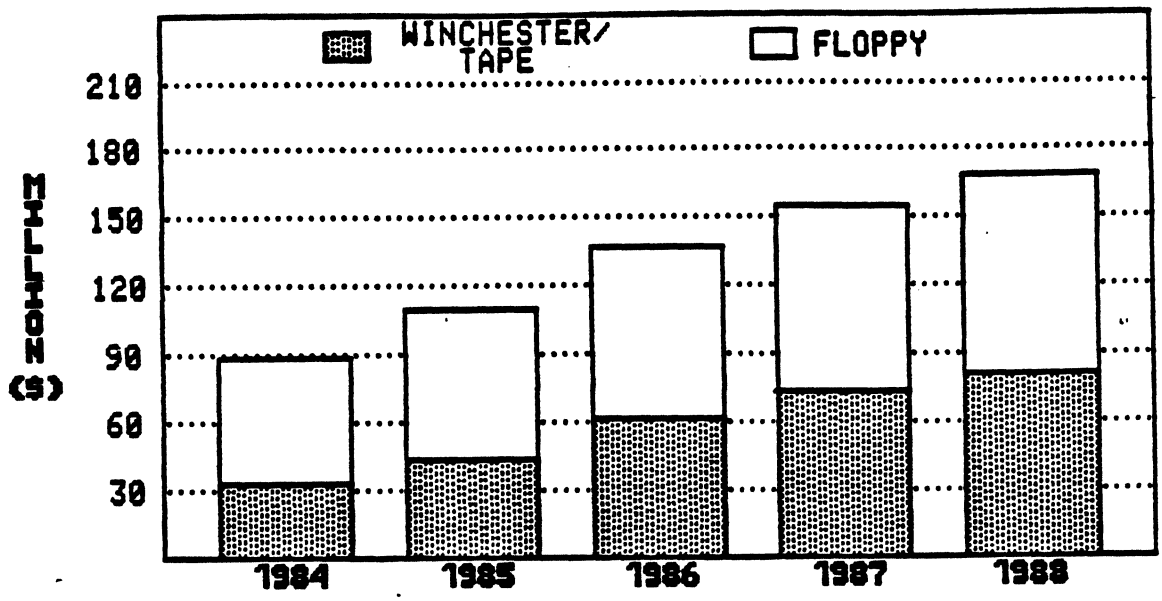
Key Assumptions

- OEM semiconductor manufacturers will enter the winchester market during 1985-86, contributing to strong market growth in Mid-86.
- Existing LSI floppy controller products will be adequate for most designs, slowing the need for next generation products.
- By the end of 1987, OEM consumption will surpass captive consumption of winchester controllers.
- Winchester capacities beyond 20 Megabytes will fuel the need for LSI tape controllers and multifunction (winchester/tape) devices.

CALENDAR 1984 MARKET SHARES
REVENUES BY MANUFACTURER

Western Digital Corporation	36.4%
Standard Microsystems	21.8%
NEC Electronics USA	17.6%
Intel Corporation	13.4%
National Semiconductor	3.2%
Other	7.6%
	100.0%



SEMICONDUCTOR CONTROLLERS

REVENUE SUMMARY

	← REVENUES BY PRODUCT TYPE ($000) →										
	ACTUAL		← FORECAST →								
	1984		1985		1986		1987		1988		1984-88
CONTROLLER TYPE											CAGR:
	REV($K)	(%)	REV($K)	(%)	REV($K)	(%)	REV($K)	(%)	REV($K)	(%)	
Winchester/Tape	33,554	37.4	43,362	39.4	61,600	45.4	74,144	48.2	81,175	48.3	24.7%
Floppy	56,150	62.6	66,636	60.6	74,200	54.6	79,840	51.8	86,880	51.7	11.5%
TOTAL REVENUES ($000)	$89,704	100%	$109,998	100%	$135,800	100%	$153,984	100%	$168,055	100%	17.0%
ANNUAL GROWTH RATE		—		22.6%		23.5%		13.4%		9.1%	

SOURCE: PERIPHERAL CONCEPTS, INC.

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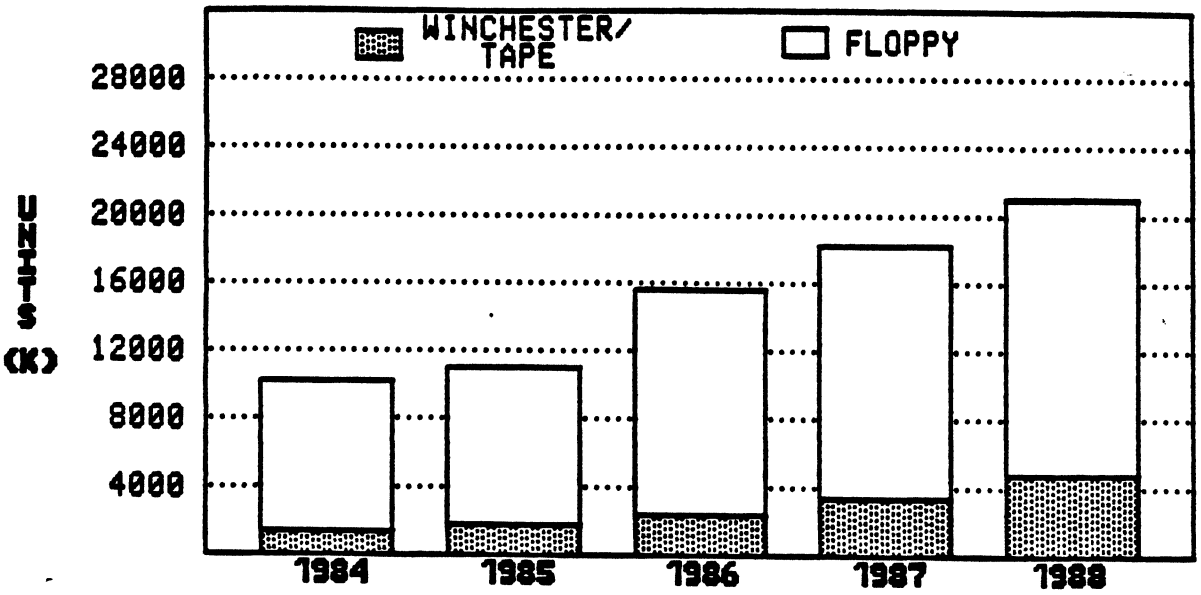

SEMICONDUCTOR CONTROLLERS

SHIPMENT SUMMARY

	←SHIPMENTS BY PRODUCT TYPE (000)→										
	ACTUAL		←FORECAST→								
	1984		1985		1986		1987		1988		1984-88
CONTROLLER TYPE											CAGR:
	UNITS(K)	(%)	UNITS(K)	(%)	UNITS(K)	(%)	UNITS(K)	(%)	UNITS(K)	(%)	
Winchester/Tape	1,466.4	14.2	1,806.7	13.9	2,514.3	16.0	3,513.9	19.2	4,775.0	22.7	34.3%
Floppy	8,872.7	85.8	11,199.3	86.1	13,226.4	84.0	14,757.8	80.8	16,239.3	77.3	16.3%
TOTAL SHIPMENTS (000)	10,339.1	100%	13,006.0	100%	15,740.7	100%	18,271.7	100%	21,014.3	100%	19.4%
ANNUAL GROWTH RATE		—		25.8%		21.0%		16.1%		15.0%	

SOURCE: PERIPHERAL CONCEPTS, INC.

IMBEDDED DISK CONTROLLERS

Introduction

Since the development of the first disk drives, the functions of the controller or formatter have been treated as a separate entity. Probably most responsible for this way of thinking was the original organizational lines at IBM. A separate peripheral division developed the disk drives, while another developed controllers and formatters for specific systems. Control Data Corporations' 1968 introduction of the SMD interface further promoted this separation. By providing this new peripheral interface, system manufacturers could use the disk drive as a building block to create a variety of mass storage systems for different computer requirements. Each new generation of a machine always requires some "customization" of the mass storage system; that customization was and is still done on the controller, not the disk drive interface.

In the minicomputer sector, Digital Equipment's unique disk drives (and controllers) used on Unibus machines opened up a whole new market for add-on companies specializing in controllers. By designing Unibus controllers that worked with the general purpose SMD interface, a lower-cost, high performance alternative was offered to the end-user. Hence, the add-on controller market was born.

Today, a separate controller/formatter is still the dominant way to partition a mass storage system. But many companies are beginning to

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look at a "merger" of the controller and disk drive within the same product. The controllers used in this new concept are being called "imbedded".

Imbedding the controller within the disk drive is not a new concept. During the mid-70's, when the eight-inch floppy disk drive was in full swing, intelligent floppy drives were introduced by Remex-Excello Corporation and Innovex (both companies have long since left the floppy drive business). These products were never too successful, but the lack of an intelligent interface standard at the time may be responsible for their premature death. The coming wave of LSI devices also contributed to their demise, as the component count and board space of the entire floppy controller was quickly reduced to 3 or 4 square inches and less than 5 chips. Since that time, no other attempts were tried to add an intelligent interface or imbedded controller within a floppy disk drive for the OEM market.

A different situation than that of the floppy exists with winchester and tape peripherals. There is no dedicated LSI devices to control these peripherals, at least not at the level of integration that the floppy disk drive now enjoys. Capacities, transfer rates, and all of the parameters that affect a "locked in silicon" winchester controller are changing, so it is likely that total LSI support comparable to the floppy will not occur for a number of years on "non-ST506" controllers.

The [illegible]ed for Imbedding

There are now several choices of intelligent, general-purpose interfaces available today (such as SCSI and IPI-3). The overwhelming advantage of using these interfaces within the disk drive is that they "isolate" the computer from the intricacies of the peripheral.

Disk drive performance is changing for the better, but interfaces must remain stagnant. The need for imbedding is being driven by the increasing capacities of winchester disk drives. The quality of the media used in these drives is not increasing proportionately to capacity. As a result, the flawed areas or "bad spots" on the disk's surface increase in both frequency and size. Although a combined effort of the controller and host I/O firmware handles these bad spots today, at some point in time they will become unmanageable. A multi-user environment, for example, leaves little time for the CPU or controller to both manage and search the disk for alternate sectors/tracks. By imbedding the controller with the drive electronics, more internal management of these flawed spots can be realized, improving overall system performance.

The static nature of peripheral interfaces is a detriment to higher transfer rate, higher capacity winchesters. It is unlikely that an existing system manufacturer would specify/purchase any drive that contains a unique device-level interface, regardless of its performance or capacity improvements. With an imbedded controller, the true device-level interface is "buried" in the disk drive and may be

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totally unique, since the system designer neither uses it nor cares how it is structured. In addition, complete changes in technology, such as a transition from magnetic to optical disk drives, can be made smoothly with an intelligent interface on the drive (providing both the "old" and the "new" interfaces are the same). Imbedded controllers can "hide" these physical characteristics of the technology used.

There are definite cost advantages to be gained from imbedding. Since flaw management becomes an internal function of the drive, a lower-grade media can be used. This is one of the major cost components in a winchester drive. A similar move could also be applied to the recording heads. The life span of existing, lower cost technologies (such as ferrite heads and oxide media) may well be expanded as a result of imbedding.

The manufacturing cost of the combined controller/drive should be less than the cost of separate units. Many duplicate components such as microprocessors, ROM and RAM, drivers/receivers, etc., can be shared by both drive control and formatter electronics, resulting in less printed-circuit board "real estate", fewer components, and lower power consumption.

The possibilites of imbedded controller configurations are many. The higher-volume computer systems, such as the IBM-PC and compatibles, have the potential to eliminate the intelligent I/O bus altogether. It is certainly possible to develop a drive bus that in actuality, is the backplane bus of the target system. All that would be needed is a

cable between the disk drive and one of the slots in the backplane. On smaller diameter winchesters, it may even be possible to plug the drive directly into a backplane slot with appropriate hardware.

But there are also disadvantages in offering a combined controller and disk drive. The primary one is cost. Even if the price of the combined unit is equal to that of its separate counterparts, replacing a host-specific controller board will create the need for a host adapter. The controller board may have moved into the drive, but the backplane slot is now occupied by the host adapter. Another problem is multiple drives. Although very few systems use more than one fixed drive today, there are a number of computers with one-fixed/ one-removable configurations. Each drive is likely to have its own imbedded controller, increasing the total system cost. A possible solution may be a device-level port, such as ST506 or SMD, feeding a second drive from the intelligent primary drive. But this will bring back some of the cost in components (such as drivers/receivers) which were eliminated by imbedding.

Many alternate sources exist for mature, device-level drives (e.g., ST506/412, SMD) as well as controller boards. The OEM equates this to more competitive pricing, easy procurement, and fast reponse when demand changes. It is unlikely that a combination controller/drive will have many second-sources, even at the functional level. There are no standards for intelligent drives and even if, say, SCSI was chosen, the actual command and hardware options implemented by each manufacturer would vary considerably.

Custom modifications of a standard controller product, in order to meet a specific customer's needs, is in common practice today. Many of these changes require both firmware and hardware changes. Modifying an imbedded controller will be prohibitively expensive, since much of the logic is shared by the drive electronics. There is also less available space in the shared ROM/RAM to implement new functions and features.

Market Structure Analysis

Market entry into intelligent disk drives require developing a dual expertise in both drive and controller technology. The potential manufacturer must have electrical and mechanical skills to build the drive itself, while the controller portion will require operating systems knowledge, analog/data separator engineering, and error correction/file management expertise. For these reasons, the first imbedded products are the result of joint product developments between drive and controller manufacturer. It is likely that custom or semi-custom controller components will have to be developed to meet physical space requirements and new functional characteristics not normally done within today's controller chips.

The first imbedded products will however, use existing controller chips. Obviously, this is not the lowest cost/lowest component count method to imbedding, but it does allow the development of entry-level products.

In the short term, the imbedded market will be a "chip business". Drive manufacturers will purchase standard and/or custom chips from controller suppliers (unless of course, the controller supplier is also in the disk business) and incorporate them into drive designs. Another distribution channel in the future may be the large OEM who purchases "mechanism-only" winchesters and does the electronics design himself using various controller chips. Indeed, this would be an ambitious effort, since it implies that the OEM will have in-house drive and controller expertise. Any OEM who can afford this level of engineering and manufacturing overhead probably has the clout to establish their own standards anyway, and would have no incentive to use these products.

The uniqueness of the peripheral manufacturers' drive electronics (especially in the servo area) and the physical size differences of the drive electronics board from one manufacturer to the next, will prohibit the creation of any intelligent drive and controller board combination for the OEM market. In addition, mechanism-only winchesters are not normally available as standard products from winchester suppliers (although they can be had on a custom basis). It is also unlikely that a drive manufacturer will purchase boards from the controller supplier, containing his drive electronics design and the added controller circuitry. Almost all drive vendors have captive PC manufacturing facilities here and abroad, now producing drive electronics boards for existing winchesters. The only difference (from

a manufacturing standpoint) would be added component count. Hardly a reason to "farm-out" the new board product.

The future suppliers of imbedded controller chips will most likely be those manufacturers who now produce board-level controllers. Many of the chips used captively on these boards can be modified and/or augmented to produce the new functions.

As the imbedded market begins to develop, board-level controllers will not go away. In fact, as the traditional functions considered "the job of the controller" move into the disk drive, a new generation of controllers will emerge for use with these intelligent drives.

Product Definition

Forecasts within this group refer to semiconductor products designed to be used within winchester and tape drives of various form factors. During calendar 1984, there were no OEM products being sold specifically for this purpose. During 1985, several controller manufacturers began to sell traditional controller chips for use within disk drives including National Semiconductor, Scientific Micro Systems, and NCR Corporation.

Market Trends

Peripheral Concepts estimates the total imbedded controller market to be:

	1984	1985	1986	1987	1988
SHIPMENTS	-	19.8K	71.7K	290.9K	817.6K
REVENUES(IF SOLD)$	-	937K	3,425K	12,910K	33,180K

Shipments for this market have begun in 1985, as existing winchester controller chips are beginning to find their way into some disk drive products. Compound annual growth rate of shipments for 1985 through 1988 is expected to be 245.4% which represents a strong growth rate, but typical of a new market. Winchester shipments will grow faster than imbedded tape controller shipments, with levels approximately ten times higher. Estimates for 1986 winchester projections are 63.87K units and tapes at 7.85K units.

The valuation of revenues are on an "if-sold" basis. Many different configurations will require a different number of chips per drive, as well as some custom drive devices, especially in 1986 and 1987 when new circuits become available. The average selling price for the industry in 1985 is estimated at $47.00 per unit (a "unit" being an average one or more chips in a set), dropping to $40.20 by 1988. If-sold revenues from 1984 to 1988 will grow at a compound annual rate of 228.4%, or slightly less than units due to this moderate price erosion. It is expected that price erosions will not be more

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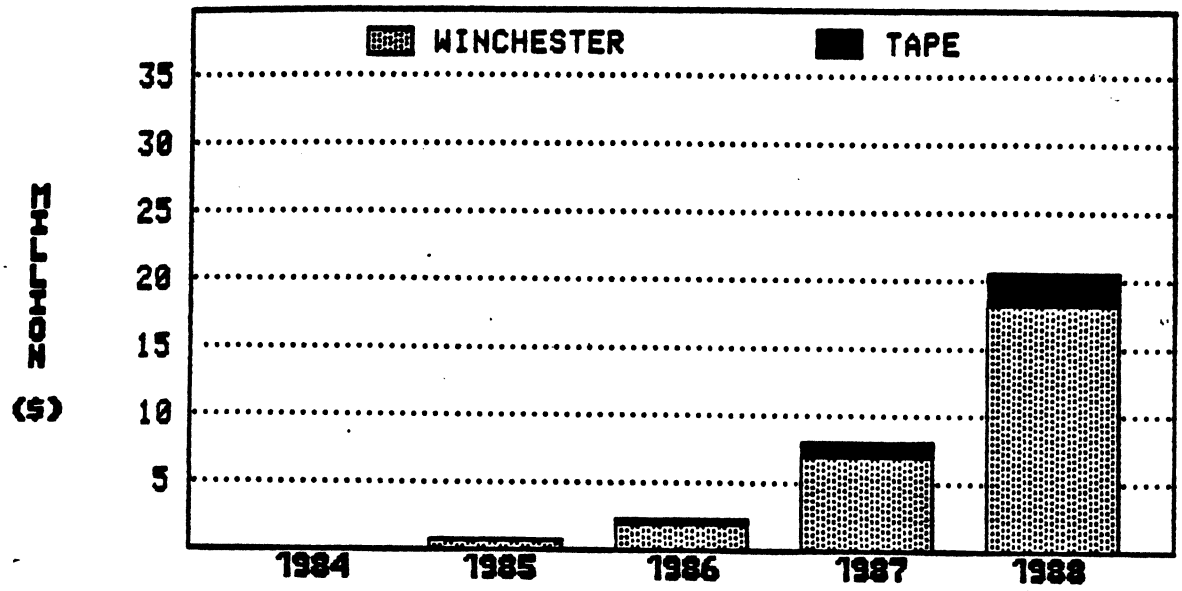
significant than stated, since this new market will see many new chips targeted specifically for drives. In fact, only 5-6% of the 1986 shipments will constitute unique chips designed especially for drive imbedding, while the remaining 94-95% of the shipments will be "standard" chips currently used on winchester controller boards. By 1988, high performance devices specific for drive-imbedded applications will constitute 33.5% of shipments, or 543,000 units. Over the 4-year forecast period (1985-1988), it is expected that the SCSI interface will account for over 96% of all imbedded controller types.

Key Assumptions

- Most of the imbedded controller market will be a "chip" market, as drive manufacturers will purchase devices for captive board manufacturing.
- In the short term, most imbedded controller devices will be existing semiconductors now used on board-level controllers.
- Over 96% of all imbedded controllers will use the SCSI interface.
- Imbedded controllers for tape drives will grow at a similar rate to winchesters, but unit volumes will be significantly less.
- Imbedded controllers will displace the lower-performance SASI board-level controller market.



IMBEDDED CONTROLLERS

REVENUE SUMMARY

	<——REVENUES BY PRODUCT TYPE ($000)——>										
	ACTUAL		<—— FORECAST ——>								
	1984		1985		1986		1987		1988		1985-88
CONTROLLER TYPE											CAGR:
	REV($K)	(%)	REV($K)	(%)	REV($K)	(%)	REV($K)	(%)	REV($K)	(%)	
WINCHESTER	0	0.0	840	89.6	3,040	88.8	11,530	89.3	29,540	89.0	227.6%
TAPE	0	0.0	97	10.4	385	11.2	1,380	10.7	3,640	11.0	234.8%
TOTAL REVENUES ($000)	$0	0%	$937	100%	$3,425	100%	$12,910	100%	$33,180	100%	228.4%
ANNUAL GROWTH RATE		—		—		265.5%		276.9%		157.0%	

SOURCE: PERIPHERAL CONCEPTS, INC.

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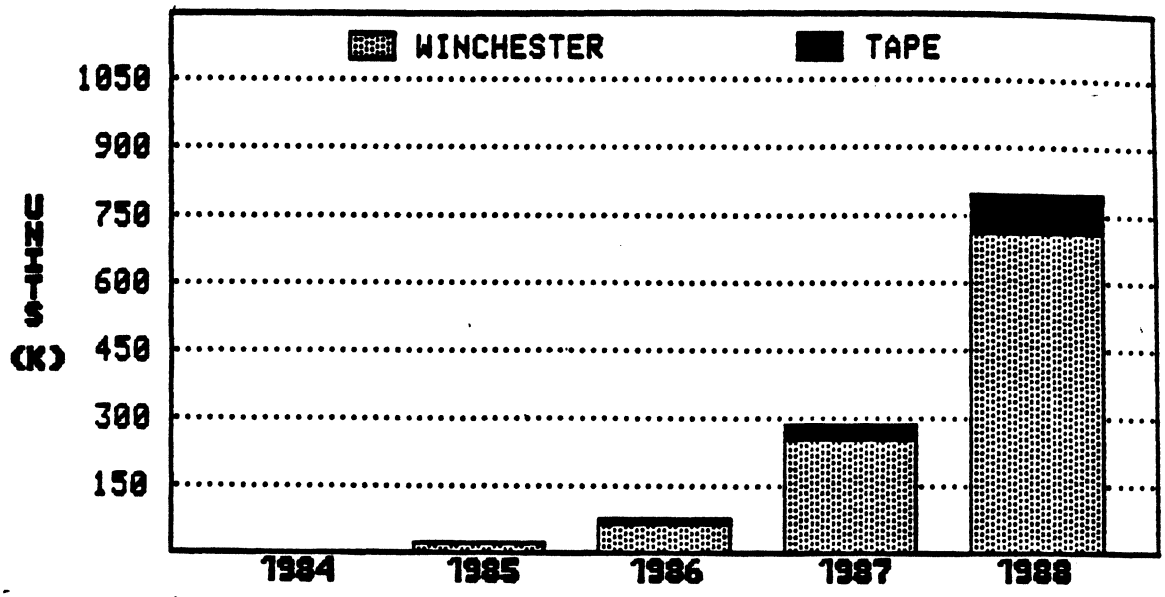

IMBEDDED CONTROLLERS

SHIPMENT SUMMARY

	← SHIPMENTS BY PRODUCT TYPE (000) →										
	ACTUAL		← FORECAST →								
	1984		1985		1986		1987		1988		1985–88
CONTROLLER TYPE											CAGR:
	UNITS(K)	(%)	UNITS(K)	(%)	UNITS(K)	(%)	UNITS(K)	(%)	UNITS(K)	(%)	
WINCHESTER	0.0	0.0	17.9	90.4	63.9	89.1	261.5	89.9	734.8	89.9	245.0%
TAPE	0.0	0.0	1.9	9.6	7.8	10.9	29.4	10.1	82.7	10.1	251.8%
TOTAL SHIPMENTS (000)	0.0	0%	19.8	100%	71.7	100%	290.9	100%	817.5	100%	245.6%
ANNUAL GROWTH RATE		—		—		262.1%		305.7%		181.0%	

SOURCE: PERIPHERAL CONCEPTS, INC.

PRODUCT MATRIX

This section details manufacturers products which are in production or will enter production before the second quarter of 1986. The products are segmented into SCSI, IBM-PC, Host Adapters, and LSI sections. Within each section, products are alphabetized by manufacturer.

Although most current controller products are listed, those which are being phased-out of production have been omitted. Likewise, products in which the individual manufacturer could not supply OEM pricing have not been included since these products are too new for reliable availability data or are simply not sold on an OEM basis.

The product data presented here has been compiled from manufacturers specifications and/or phone inquiry to personnel at each company. We have checked all data for accuracy. Inevitably, omissions and/or errors occur, so please contact us so we may correct them prior to the next edition.

SCSI

Products in this section are classified as either Winchester-only, Tape-only, Floppy-only, or Multifunction. Form factors of the drives they support (i.e., 5-1/4 inch) are based upon the physical size of the controller product or the interface type it supports.

Drive Characteristics: The type of interface, maximum number of drives, sector sizes, and error correction methods are listed.

Host Characteristics: The level of SCSI, size of the RAM buffer resident on the product, SCSI transfer rate, and minimum interleave factors are included. In the case of the level of SCSI, products have been categorized as XSASI-compatible, Single-Initiator (Basic SCSI without arbitration), or Reconnect-Disconnect (Full SCSI or Arbitration supported). Keep in mind that this is a classification, not a performance measurement. For example, it is possible for a Basic SCSI controller to outperform a reconnect/disconnect one, depending upon the performance specifications measured.

Physical Characteristics: Physical dimensions of the board and power requirements are included.

Availablility/Price: Current availablility as of August, 1985 and the OEM list price are provided.

Comments: Some comments have been added to those controllers which have unique characteristics that could not be stated in the above categories.

IBM-PC

IBM-PC controller products have been listed in a similar fashion to SCSI, except the model of support (PC, XT, or AT) and the status of the BIOS ROM (whether included or not) has been added.

Host Adapters

Host adapters include the type of Host bus supported (i.e., Qbus, IBM-PC, S-100, etc.) as well as any particular host features or characteristics supported.

LSI

Semiconductor controllers come in a wide variety of fuctions and features. Products have been listed by "Controller" definition or the type of support chip they are (i.e., Buffer Memory Controller, Data Separator, etc.). OEM Price refers to the first package type listed in the "Package Size" category.

MANUFACTURER	ADAPTEC, INCORPORATED	ADAPTEC, INCORPORATED	ADAPTEC, INCORPORATED	ADAPTEC, INCORPORATED
MODEL NUMBER	ACB-3530	ACB-4000	ACB-4010	ACB-4070
CONTROLLER TYPE	Tape Only (1/4 inch Streamer)	Winchester Only (5-1/4 inch)	Winchester Only (5-1/4 inch)	Winchester Only (5-1/4 inch)
DRIVE CHARACTERISTICS				
Drive interface	QIC-36	ST506/412	ST506/412, Removable and/or Hard Sectored	ST506/412 (2,7 RLL code) @ 7.5Mbit/sec data rate
Maximum # Drives	1 Tape	2 Winchesters	2 Winchesters	2 Winchesters
Sector Sizes -Bytes	Per QIC-11/24	256 through 1,024	256 through 1,024	256 through 1,024
Error Detection	16-Bit CRC	32-Bit ECC	32-Bit ECC	32-Bit ECC
Error Correction	Read-after-Write	Single-Burst/8 Bits	Single-Burst/8 Bits	Single-Burst/8 Bits
Flaw Skipping	Block Re-write	Sector-level	Sector-level	Sector-level
HOST CHARACTERISTICS				
Level of SCSI	Reconnect/Disconnect	Single-Initiator	Single-Initiator	Single-Initiator
Size of Buffer	8K Bytes	1K Bytes	1K Bytes	1K Bytes
Host Transfer Rate	1.5 MBytes/sec.	1.5 MBytes/sec.	1.5 MBytes/sec.	1.5 MBytes/sec.
Minimum Interleave	N/A	1:1	1:1	1:1
PHYSICAL CHARACTERISTICS				
Physical Dimensions	Length: 8.75 inches Width: 5.50 inches Height: 0.50 inches	Length: 7.75 inches Width: 5.75 inches Height: 0.50 inches	Length: 7.75 inches Width: 5.75 inches Height: 0.50 inches	Length: 7.75 inches Width: 5.75 inches Height: 0.50 inches
Power Supply	+5VDC @ 1.7A (Max) +12VDC @ 100mA (Max)	+5VDC @ 1.5A (Max) +12VDC @ 300mA (Max)	+5VDC @ 1.5A (Max) +12VDC @ 300mA (Max)	+5VDC @ 1.5A (Max) +12VDC @ 300mA (Max)
Availability	NOW	NOW	NOW	NOW
OEM Price (U.S.)/QTY	$425/100's	$225/100's	$255/100's	$280/100's
COMMENTS				

MANUFACTURER	ADAPTEC, INCORPORATED	ADAPTEC, INCORPORATED	ADAPTIVE DATA SYSTEMS INCORPORATED	ADAPTIVE DATA SYSTEMS INCORPORATED
MODEL NUMBER	ACB-5500	ACB-5580	COMBO-I	COMBO-II
CONTROLLER TYPE	Winchester Only (5-1/4 inch)	Winchester Only (8 or 14 inch)	Multifunction (Winchester/Tape)	Multifunction (Winchester/Tape)
DRIVE CHARACTERISTICS				
Drive interface	ST506/412	SMD	ST506/412, and QIC-36	ESDI (10 Mbits/sec), and QIC-36
Maximum # Drives	4 Winchesters	8 Winchesters	2 Winchesters and 1 Tape	2 Winchesters and 1 Tape
Sector Sizes -Bytes	256 through 2,048	256 through 2,048	128 through 4,096	128 through 4,096
Error Detection	32-Bit ECC	32-Bit ECC	48-Bit ECC	48-Bit ECC
Error Correction	Single-Burst/8 Bits	Single-Burst/8 Bits	Double-Burst/12 Bits	Double-Burst/12 Bits
Flaw Skipping	Sector-level	Sector-level	Sector-level	Sector-level
HOST CHARACTERISTICS				
Level of SCSI	Reconnect/Disconnect	Reconnect/Disconnect	Reconnect/Disconnect	Reconnect/Disconnect
Size of Buffer	2K Bytes	2K Bytes	64K Bytes	64K Bytes
Host Transfer Rate	1.5 MBytes/sec.	1.5 MBytes/sec.	2.0 MBytes/sec.	2.0 MBytes/sec.
Minimum Interleave	1:1	1:1	1:1	1:1
PHYSICAL CHARACTERISTICS				
Physical Dimensions	Length: 8.75 inches Width: 5.75 inches Height: 0.50 inches	Length: 14.00 inches Width: 7.00 inches Height: 0.50 inches	Length: 7.50 inches Width: 5.25 inches Height: 0.50 inches	Length: 7.50 inches Width: 5.25 inches Height: 0.50 inches
Power Supply	+5VDC @ 1.5A (Max) +12VDC @ 300mA (Max)	+5VDC @ 3.0A (Max) -12VDC @ 0.6A (Max)	+5VDC @ 1.5A (Max) +12VDC @ 0.1A (Max)	+5VDC @ 1.5A (Max) +12VDC @ 0.1A (Max)
Availability	NOW	NOW	1Q '86	1Q '86
OEM Price (U.S.)/QTY	$560/100's	$800/100's	$480/100's	$525/100's
COMMENTS	Command Chaining and Queueing Supported.	Command Chaining and Queueing Supported.		

MANUFACTURER	ADAPTIVE DATA SYSTEMS INCORPORATED	ADAPTIVE DATA SYSTEMS INCORPORATED	ADAPTIVE DATA SYSTEMS INCORPORATED	ADVANCED STORAGE CONCEPTS, INC.
MODEL NUMBER	PYTHON-II	SABER-II	RAPIER-I	ASC-525
CONTROLLER TYPE	Tape Only (1/4 inch Streamer)	Winchester Only (5-1/4 inch)	Winchester Only (5-1/4 inch)	Winchester Only (5-1/4 inch)
DRIVE CHARACTERISTICS				
Drive interface	QIC-36	ST506/412	ESDI (10 Mbits/sec)	ST506/412
Maximum # Drives	1 Tape	4 Winchesters	4 Winchesters	2 Winchesters
Sector Sizes -Bytes	Per QIC-11/24	128 through 4,096	128 through 4,096	256 through 1,024
Error Detection	16-Bit CRC	48-Bit ECC	48-Bit ECC	32-Bit ECC
Error Correction	Read-after-Write	Double-Burst/12 Bits	Double-Burst/12 Bits	Single-Burst/5 Bits
Flaw Skipping	Block Re-write	Sector-level	Sector-level	Sector-level
HOST CHARACTERISTICS				
Level of SCSI	Reconnect/Disconnect	Reconnect/Disconnect	Reconnect/Disconnect	Reconnect/Disconnect
Size of Buffer	16K Bytes	64K Bytes	64K Bytes	320K Bytes (Cache)
Host Transfer Rate	2.0 MBytes/sec.	2.0 MBytes/sec.	2.0 MBytes/sec.	1.5 MBytes/sec.
Minimum Interleave	N/A	1:1	1:1	1:1
PHYSICAL CHARACTERISTICS				
Physical Dimensions	Length: 7.75 inches Width: 5.60 inches Height: 0.50 inches	Length: 7.50 inches Width: 5.25 inches Height: 0.50 inches	Length: 7.50 inches Width: 5.25 inches Height: 0.50 inches	Length: 8.00 inches Width: 5.75 inches Height: 0.75 inches
Power Supply	+5VDC @ 1.5A (Nom) +12VDC @ .1A (Nom)	+5VDC @ 1.0A (Max)	+5VDC @ 1.0A (Max)	+5VDC @ 3.0A (Max)
Availability	4Q '85	4Q '85	4Q '85	NOW
OEM Price (U.S.)/QTY	$305/100's	$295/100's	$350/100's	$992/100's
COMMENTS				Programmable cache parameters

MANUFACTURER	AMPRO COMPUTERS, INCORPORATED	AMPRO COMPUTERS, INCORPORATED	CENTAN CORPORATION	DATA TECHNOLOGY CORPORATION
MODEL NUMBER	Little Board/PLUS	Little Board/186	NDC-3011	520D/DB
CONTROLLER TYPE	Special (Floppy/SCSI Port)	Special (Floppy/SCSI Port)	Winchester Only (3-1/2 inch)	Multifunction (Winchester/Floppy)
DRIVE CHARACTERISTICS				
Drive interface	SA450/460 and SCSI General-Purpose	SA450/460 and SCSI General-Purpose	ST506/412	ST506/412, SA400/450, and Kodak 3.3
Maximum # Drives	4 Floppies	4 Floppies	2 Winchesters	2 Winchesters and 2 Floppies
Sector Sizes -Bytes	128 through 1,024	128 through 1,024	256 through 1,024	256 through 1,024
Error Detection	16-Bit CRC (Floppy)	16-Bit CRC (Floppy)	32-Bit ECC	32-Bit ECC
Error Correction	N/A	N/A	Single-Burst/11 Bits	Single-Burst/11 Bits
Flaw Skipping	N/A	N/A	Track-level	Sector-level
HOST CHARACTERISTICS				
Level of SCSI	Reconnect/Disconnect	Reconnect/Disconnect	XSASI	Single-Initiator
Size of Buffer	N/A	N/A	1K Bytes	1K Bytes
Host Transfer Rate	1.5 Mbytes/sec.	1.5 Mbytes/sec.	1.0 MBytes/sec.	2.0 MBytes/sec.
Minimum Interleave	N/A	N/A	1:1	1:1
PHYSICAL CHARACTERISTICS				
Physical Dimensions	Length: 7.75 inches Width: 5.75 inches Height: 0.75 inches	Length: 7.75 inches Width: 5.75 inches Height: 0.75 inches	Length: 5.75 inches Width: 4.02 inches Height: 0.50 inches	Length: 8.00 inches Width: 5.75 inches Height: 0.49 inches
Power Supply	+5VDC @ 950 mA (Max) +9-12VDC @ 50mA (Max)	+5VDC @ 950 mA (Max) +9-12VDC @ 50mA (Max)	+5VDC @ 1.0A (Max)	+5VDC @ 1.5A (Max)
Availability	NOW	NOW	NOW	NOW
OEM Price (U.S.)/QTY	$297/100's	$424/100's	$135/100's	$286/100's
COMMENTS	Complete Single-Board Computer with 64K and CP/M	Complete Single-Board Computer with 128K and CPM/BIOS	Command Compatible with Xebec S1410A	

MANUFACTURER	DATA TECHNOLOGY CORPORATION	DATA TECHNOLOGY CORPORATION	DATA TECHNOLOGY CORPORATION	DATA TECHNOLOGY CORPORATION
MODEL NUMBER	530D/DB	540D/DB	703	700
CONTROLLER TYPE	Multifunction (Winchester/Tape)	Multifunction (Winchester/Floppy/Tape)	Multifunction (Winchester/Floppy)	Multifunction (Winchester/Tape)
DRIVE CHARACTERISTICS				
Drive interface	ST506/412, and QIC-02	ST506/412, SA400/450, Kodak 3.3, and QIC-02	SA1000/Q2000, and SA800/850	SA1000/Q2000, and QIC-02
Maximum # Drives	2 Winchesters and 1 Tape	2 Winchesters, 1 Tape, and 2 Floppies	4 Winchesters and 4 Floppies	4 Winchesters and 1 Tape
Sector Sizes -Bytes	256 through 1,024	256 through 1,024	256 through 1,024	256 through 1,024
Error Detection	32-Bit ECC	32-Bit ECC	24-Bit ECC	24-Bit ECC
Error Correction	Single-Burst/11 Bits	Single-Burst/11 Bits	Single-Burst/4 Bits	Single-Burst/4 Bits
Flaw Skipping	Sector-level	Sector-level	Track-level	Track-level
HOST CHARACTERISTICS				
Level of SCSI	Single-Initiator	Single-Initiator	Single-Initiator	Single-Initiator
Size of Buffer	1K Bytes	1K Bytes	1K Bytes	1K Bytes
Host Transfer Rate	2.0 MBytes/sec.	2.0 MBytes/sec.	1.0 MBytes/sec.	1.0 MBytes/sec.
Minimum Interleave	1:1	1:1	2:1	2:1
PHYSICAL CHARACTERISTICS				
Physical Dimensions	Length: 8.00 inches Width: 5.75 inches Height: 0.49 inches	Length: 8.00 inches Width: 5.75 inches Height: 0.49 inches	Length: 13.50 inches Width: 8.50 inches Height: 0.49 inches	Length: 16.00 inches Width: 8.50 inches Height: 0.49 inches
Power Supply	+5VDC @ 1.5A (Max)	+5VDC @ 2.0A (Max)	+5VDC @ 4.6A (Max) -5VDC @ 500mA (Max)	+5VDC @ 4.6A (Max) -5VDC @ 500mA (Max)
Availability	NOW	NOW	NOW	NOW
OEM Price (U.S.)/QTY	$360/100's	$440/100's	$767/100's	$793/100's
COMMENTS				

MANUFACTURER	DATA TECHNOLOGY CORPORATION	DATA TECHNOLOGY CORPORATION	DATA TECHNOLOGY CORPORATION	DATA TECHNOLOGY CORPORATION
MODEL NUMBER	510D/DB	510CU	515CD/515CU	802C
CONTROLLER TYPE	Winchester Only (5-1/4 inch)	Winchester Only (5-1/4 inch)	Winchester Only (5-1/4 inch)	Winchester Only (5-1/4 or 8 inch)
DRIVE CHARACTERISTICS				
Drive interface	ST506/412	DMA Systems/Iomega	DMA Systems/Iomega (CU), Honeywell Bull 520 (CD)	ANSI
Maximum # Drives	2 Winchesters	2 Winchesters	2 Winchesters	4 Winchesters
Sector Sizes -Bytes	256 through 1,024	256	256	256 through 1,024
Error Detection	32-Bit ECC	24-Bit ECC	24-Bit ECC	32-Bit ECC
Error Correction	Single-Burst/11 Bits	Single-Burst/4 Bits	Single-Burst/4 Bits	Single-Burst/8 Bits
Flaw Skipping	Sector-level	Track-level	Track-level	Track-level
HOST CHARACTERISTICS				
Level of SCSI	Single-Initiator	Single-Initiator	Single-Initiator	Reconnect/Disconnect
Size of Buffer	1K Bytes	1K Bytes	1K Bytes	2K Bytes
Host Transfer Rate	2.0 MBytes/sec.	1.0 MBytes/sec.	1.0 MBytes/sec.	1.6 MBytes/sec.
Minimum Interleave	1:1	2:1	2:1	1:1
PHYSICAL CHARACTERISTICS				
Physical Dimensions	Length: 8.00 inches Width: 5.75 inches Height: 0.49 inches	Length: 8.25 inches Width: 8.00 inches Height: 0.49 inches	Length: 8.25 inches Width: 8.00 inches Height: 0.49 inches	Length: 8.00 inches Width: 5.75 inches Height: 0.49 inches
Power Supply	+5VDC @ 1.0A (Max)	+5VDC @ 2.0A (Max)	+5VDC @ 2.0A (Max)	+5VDC @ 2.6A (Max)
Availability	NOW	NOW	NOW	NOW
OEM Price (U.S.)/QTY	$247/100's	$287/100's	$287/100's	$500/100's
COMMENTS				

MANUFACTURER	DATA TECHNOLOGY CORPORATION	DATA TECHNOLOGY CORPORATION	DISTRIBUTED PROCESSING TECHNOLOGY	DISTRIBUTED PROCESSING TECHNOLOGY
MODEL NUMBER	803C	801C	PM-3010A/05	PM-3010A/08
CONTROLLER TYPE	Winchester Only (5-1/4 inch)	Winchester Only (8 or 14 inch)	Floppy Only (5-1/4 inch)	Floppy Only (8 inch)
DRIVE CHARACTERISTICS				
Drive interface	ESDI	SMD (2.4 Megabytes/sec.)	SA410/460	SA810/860
Maximum # Drives	4 Winchesters	2 Winchesters	4 Floppies	4 Floppies
Sector Sizes -Bytes	256 through 1,024	256 through 1,024	128 through 1,024	128 through 1,024
Error Detection	32-Bit ECC	32-Bit ECC	32-Bit ECC	32-Bit ECC
Error Correction	Single-Burst/8 Bits	Single-Burst/8 Bits	Single-Burst/11 Bits	Single-Burst/11 Bits
Flaw Skipping	Track-level	Track-level	Sector-level	Sector-level
HOST CHARACTERISTICS				
Level of SCSI	Reconnect/Disconnect	Reconnect/Disconnect	Single-Initiator	Single-Initiator
Size of Buffer	2K Bytes	2K Bytes	512K Bytes (Cache)	512K Bytes (Cache)
Host Transfer Rate	1.6 MBytes/sec.	1.6 MBytes/sec.	1.5 MBytes/sec.	1.5 MBytes/sec.
Minimum Interleave	1:1	1:1	1:1	1:1
PHYSICAL CHARACTERISTICS				
Physical Dimensions	Length: 10.00 inches Width: 5.75 inches Height: 0.49 inches	Length: 13.00 inches Width: 8.00 inches Height: 0.49 inches	Length: 12.50 inches Width: 5.75 inches Height: 0.50 inches	Length: 12.50 inches Width: 5.75 inches Height: 0.50 inches
Power Supply	+5VDC @ 2.6A (Max)	+5VDC @ 4.0A (Max) -5VDC @ 500mA (Max)	+5VDC @ 4.0A (Max)	+5VDC @ 4.0A (Max)
Availability	NOW	NOW	4Q '85	4Q '85
OEM Price (U.S.)/QTY	$500/100's	$700/100's	$1000/100's	$1000/100's
COMMENTS	5 and 10 Megabits/sec. versions available	Supports Fixed and/or Removable Drives	Additional 2/4 Megabytes of RAM available as an option.	Additional 2/4 Megabytes of RAM available as an option.

MANUFACTURER	DISTRIBUTED PROCESSING TECHNOLOGY	DISTRIBUTED PROCESSING TECHNOLOGY	DISTRIBUTED PROCESSING TECHNOLOGY	DISTRIBUTED PROCESSING TECHNOLOGY
MODEL NUMBER	PM-3010A/85	PM-3010A/55	PM-3010A/88	PM-3010A/58
CONTROLLER TYPE	Multifunction (Winchester/Floppy)	Multifunction (Winchester/Floppy)	Multifunction (Winchester/Floppy)	Multifunction (Winchester/Floppy)
DRIVE CHARACTERISTICS				
Drive interface	SA1000, and SA410/460	ST506/412, and SA410/460	SA1000, and SA810/860	ST506/412, and SA810/860
Maximum # Drives	4 Winchesters and 4 Floppies	4 Winchesters and 4 Floppies	4 Winchesters and 4 Floppies	4 Winchesters and 4 Floppies
Sector Sizes -Bytes	128 through 1,024	128 through 1,024	128 through 1,024	128 through 1,024
Error Detection	32-Bit ECC	32-Bit ECC	32-Bit ECC	32-Bit ECC
Error Correction	Single-Burst/11 Bits	Single-Burst/11 Bits	Single-Burst/11 Bits	Single-Burst/11 Bits
Flaw Skipping	Sector-level	Sector-level	Sector-level	Sector-level
HOST CHARACTERISTICS				
Level of SCSI	Single-Initiator	Single-Initiator	Single-Initiator	Single-Initiator
Size of Buffer	512K Bytes (Cache)	512K Bytes (Cache)	512K Bytes (Cache)	512K Bytes (Cache)
Host Transfer Rate	1.5 MBytes/sec.	1.5 MBytes/sec.	1.5 MBytes/sec.	1.5 MBytes/sec.
Minimum Interleave	1:1	1:1	1:1	1:1
PHYSICAL CHARACTERISTICS				
Physical Dimensions	Length: 12.50 inches Width: 5.75 inches Height: 0.50 inches	Length: 12.50 inches Width: 5.75 inches Height: 0.50 inches	Length: 12.50 inches Width: 5.75 inches Height: 0.50 inches	Length: 12.50 inches Width: 5.75 inches Height: 0.50 inches
Power Supply	+5VDC @ 4.0A (Max)	+5VDC @ 4.0A (Max)	+5VDC @ 4.0A (Max)	+5VDC @ 4.0A (Max)
Availability	4Q '85	4Q '85	4Q '85	4Q '85
OEM Price (U.S.)/QTY	$1185/100's	$1185/100's	$1185/100's	$1185/100's
COMMENTS	Additional 2/4 Megabytes of RAM available as an option.	Additional 2/4 Megabytes of RAM available as an option.	Additional 2/4 Megabytes of RAM available as an option.	Additional 2/4 Megabytes of RAM available as an option.

MANUFACTURER	DISTRIBUTED PROCESSING TECHNOLOGY	DISTRIBUTED PROCESSING TECHNOLOGY	EMULEX CORPORATION	EMULEX CORPORATION
MODEL NUMBER	PM-3010A/80	PM-3010A/50	TITLEIST MT02	CHAMPION MD21
CONTROLLER TYPE	Winchester Only (8-inch)	Winchester Only (5-1/4 inch)	Tape Only (1/4 inch Streamer)	Winchester Only (5-1/4 inch)
DRIVE CHARACTERISTICS				
Drive interface	SA1000	ST506/412	QIC-36	ESDI (10 Mbit/sec)
Maximum # Drives	4 Winchesters	4 Winchesters	1 Tape	2 Winchesters
Sector Sizes -Bytes	256 through 1,024	256 through 1,024	Per QIC-11/24	256 and 512
Error Detection	32-Bit ECC	32-Bit ECC	16-Bit CRC	48-Bit ECC
Error Correction	Single-Burst/11 Bits	Single-Burst/11 Bits	Read-after-Write	Single-Burst/11 Bits
Flaw Skipping	Sector-level	Sector-level	Block Re-write	Sector-level
HOST CHARACTERISTICS				
Level of SCSI	Single-Initiator	Single-Initiator	Reconnect/Disconnect	Reconnect/Disconnect
Size of Buffer	512K Bytes (Cache)	512K Bytes (Cache)	14K Bytes	14K Bytes
Host Transfer Rate	1.5 MBytes/sec.	1.5 MBytes/sec.	1.5 MBytes/sec.	1.5 MBytes/sec.
Minimum Interleave	1:1	1:1	N/A	1:1
PHYSICAL CHARACTERISTICS				
Physical Dimensions	Length: 12.50 inches Width: 5.75 inches Height: 0.50 inches	Length: 12.50 inches Width: 5.75 inches Height: 0.50 inches	Length: 8.00 inches Width: 5.75 inches Height: 0.50 inches	Length: 8.00 inches Width: 5.75 inches Height: 0.50 inches
Power Supply	+5VDC @ 4.0A (Max)	+5VDC @ 4.0A (Max)	+5VDC @ 2.0A (Max) +12VDC @ 400mA (Max)	+5VDC @ 2.0A (Max)
Availability	4Q '85	4Q '85	NOW	NOW
OEM Price (U.S.)/QTY	$1145/100's	$1145/100's	$435/100's	$395/100's
COMMENTS	Additional 2/4 Megabytes of RAM available as an option.	Additional 2/4 Megabytes of RAM available as an option.		Differential SCSI I/O option available.

MANUFACTURER	EMULEX CORPORATION	FUJITSU AMERICA, INCORPORATED	KONAN CORPORATION	NCR CORPORATION
MODEL NUMBER	MEDALIST MD01	M1053A	DJ210	ADP-41-01
CONTROLLER TYPE	Winchester Only (5-1/4 inch)	Winchester Only (8 or 14 inch)	Winchester Only (3-1/2 inch)	Multifunction (Winchester/Floppy)
DRIVE CHARACTERISTICS				
Drive interface	ST506/412	SMD (2.4 Megabytes/sec.)	ST506/412	ST506/412, and SA400/450
Maximum # Drives	2 Winchesters	4 Winchesters	2 Winchesters	Any combination up to 4 Winchesters/Floppies
Sector Sizes -Bytes	256 and 512	256 through 1,024	256 and 512	256 and 512
Error Detection	48-Bit ECC	48-Bit ECC	32 Bit ECC	56-Bit ECC
Error Correction	Single-Burst/11 Bits	Single-Burst/11 Bits	Single-Burst/11 Bits	Single-Burst/11 Bits
Flaw Skipping	Sector-level	Sector-level	Track-Level	Track-Level
HOST CHARACTERISTICS				
Level of SCSI	Reconnect/Disconnect	Reconnect/Disconnect	XSASI	Reconnect/Disconnect
Size of Buffer	14K Bytes	1K Bytes	512 Bytes	512 Bytes
Host Transfer Rate	1.5 MBytes/sec.	1.5 MBytes/sec.	1.0 Mbytes/sec.	1.3 MBytes/sec.
Minimum Interleave	1:1	1:1	1:1	1:1
PHYSICAL CHARACTERISTICS				
Physical Dimensions	Length: 8.00 inches Width: 5.75 inches Height: 0.50 inches	Length: 13.00 inches Width: 7.70 inches Height: 0.80 inches	Length: 5.75 inches Width: 4.00 inches Height: 0.50 inches	Length: 10.20 inches Width: 5.75 inches Height: 0.60 inches
Power Supply	+5VDC @ 2.0A (Max)	+5VDC @ 5.0A (Max) -12VDC @ 1.0A (Max)	+5VDC @ 0.9A (Max)	+5VDC @ 2.6A (Max)
Availability	NOW	NOW	NOW	NOW
OEM Price (U.S.)/QTY	$395/100's	$895/100's	$140/100's	$497/100's
COMMENTS	Differential SCSI I/O option available.	2.4 Mbytes/sec SCSI transfer rate in synchronous mode.		Differential SCSI I/O Version also available.

MANUFACTURER	NCR CORPORATION	NCR CORPORATION	NCR CORPORATION	NCR CORPORATION
MODEL NUMBER	ADP-54-01	ADP-52-01	ADP-52-02	ADP-41-04
CONTROLLER TYPE	Tape Only (1/4 inch Streamer)	Tape Only (1/2 inch S/S, Streamer)	Tape Only (1/2 inch S/S, Streamer)	Winchester Only (5-1/4 inch)
DRIVE CHARACTERISTICS				
Drive interface	QIC-36	PERTEC 9-Track PE, Up To 1.25 MB/sec	PERTEC 9-Track PE, Up To 1.25 MB/sec	ST506/412
Maximum # Drives	1 Tape	4 Tapes	4 Tapes	2 Winchesters
Sector Sizes -Bytes	Per QIC-11/24	N/A	N/A	256 and 512
Error Detection	16-Bit CRC	Parity	Parity	56-Bit ECC
Error Correction	Read-after-Write	Single Track/1 Bit	Single Track/1 Bit	Single-Burst/11 Bits
Flaw Skipping	Block Re-write	Block Re-write	Block Re-write	Track-level
HOST CHARACTERISTICS				
Level of SCSI	Reconnect/Disconnect	Reconnect/Disconnect	Reconnect/Disconnect	Reconnect/Disconnect
Size of Buffer	N/A	64K Bytes	64K Bytes	512 Bytes
Host Transfer Rate	1.5 MBytes/sec.	1.1 MBytes/sec.	1.1 MBytes/sec.	1.3 MBytes/sec.
Minimum Interleave	N/A	N/A	N/A	1:1
PHYSICAL CHARACTERISTICS				
Physical Dimensions	Length: 8.00 inches Width: 5.75 inches Height: 0.50 inches	Length: 12.00 inches Width: 9.00 inches Height: 0.60 inches	Length: 12.00 inches Width: 9.00 inches Height: 0.60 inches	Length: 8.00 inches Width: 5.75 inches Height: 0.60 inches
Power Supply	+5VDC @ 1.5A (Max) +12VDC @ 200mA (Max)	+5VDC @ 5.0A (Max)	+5VDC @ 5.0A (Max)	+5VDC @ 2.6A (Max)
Availability	4Q '85	NOW	NOW	NOW
OEM Price (U.S.)/QTY	$417/100's	$930/100's	$930/100's	$407/100's
COMMENTS	2-Board Set	Single-Ended SCSI I/O Lines.	Differential SCSI I/O Lines.	

MANUFACTURER	NCR CORPORATION	NCR CORPORATION	SCIENTIFIC MICRO SYSTEMS INCORPORATED	SCIENTIFIC MICRO SYSTEMS INCORPORATED
MODEL NUMBER	ADP-41-03	ADP-44-02	5200	5300
CONTROLLER TYPE	Winchester Only (5-1/4 inch)	Winchester Only (8 or 14 inch)	Multifunction (Winchester/Floppy)	Multifunction (Winchester/Tape)
DRIVE CHARACTERISTICS				
Drive interface	ST506/412	SMD (1.2 Megabytes/sec.)	ST506/412, and SA400/450/800/850	ST506/412, and QIC-02
Maximum # Drives	4 Winchesters	4 Winchesters	2 Winchesters and 2 Floppies	2 Winchesters and 1 Tape
Sector Sizes -Bytes	256 and 512	512 Bytes	256 through 1,024	256 through 1,024
Error Detection	56-Bit ECC	56-Bit ECC	32-Bit ECC	32-Bit ECC
Error Correction	Single-Burst/11 Bits	Single-Burst/11 Bits	Single-Burst/5 Bits	Single-Burst/5 Bits
Flaw Skipping	Track-level	Sector-level	Track-level	Track-level
HOST CHARACTERISTICS				
Level of SCSI	Reconnect/Disconnect	Reconnect/Disconnect	Single-Initiator	Single-Initiator
Size of Buffer	512 Bytes	512 Bytes	2K Bytes	8K Bytes
Host Transfer Rate	1.3 MBytes/sec.	1.5 MBytes/sec.	1.5 MBytes/sec.	1.5 MBytes/sec.
Minimum Interleave	1:1	1:1	1:1	1:1
PHYSICAL CHARACTERISTICS				
Physical Dimensions	Length: 10.20 inches Width: 5.75 inches Height: 0.60 inches	Length: 14.00 inches Width: 8.00 inches Height: 0.60 inches	Length: 8.00 inches Width: 5.75 inches Height: 0.75 inches	Length: 8.00 inches Width: 5.75 inches Height: 0.75 inches
Power Supply	+5VDC @ 2.6A (Max)	+5VDC @ 5.0A (Max) -5VDC @ 1.2A (Max)	+5VDC @ 1.8A (Max)	+5VDC @ 1.8A (Max)
Availability	NOW	NOW	NOW	NOW
OEM Price (U.S.)/QTY	$460/100's	$800/100's	$262/100's	$262/100's
COMMENTS		Differential SCSI I/O Lines.	Model 5201 supports the Cipher 525 FloppyTape.	

MANUFACTURER	SCIENTIFIC MICRO SYSTEMS INCORPORATED	SCIENTIFIC MICRO SYSTEMS INCORPORATED	SCIENTIFIC MICRO SYSTEMS INCORPORATED	SCIENTIFIC MICRO SYSTEMS INCORPORATED
MODEL NUMBER	7200	7300	5400	7400
CONTROLLER TYPE	Multifunction (Winchester/Floppy)	Multifunction (Winchester/Tape)	Multifunction (Winchester/Floppy/Tape)	Multifunction (Winchester/Floppy/Tape)
DRIVE CHARACTERISTICS				
Drive interface	ST506/412, ESDI, and SA400/450/800/850	ST506/412, ESDI, and QIC-02	ST506/412, SA400/800, and QIC-02	ST506/412, ESDI, SA400/800, and QIC-02
Maximum # Drives	2 Winchesters and 2 Floppies	2 Winchesters and 1 Tape	2 Winchesters and 1 Floppy	2 Winchesters, 4 Floppies, 1 Tape
Sector Sizes -Bytes	256 through 1,024	256 through 1,024	256 through 1,024	256 through 1,024
Error Detection	32-Bit/48-Bit ECC	32-Bit/48-Bit ECC	32-Bit ECC	32-Bit/48-Bit ECC
Error Correction	Single-Burst/5-11 Bits	Single-Burst/5-11 Bits	Single-Burst/5 Bits	Single-Burst/5-11 Bits
Flaw Skipping	Sector-level	Sector-level	Track-level	Track-level
HOST CHARACTERISTICS				
Level of SCSI	Reconnect/Disconnect	Reconnect/Disconnect	Single-Initiator	Single-Initiator
Size of Buffer	2K Bytes	8K Bytes	8K Bytes	8K Bytes
Host Transfer Rate	2.0 MBytes/sec.	2.0 MBytes/sec.	1.5 MBytes/sec.	2.0 MBytes/sec.
Minimum Interleave	1:1	1:1	1:1	1:1
PHYSICAL CHARACTERISTICS				
Physical Dimensions	Length: 8.00 inches Width: 5.75 inches Height: 0.75 inches	Length: 8.00 inches Width: 5.75 inches Height: 0.75 inches	Length: 8.00 inches Width: 5.75 inches Height: 0.75 inches	Length: 8.00 inches Width: 5.75 inches Height: 0.75 inches
Power Supply	+5VDC @ 1.8A (Max)	+5VDC @ 1.8A (Max)	+5VDC @ 2.0A (Max)	+5VDC @ 2.0A (Max)
Availability	4Q '85	4Q '85	NOW	4Q '85
OEM Price (U.S.)/QTY	$312/100's	$312/100's	$335/100's	$385/100's
COMMENTS				

MANUFACTURER	SCIENTIFIC MICRO SYSTEMS INCORPORATED	SCIENTIFIC MICRO SYSTEMS INCORPORATED	SCIENTIFIC MICRO SYSTEMS INCORPORATED	SCIENTIFIC MICRO SYSTEMS INCORPORATED
MODEL NUMBER	FWD5001	5100	5110	3100
CONTROLLER TYPE	Multifunction (Winchester/Floppy)	Winchester Only (5-1/4 inch)	Winchester Only (5-1/4 inch)	Winchester Only (3-1/2 inch)
DRIVE CHARACTERISTICS				
Drive interface	SA1000, and SA800/850	ST506/412	ST506/412	ST506/412
Maximum # Drives	2 Winchesters and 2 Floppies	2 Winchesters	2 Winchesters	2 Winchesters
Sector Sizes -Bytes	128 through 1,024	256 through 1,024	256 through 1,024	256 through 1,024
Error Detection	32-Bit ECC	32-Bit ECC	32-Bit ECC	32-Bit ECC
Error Correction	Single-Burst/6 Bits	Single-Burst/5 Bits	Single-Burst/5 Bits	Single-Burst/5 Bits
Flaw Skipping	Track-level	Track-level	Track-level	Track-level
HOST CHARACTERISTICS				
Level of SCSI	SASI (SA1403D)	Single-Initiator	XSASI	Single-Initiator
Size of Buffer	1K Bytes	2K Bytes	2K Bytes	2K Bytes
Host Transfer Rate	1.0 MBytes/sec.	1.5 MBytes/sec.	1.5 MBytes/sec.	1.5 MBytes/sec.
Minimum Interleave	1:1	1:1	1:1	1:1
PHYSICAL CHARACTERISTICS				
Physical Dimensions	Length: 13.70 inches Width: 8.25 inches Height: 0.75 inches	Length: 8.00 inches Width: 5.75 inches Height: 0.75 inches	Length: 8.00 inches Width: 5.75 inches Height: 0.75 inches	Length: 4.00 inches Width: 5.75 inches Height: 0.75 inches
Power Supply	+5VDC @ 5.0A (Max)	+5VDC @ 1.5A (Max)	+5VDC @ 1.8A (Max)	+5VDC @ 750 mA (Max)
Availability	NOW	NOW	NOW	NOW
OEM Price (U.S.)/QTY	$700/100's	$200/100's	$200/100's	$200/100's
COMMENTS			Command Compatible to Xebec S1410A	

MANUFACTURER	SCIENTIFIC MICRO SYSTEMS INCORPORATED	SYSGEN CORPORATION	SYSGEN CORPORATION	SYSGEN CORPORATION
MODEL NUMBER	7100	SC3011/SC3021	SI536	SC2101/SC2111/SC2201
CONTROLLER TYPE	Winchester Only (5-1/4 inch)	Multifunction (Winchester/Tape)	Multifunction (Winchester/Tape)	Multifunction (Winchester/Tape)
DRIVE CHARACTERISTICS				
Drive interface	ST506/412 and ESDI	SMD and Archive 9045/Rosscomp160	ST506/412, and QIC-02	ST506/412, Tape: See COMMENTS
Maximum # Drives	2 Winchesters	2 Winchesters and 1 Tape	2 Winchesters and 1 Tape	4 Winchesters and 1 Tape
Sector Sizes -Bytes	256 through 1,024	256	256 and 512	256
Error Detection	32-Bit/48-Bit ECC	32-Bit ECC	32-Bit ECC	32-Bit ECC
Error Correction	Single-Burst/5,11 Bits	Single-Burst/5 Bits	Single-Burst/5 Bits	Single-Burst/5 Bits
Flaw Skipping	Sector-level	Track-level	Sector-level	Track-level
HOST CHARACTERISTICS				
Level of SCSI	Reconnect/Disconnect	Single-Initiator	Reconnect/Disconnect	Single-Initiator
Size of Buffer	2K Bytes	8K Bytes	512 Bytes	256 Bytes
Host Transfer Rate	2.0 MBytes/sec.	1.2 Mbytes/sec.	1.25 MBytes/sec.	1.0 Mbytes/sec.
Minimum Interleave	1:1	1:1	1:1	1:1
PHYSICAL CHARACTERISTICS				
Physical Dimensions	Length: 8.00 inches Width: 5.75 inches Height: 0.75 inches	Length: 14.00 inches Width: 8.50 inches Height: 0.75 inches	Length: 8.00 inches Width: 5.75 inches Height: 0.75 inches	Length: 15.00 inches Width: 8.25 inches Height: 0.75 inches
Power Supply	+5VDC @ 1.5A (Max)	+5VDC @ 6.0A (Max)	+5VDC @ 2.5A (Max)	+5VDC @ 6.0A (Max)
Availability	4Q '85	NOW	NOW	NOW
OEM Price (U.S.)/QTY	$250/100's	$1200/100's	$500/100's	$675/100's
COMMENTS		SC3011: Archive 9045/20B SC3021: Rosscomp 160	512K Bytes of cache RAM available as an option.	SC2101 DEI 1190/1290, SC2111 Archive 9020/45, SC2201 DEI Slider SL-1.

MANUFACTURER	SYSGEN CORPORATION	SYSGEN CORPORATION	SYSGEN CORPORATION	WANGTEK
MODEL NUMBER	SC2131	SC4000XR	SC3000	SCSI-36
CONTROLLER TYPE	Multifunction (Winch/Digital Cassette)	Tape Only (1/4 inch Streamer)	Winchester Only (8 or 14 inch)	Tape Only (1/4 inch Streamer)
DRIVE CHARACTERISTICS				
Drive interface	ST506/412, and MFE Companion	QIC-02	SMD	QIC-36
Maximum # Drives	4 Winchesters and 1 Tape (Cassette)	1 Tape	2 Winchesters	1 Tape
Sector Sizes -Bytes	256	Per QIC-11/24	256	Per QIC-11/24
Error Detection	32-Bit ECC	16-Bit CRC	32-Bit ECC	16-Bit CRC
Error Correction	Single-Burst/5 Bits	Read-after-Write	Single-Burst/5 Bits	Read-after-Write
Flaw Skipping	Track-level	Block Re-write	Track-level	Block Re-write
HOST CHARACTERISTICS				
Level of SCSI	Single-Initiator	Single-Initiator	Single-Initiator	Reconnect/Disconnect
Size of Buffer	256 Bytes	8K Bytes	8K Bytes	10K Bytes
Host Transfer Rate	1.0 Mbytes/sec.	1.0 MBytes/sec.	1.2 Mbytes/sec.	1.5 MBytes/sec.
Minimum Interleave	1:1	N/A	1:1	N/A
PHYSICAL CHARACTERISTICS				
Physical Dimensions	Length: 15.00 inches Width: 8.25 inches Height: 0.75 inches	Length: 8.00 inches Width: 5.75 inches Height: 0.75 inches	Length: 14.00 inches Width: 8.50 inches Height: 0.75 inches	Length: 8.00 inches Width: 5.75 inches Height: 0.50 inches
Power Supply	+5VDC @ 6.0A (Max)	+5VDC @ 1.5A (Max)	+5VDC @ 6.0A (Max)	+5VDC @ 2.0A (Max) +12VDC @ 300mA (Max)
Availability	NOW	NOW	NOW	NOW
OEM Price (U.S.)/QTY	$675/100's	$265/100's	$850/100's	$500/100's
COMMENTS				Supports QIC-24 and -11 Recording Formats.

NUFACTURER	WESTERN DIGITAL CORPORATION	WESTERN DIGITAL CORPORATION	WESTERN DIGITAL CORPORATION	WESTERN DIGITAL CORPORATION
MODEL NUMBER	WD1036R-SHD	WD1002S-SHD	WD1002-SHD	WD1003-SCS
CONTROLLER TYPE	Tape Only (1/4 inch Streamer)	Winchester Only (3-1/2 inch)	Winchester Only (5-1/4 inch)	Winchester Only (5-1/4 inch)
DRIVE CHARACTERISTICS				
Drive interface	QIC-36	ST506/412	ST506/412	ST506/412
Maximum # Drives	1 Tape	2 Winchesters	2 Winchesters	2 Winchesters
Sector Sizes -Bytes	Per QIC-11/24	256 and 512	256 and 512	128 through 1,024
Error Detection	16-Bit CRC	32-Bit ECC	32-Bit ECC	32-Bit ECC
Error Correction	Read-after-Write	Single-Burst/5 Bits	Single-Burst/5 Bits	Single-Burst/5 Bits
Flaw Skipping	Block Re-write	Track-level	Track-level	Sector-level
HOST HARACTERISTICS				
Level of SCSI	XSASI	XSASI	XSASI	Reconnect/Disconnect
Size of Buffer	8K Bytes	512 Bytes	512 Bytes	1K Bytes
Host Transfer Rate	1.0 Mbyte/sec.	0.8 MBytes/sec.	0.8 MBytes/sec.	1.0 MBytes/sec.
Minimum Interleave	N/A	2:1	2:1	1:1
PHYSICAL CHARACTERISTICS				
Physical Dimensions	Length: 8.00 inches Width: 5.50 inches Height: 0.75 inches	Length: 5.75 inches Width: 4.00 inches Height: 0.75 inches	Length: 8.00 inches Width: 5.75 inches Height: 0.75 inches	Length: 8.00 inches Width: 5.75 inches Height: 0.75 inches
Power Supply	+5VDC @ 1.8A (Max) +12VDC @ 100mA (Max)	+5VDC @ 1.5A (Max)	+5VDC @ 1.5A (Max)	+5VDC @ 1.5A (Max) +12VDC @ 250mA (Max)
Availability	NOW	NOW	NOW	NOW
OEM Price (U.S.)/QTY	$215/100's	$175/100's	$175/100's	$185/100's
COMMENTS	Command compatible with the WD1002-SHD for off-line Backup.	3.5" version of WD1002-SHD		

MANUFACTURER	XEBEC CORPORATION	XEBEC CORPORATION	XEBEC CORPORATION	XEBEC CORPORATION
MODEL NUMBER	S1401	S1420	S1405	S1410A
CONTROLLER TYPE	Floppy Only (5-14 or 8 inch)	Multifunction (Winchester/Floppy)	Winchester Only (5-1/4 inch)	Winchester Only (5-1/4 inch)
DRIVE CHARACTERISTICS				
Drive interface	SA400/450/800/850	ST506/412, and SA400/450	ST506/412	ST506/412
Maximum # Drives	4 Floppies	2 Winchesters and 2 Floppies	2 Winchesters	2 Winchesters
Sector Sizes -Bytes	128 through 1,024	256 and 512	256 and 512	256 and 512
Error Detection	16-Bit CRC	32-Bit ECC	32-Bit ECC	32-Bit ECC
Error Correction	None	Single-Burst/11 Bits	Single-Burst/11 Bits	Single-Burst/11 Bits
Flaw Skipping	Track-level	Track-level	Track-level	Track-level
HOST CHARACTERISTICS				
Level of SCSI	XSASI	XSASI	XSASI	XSASI
Size of Buffer	1K Bytes	512 Bytes	512 Bytes	512 Bytes
Host Transfer Rate	0.6 MBytes/sec.	1.0 MBytes/sec.	1.0 MBytes/sec.	1.0 MBytes/sec.
Minimum Interleave	1:1	3:1	3:1	3:1
PHYSICAL CHARACTERISTICS				
Physical Dimensions	Length: 8.00 inches Width: 5.75 inches Height: 0.60 inches	Length: 8.00 inches Width: 5.75 inches Height: 0.69 inches	Length: 8.00 inches Width: 5.75 inches Height: 0.75 inches	Length: 8.00 inches Width: 5.75 inches Height: 0.75 inches
Power Supply	+5VDC @ 1.9A (Max) +12VDC @ 20mA (Max)	+5VDC @ 2.0A (Max) +12VDC @ 3mA (Max)	+5VDC @ 2.0A (Max) +12VDC @ 50mA (Max)	+5VDC @ 2.0A (Max) +12VDC @ 50mA (Max)
Availability	NOW	NOW	NOW	NOW
OEM Price (U.S.)/QTY	$150/100's	$200/100's	$185/100's	$200/100's
COMMENTS				

MANUFACTURER	XEBEC CORPORATION	XEBEC CORPORATION	XEBEC CORPORATION	
MODEL NUMBER	S1490	S2410A	S2410	
CONTROLLER TYPE	Winchester Only (8 or 14 inch)	Winchester Only (5-1/4 inch)	Winchester Only (5-1/4 inch)	
DRIVE CHARACTERISTICS				
Drive interface	SMD	ESDI (10 Mbits/sec.)	ESDI (5 Mbits/sec.)	
Maximum # Drives	2 Winchesters	4 Winchesters	4 Winchesters	
Sector Sizes -Bytes	256 and 512	256 through 1,024	256 through 1,024	
Error Detection	32-Bit ECC	48-Bit ECC	48-Bit ECC	
Error Correction	Single-Burst/11 Bits	Single-Burst/16 Bits	Single-Burst/16 Bits	
Flaw Skipping	Track-level	Sector-level	Sector-level	
HOST CHARACTERISTICS				
Level of SCSI	XSASI	Reconnect/Disconnect	Reconnect/Disconnect	
Size of Buffer	512 Bytes	1K Bytes	1K Bytes	
Host Transfer Rate	1.0 MBytes/sec.	1.5 MBytes/sec.	1.5 MBytes/sec.	
Minimum Interleave	3:1	1:1	1:1	
PHYSICAL CHARACTERISTICS				
Physical Dimensions	Length: 10.00 inches Width: 8.00 inches Height: 0.75 inches	Length: 8.00 inches Width: 5.75 inches Height: 0.75 inches	Length: 8.00 inches Width: 5.75 inches Height: 0.75 inches	
Power Supply	+5VDC @ 2.5A (Max) -5VDC @ 110mA (Max)	+5VDC @ 2.0A (Max) +12VDC @ 3mA (Max)	+5VDC @ 2.0A (Max) +12VDC @ 3mA (Max)	
Availability	NOW	NOW	NOW	
OEM Price (U.S.)/QTY	$200/100's	$295/100's	$295/100's	
COMMENTS		Supports serial channel and hard-sectoring.	Supports serial channel and hard-sectoring.	

MANUFACTURER	ADAPTEC, INCORPORATED	ADAPTEC, INCORPORATED	ADAPTEC, INCORPORATED	ARCHIVE CORPORATION
MODEL NUMBER	ACB-2002	ACB-2002A	ACB-2010A	SC400
CONTROLLER TYPE	Winchester Only (5-1/4 inch)	Winchester Only (5-1/4 inch)	Winchester Only (5-1/4 inch)	Tape Only (1/4 inch Streamer)
ELECTRICAL CHARACTERISTICS				
Drive interface	ST506/412	ST506/412	ST506/412 and Hard Sectored Removables	QIC-36
Maximum # Drives	2 Winchesters	2 Winchesters	2 Winchesters	1 Tape
Error Detection	32-Bit ECC	32-Bit ECC	32-Bit ECC	16-Bit CRC
Error Correction	Single-Burst/11 Bits	Single-Burst/11 Bits	Single-Burst/11 Bits	Block Rewrite
Flaw Skipping	Sector-level	Sector-level	Sector-level	Read-after-Write
Minimum Interleave	2:1	2:1	2:1	N/A
Model Support	IBM-PC, PC/XT	IBM-PC, PC/XT	IBM-PC, PC/XT	IBM-PC
BIOS ROM	Without BIOS	BIOS included	BIOS Included	BIOS included
PHYSICAL CHARACTERISTICS				
Physical Dimensions	Length: 13.00 inches Width: 4.40 inches Height: 0.75 inches	Length: 13.00 inches Width: 4.40 inches Height: 0.75 inches	Length: 13.00 inches Width: 4.40 inches Height: 0.75 inches	Length: 12.00 inches Width: 4.00 inches Height: 0.75 inches
Power Supply	+5VDC @ 1.5A (Max) +12VDC @ 100mA (Max) -12VDC @ 40mA (Max)	+5VDC @ 1.5A (Max) +12VDC @ 100mA (Max) -12VDC @ 40mA (Max)	+5VDC @ 1.5A (Max) +12VDC @ 100mA (Max) -12VDC @ 40mA (Max)	+5VDC @ 1.5A (Max) +12VDC @ 125mA (Max)
Availability	NOW	NOW	NOW	
OEM Price (U.S.)/QTY	$235/100's	$245/100's	$265/100's	
COMMENTS	Same as ACB-2002A but Without BIOS ROM.			Supports QIC-24 and QIC-11 Recording Formats

MANUFACTURER	CENTAN CORPORATION	DATA TECHNOLOGY CORPORATION	DATA TECHNOLOGY CORPORATION	DATA TECHNOLOGY CORPORATION
MODEL NUMBER	NDC-5027	3251	5051	5091
CONTROLLER TYPE	Winchester Only (5-1/4 inch)	Floppy Only (5-1/4 inch)	Tape Only (1/4 inch Streamer)	Tape Only (1/4 inch Streamer)
ELECTRICAL CHARACTERISTICS				
Drive interface	ST506/412	SA400/450 and Kodak 3.3	QIC-02	QIC-02
Maximum # Drives	2 Winchesters	2 Floppies	1 Tape	1 Tape
Error Detection	32-Bit ECC	16-Bit CRC	16-Bit CRC	16-Bit CRC
Error Correction	Single-Burst/11 Bits	None	None	None
Flaw Skipping	Sector-level	N/A	Block-Rewrite	Block-Rewrite
Minimum Interleave	3:1	N/A	N/A	N/A
[illegible] Support	IBM-PC, PC/XT	IBM-PC, PC/XT	IBM-PC, PC/XT	IBM-PC AT
BIOS ROM	BIOS included	BIOS included	BIOS included	BIOS included
PHYSICAL CHARACTERISTICS				
Physical Dimensions	Length: 8.00 inches Width: 3.85 inches Height: 0.50 inches	Length: 8.00 inches Width: 3.85 inches Height: 0.75 inches	Length: 13.38 inches Width: 3.90 inches Height: 0.75 inches	Length: 13.38 inches Width: 3.90 inches Height: 0.75 inches
Power Supply	+5VDC @ 1.4A (Max)	+5VDC @ 1.0A (Max)	+5VDC @ 2.0A (Max)	+5VDC @ 2.0A (Max)
Availability	NOW	NOW	4Q '85	4Q '85
OEM Price (U.S.)/QTY	$135/100's	$209/100's	$185/100's	$185/100's
COMMENTS		Versions available for Internal or External Drives.		

MANUFACTURER	DATA TECHNOLOGY CORPORATION	DATA TECHNOLOGY CORPORATION	DATA TECHNOLOGY CORPORATION	DATA TECHNOLOGY CORPORATION
MODEL NUMBER	5150BX	5150BXE	5190	5250CX
CONTROLLER TYPE	Winchester Only (5-1/4 inch)	Winchester Only (5-1/4 inch)	Winchester Only (5-1/4 inch)	Multifunction (Winchester/Floppy)
ELECTRICAL CHARACTERISTICS				
Drive interface	ST506/412	ST506/412	ST506/412	ST506/412, SA400/450, and Kodak 3.3
Maximum # Drives	2 Winchesters	2 Winchesters	2 Winchesters	2 Winchesters and 2 Floppies
Error Detection	24-Bit ECC	24-Bit ECC	32-Bit ECC	24-Bit ECC
Error Correction	Single-Burst/4 Bits	Single-Burst/4 Bits	Single-Burst/11 Bits	Single-Burst/4 Bits
Flaw Skipping	Track-level	Track-level	Sector-level	Track-level
Minimum Interleave	2:1	2:1	2:1	2:1
Model Support	IBM-PC, PC/XT	IBM-PC, PC/XT	IBM-PC AT	IBM-PC, PC/XT
BIOS ROM	BIOS included	BIOS included	BIOS included	BIOS included
PHYSICAL CHARACTERISTICS				
Physical Dimensions	Length: 13.38 inches Width: 3.90 inches Height: 0.75 inches	Length: 13.38 inches Width: 3.90 inches Height: 0.75 inches	Length: 13.38 inches Width: 3.90 inches Height: 0.75 inches	Length: 13.38 inches Width: 3.90 inches Height: 0.75 inches
Power Supply	+5VDC @ 1.7A (Max)	+5VDC @ 1.7A (Max)	+5VDC @ 1.7A (Max)	+5VDC @ 2.0A (Max)
Availability	NOW	NOW	NOW	NOW
OEM Price (U.S.)/QTY	$155/100's	$195/100's	$238/100's	$295/100's
COMMENTS	For internal Drives.	For external Drives.	Supports Removable Winchesters.	

MANUFACTURER	DATA TECHNOLOGY CORPORATION	DATA TECHNOLOGY CORPORATION	INTERPHASE CORPORATION	SCIENTIFIC MICRO SYSTEMS INCORPORATED
MODEL NUMBER	5290	5350	MAVERICK SMD PC-80	5510
CONTROLLER TYPE	Multifunction (Winchester/Floppy)	Multifunction (Winchester/Tape)	Winchester Only (8 or 14 inch)	Winchester Only (5-1/4 inch)
ELECTRICAL CHARACTERISTICS				
Drive interface	ST506/412, SA400/450, and Kodak 3.3	ST506/412 and QIC-02	SMD (2.1 Megabytes/sec)	ST506/412
Maximum # Drives	2 Winchesters and 2 Floppies	2 Winchesters and 1 Tape	2 Winchesters	2 Winchesters
Error Detection	32-Bit ECC	32-Bit ECC	32-Bit ECC	32-Bit ECC
Error Correction	Single-Burst/11 Bits	Single-Burst/11 Bits	Single-Burst/11 Bits	Single-Burst/5 Bits
Flaw Skipping	Sector-level	Sector-level	Track-level	Track-level
Minimum Interleave	2:1	2:1	1:1	1:1
[illegible] Support	IBM-PC AT	IBM-PC XT	IBM-PC, PC/XT, AT	IBM-PC, PC/XT
BIOS ROM	BIOS included	BIOS included	BIOS included	BIOS Included
PHYSICAL CHARACTERISTICS				
Physical Dimensions	Length: 13.38 inches Width: 3.90 inches Height: 0.75 inches	Length: 13.25 inches Width: 3.90 inches Height: 0.94 inches	Length: 13.13 inches Width: 4.19 inches Height: 0.63 inches	Length: 5.50 inches Width: 4.15 inches Height: 0.75 inches
Power Supply	+5VDC @ 1.75A (Max)	+5VDC @ 1.85A (Max)	+5VDC @ 1.2A (Max)	+5VDC @ 500mA (Max)
Availability	NOW	NOW	NOW	NOW
OEM Price (U.S.)/QTY	$264/100's	$428/100's	$950/100's	$150/100's
COMMENTS	Supports Removable Winchesters.	Auto-Backup commands	BIOS ROMs available for Corona, Columbia, and Eagle PC's.	

IBM PC

MANUFACTURER	SCIENTIFIC MICRO SYSTEMS INCORPORATED	SIGEN CORPORATION	SIGEN CORPORATION	SIGEN CORPORATION
MODEL NUMBER	5710	DC6	T-36	T-36M
CONTROLLER TYPE	Multifunction (Winchester/Tape)	Winchester Only (5-1/4 inch)	Tape Only (1/4 inch Streamer)	Tape Only (Digital Cassette)
ELECTRICAL CHARACTERISTICS				
Drive interface	ST506/412 and QIC-02	ST506/412	QIC-36	MEMTEC (Cassette) Interface
Maximum # Drives	2 Winchesters and 1 Tape	2 Winchesters	1 Tape	1 Tape
Error Detection	32-Bit ECC	32-Bit ECC	16-Bit CRC	16-Bit CRC
Error Correction	Single-Burst/5 Bits	Single-Burst/5 Bits	N/A	N/A
Flaw Skipping	Track-level	Sector-Level	Block-ReWrite	Block-ReWrite
Minimum Interleave	1:1	1:1	N/A	N/A
Model Support	IBM-PC, PC/XT	IBM-PC, PC/XT	IBM-PC, PC/XT, AT	IBM-PC, PC/XT, AT
BIOS ROM	BIOS Included	BIOS Included	BIOS Included	BIOS Included
PHYSICAL CHARACTERISTICS				
Physical Dimensions	Length: 5.50 inches Width: 4.15 inches Height: 0.75 inches	Length: 13.00 inches Width: 4.00 inches Height: 0.75 inches	Length: 5.50 inches Width: 3.90 inches Height: 0.75 inches	Length: 5.50 inches Width: 3.90 inches Height: 0.75 inches
Power Supply	+5VDC @ 500mA (Max)	+5VDC @ 1.8A (Max) +12VDC @ 50mA (Max) -12VDC @ 3mA (Max)	+5VDC @ 0.6A (Max)	+5VDC @ 0.6A (Max)
Availability	4Q '85	NOW	NOW	NOW
OEM Price (U.S.)/QTY	$200/100's	$225/100's	$175/100's	$175/100's
COMMENTS		Contains NBS Data Encryption circuitry.	Short-Slot form factor	Short-Slot form factor

MANUFACTURER	SIGEN CORPORATION	SUNOL SYSTEMS	SUNOL SYSTEMS	WANGTEK
MODEL NUMBER	T-44	BLP-IBM1	BLP-IBM2	PC-36
CONTROLLER TYPE	Tape Only (1/4 inch Streamer)	Multifunction (Winchester/Floppy)	Multifunction (Winchester/Floppy/Tape)	Tape Only (1/4 inch Streamer)
ELECTRICAL CHARACTERISTICS				
Drive interface	QIC-44 (Tanberg)	ST506/412 and ESDI (10 Mbits/sec)	ST506/412, ESDI, QIC-36 and SA450/460	QIC-36
Maximum # Drives	1 Tape	4 Winchesters and 2 Floppies	4 Winchesters, 1 Tape, and 2 Floppies	1 Tape
Error Detection	16-Bit CRC	32-Bit ECC	32-Bit ECC	16-Bit CRC
Error Correction	N/A	Single-Burst/11 Bits	Single-Burst/11 Bits	Block Rewrite
Flaw Skipping	Block-ReWrite	Sector-Level	Sector-Level	Read-after-Write
Minimum Interleave	N/A	1:1	1:1	N/A
Model Support	IBM-PC, PC/XT, AT	IBM-PC, PC/XT	IBM-PC, PC/XT, AT	IBM-PC, PC/XT
BIOS ROM	BIOS Included	BIOS Included	BIOS Included	BIOS Included
PHYSICAL CHARACTERISTICS				
Physical Dimensions	Length: 5.50 inches Width: 3.90 inches Height: 0.75 inches	Length: 13.00 inches Width: 4.50 inches Height: 0.50 inches	Length: 13.00 inches Width: 4.50 inches Height: 0.50 inches	Length: 13.00 inches Width: 4.75 inches Height: 0.75 inches
Power Supply	+5VDC @ 0.6A (Max)	+5VDC @ 1.5A (Max)	+5VDC @ 1.5A (Max)	+5VDC @ 1.0A (Max) +12VDC @ 100mA (Max)
Availability	NOW	4Q '85	1Q '86	NOW
OEM Price (U.S.)/QTY	$170/100's	$295/100's	$395/100's	$947/100's
COMMENTS	Short-Slot form factor	Supports MFM or 2,7 RLL (7.5 Mbits/s).	Supports MFM or 2,7 RLL (7.5 Mbits/s).	Supports the QIC-24 Recording Format.

IBM PC

MANUFACTURER	WESTERN DIGITAL CORPORATION	WESTERN DIGITAL CORPORATION	WESTERN DIGITAL CORPORATION	WESTERN DIGITAL CORPORATION
MODEL NUMBER	WD1002-WA2	WD1002-WAH	WD1002C-WX2	WD1002S-WX2
CONTROLLER TYPE	Multifunction (Winchester/Floppy)	Winchester Only (5-1/4 inch)	Winchester Only (5-1/4 inch)	Winchester Only (5-1/4 inch)
ELECTRICAL CHARACTERISTICS				
Drive interface	ST506/412 and SA400/450	ST506/412	ST506/412	ST506/412
Maximum # Drives	2 Winchesters and 2 Floppies	2 Winchesters	2 Winchesters	2 Winchesters
Error Detection	32-Bit ECC	32-Bit ECC	32-Bit ECC	32-Bit ECC
Error Correction	Single-Burst/5 Bits	Single-Burst/5 Bits	Single-Burst/11 Bits	Single-Burst/11 Bits
Flaw Skipping	Track-level	Track-level	Track-level	Track-level
Minimum Interleave	2:1	2:1	2:1	2:1
Model Support	IBM-PC AT	IBM-PC AT	IBM-PC, PC/XT	IBM-PC, PC/XT
BIOS ROM	Without BIOS	Without BIOS	BIOS Included	BIOS Included
PHYSICAL CHARACTERISTICS				
Physical Dimensions	Length: 13.10 inches Width: 4.80 inches Height: 0.75 inches	Length: 8.10 inches Width: 4.20 inches Height: 0.50 inches	Length: 8.10 inches Width: 4.20 inches Height: 0.50 inches	Length: 5.75 inches Width: 4.20 inches Height: 0.50 inches
Power Supply	+5VDC @ 2.5A (Max) +12VDC @ 150mA (Max) -12VDC @ 10mA (Max)	+5VDC @ 1.5A (Max) +12VDC @ 50mA (Max)	+5VDC @ 1.0A (Max) +12VDC @ 50mA (Max)	+5VDC @ 1.0A (Max) +12VDC @ 50mA (Max)
Availability	NOW	NOW	NOW	4Q '85
OEM Price (U.S.)/QTY	$230/100's	$200/100's	$150/100's	$150/100's
COMMENTS	Supports 4 different Floppy Data Rates.	Winchester-only version of WD1002-WA2.	Short-Slot Compatible with Bad Block Mapping/ Auto-Configure Modes.	Short-Slot Compatible

MANUFACTURER	WESTERN DIGITAL CORPORATION	WESTERN DIGITAL CORPORATION	WESTERN DIGITAL CORPORATION	XEBEC CORPORATION
MODEL NUMBER	WD1003A-WA2	WD1003A-WAH	WD1036S-WX2	S1210A
CONTROLLER TYPE	Multifunction (Winchester/Floppy)	Winchester Only (5-1/4 inch)	Tape Only (1/4 inch Streamer)	Winchester Only (5-1/4 inch)
ELECTRICAL CHARACTERISTICS				
Drive interface	ST506/412 and Removables SA400/450	ST506/412 and Removables	QIC-36	ST506/412 and Removables
Maximum # Drives	2 Winchesters and 2 Floppies	2 Winchesters	1 Tape	2 Winchesters
Error Detection	32-Bit ECC	32-Bit ECC	16-Bit CRC	32-Bit ECC
Error Correction	Single-Burst/5 Bits	Single-Burst/5 Bits	Block Rewrite	Single-Burst/11 Bits
Flaw Skipping	Track-level	Track-level	Read-after-Write	Track-level
Minimum Interleave	1:1	1:1	N/A	2:1
Model Support	IBM-PC AT	IBM-PC AT	IBM-PC, PC/XT, AT	IBM-PC, PC/XT
BIOS ROM	Without BIOS	Without BIOS	Without BIOS	Without BIOS
PHYSICAL CHARACTERISTICS				
Physical Dimensions	Length: 13.10 inches Width: 4.80 inches Height: 0.75 inches	Length: 8.10 inches Width: 4.20 inches Height: 0.50 inches	Length: 8.10 inches Width: 4.20 inches Height: 0.75 inches	Length: 13.13 inches Width: 4.20 inches Height: 0.85 inches
Power Supply	+5VDC @ 2.5A (Max) +12VDC @ 150mA (Max) -12VDC @ 10mA (Max)	+5VDC @ 1.5A (Max) +12VDC @ 50mA (Max)	+5VDC @ 1.0A (Max) +12VDC @ 30mA (Max)	+5VDC @ 1.25A (Max) +12VDC @ 15mA (Max)
Availability	1Q '86	NOW	NOW	NOW
OEM Price (U.S.)/QTY	$240/100's	$190/100's	$215/100's	$185/100's
COMMENTS	RLL option available		Supports the QIC-24 Recording Format.	

IBM PC

MANUFACTURER	XEBEC CORPORATION	XEBEC CORPORATION	XEBEC CORPORATION	XEBEC CORPORATION
MODEL NUMBER	S1220	S1240	S1250	S1255
CONTROLLER TYPE	Multifunction (Winchester/Floppy)	Winchester Only (5-1/4 inch)	Multifunction (Winchester/Floppy)	Winchester Only (5-1/4 inch)
ELECTRICAL CHARACTERISTICS				
Drive interface	ST506/412 and SA460	ESDI (10 Mbits/sec.)	ST506/412 and SA460	ST506/412
Maximum # Drives	2 Winchesters and 2 Floppies	4 Winchesters	2 Winchesters and 2 Floppies	4 Winchesters
Error Detection	32-Bit ECC	32-Bit ECC	32-Bit ECC	32-Bit ECC
Error Correction	Single-Burst/11 Bits	Single-Burst/11 Bits	Single-Burst/11 Bits	Single-Burst/11 Bits
Flaw Skipping	Track-level	Track-level	Track-level	Track-level
Minimum Interleave	1:1	2:1	2:1	2:1
Model Support	IBM-PC, PC/XT	IBM-PC AT	IBM-PC AT	IBM-PC AT
BIOS ROM	Without BIOS	Without BIOS	Without BIOS	Without BIOS
PHYSICAL CHARACTERISTICS				
Physical Dimensions	Length: 13.00 inches Width: 7.20 inches Height: 0.75 inches	Length: 13.13 inches Width: 4.20 inches Height: 0.85 inches	Length: 13.13 inches Width: 4.20 inches Height: 0.85 inches	Length: 13.13 inches Width: 4.20 inches Height: 0.85 inches
Power Supply	+5VDC @ 3.00A (Max) +12VDC @ 66mA (Max)	+5VDC @ 1.25A (Max) +12VDC @ 15mA (Max)	+5VDC @ 1.25A (Max) +12VDC @ 15mA (Max)	+5VDC @ 1.25A (Max) +12VDC @ 15mA (Max)
Availability	NOW	4Q '85	NOW	NOW
OEM Price (U.S.)/QTY	$200/100's	$250/100's	$250/100's	$250/100's
COMMENTS				

MANUFACTURER	ADAPTEC, INCORPORATED	ADAPTIVE DATA SYSTEMS INCORPORATED	DATA TECHNOLOGY CORPORATION	DATA TECHNOLOGY CORPORATION
MODEL NUMBER	AHA-1530	PC Master Link	Model 10	Model 10-1
HOST CHARACTERISTICS				
Host Bus Type	Multibus I	IBM PC, PC/XT	S-100	S-100
Host Features	Supports 8 Tasks/8 LUN's and Concurrency	Supports DMA and programmed I/O Modes	Supports Programmed I/O	Supports Programmed I/O and DMA modes
SCSI CHARACTERISTICS				
Level of SCSI	Reconnect/Disconnect	Reconnect/Disconnect	Single-Initiator	Single-Initiator
SCSI Transfer Rate	1.5 Megabytes/sec.	1.5 Megabytes/sec.	1.0 Megabytes/sec.	1.0 Megabytes/sec.
PHYSICAL CHARACTERISTICS				
Physical Dimensions	Length: 12.00 inches Width: 6.75 inches Height: 0.50 inches	Length: 10.00 inches Width: 4.20 inches Height: 0.80 inches	Length: 10.00 inches Width: 5.25 inches Height: 0.50 inches	Length: 10.00 inches Width: 5.25 inches Height: 0.50 inches
Power Supply	+5VDC @ 2.0A (Max)	+5VDC @ 2.5A (Max)	+8VDC @ 1.4A (Max)	+8VDC @ 1.8A (Max)
Availability	Q1 86	NOW	NOW	NOW
OEM Price (U.S.)	$460	$250	$195	$225
COMMENTS	Mailbox Communications with Host	Parity Support/ Differential Version Available.		

MANUFACTURER	DATA TECHNOLOGY CORPORATION	DATA TECHNOLOGY CORPORATION	DATA TECHNOLOGY CORPORATION	DATA TECHNOLOGY CORPORATION
MODEL NUMBER	Model 11	Model 11-2	Model 12	Model 51
HOST CHARACTERISTICS				
Host Bus Type	QBus	QBus	Unibus	IBM-PC, PC/XT
Host Features	Contains Two DMA Channels	Supports up to 8 SCSI Targets		
SCSI - CHARACTERISTICS				
Level of SCSI	Single-Initiator	Single-Initiator	Single-Initiator	Single-Initiator
SCSI Transfer Rate	1.0 Megabytes/sec.	1.0 Megabytes/sec.	1.0 Megabytes/sec.	1.0 Megabytes/sec.
PHYSICAL CHARACTERISTICS				
Physical Dimensions	Length: 8.40 inches Width: 5.20 inches Height: 0.50 inches	Length: 8.40 inches Width: 5.20 inches Height: 0.50 inches	Length: 16.00 inches Width: 9.00 inches Height: 0.50 inches	Length: 8.00 inches Width: 3.90 inches Height: 0.50 inches
Power Supply	+5VDC @ 2.0A (Max)	+5VDC @ 2.0A (Max)	+5VDC @ 2.0A (Max)	+5VDC @ 1.0A (Max)
Availability	NOW	NOW	NOW	NOW
OEM Price (U.S.)	$395	$395	$828	$190
COMMENTS	Compatible with LSI-11/03, 11/23.			

MANUFACTURER	DATA TECHNOLOGY CORPORATION	DATA TECHNOLOGY CORPORATION	DATA TECHNOLOGY CORPORATION	DATA TECHNOLOGY CORPORATION
MODEL NUMBER	Model 68	Model 69	Model 75	Model 75-1
HOST CHARACTERISTICS				
Host Bus Type	EXORcisor II	VERSAbus 68000, IBM System 9000	Apple II/II+/IIe	Apple II/II+/IIe
Host Features			Supports DOS 3.3	Supports DOS 3.3 and ProDOS
SCSI CHARACTERISTICS				
Level of SCSI	Single-Initiator	Single-Initiator	Single-Initiator	Single-Initiator
SCSI Transfer Rate	1.0 Megabytes/sec.	1.0 Megabytes/sec.	1.0 Megabytes/sec.	1.0 Megabytes/sec.
PHYSICAL CHARACTERISTICS				
Physical Dimensions	Length: 9.75 inches Width: 5.50 inches Height: 0.50 inches	Length: 14.50 inches Width: 9.24 inches Height: 0.50 inches	Length: 7.00 inches Width: 3.05 inches Height: 0.50 inches	Length: 7.00 inches Width: 3.05 inches Height: 0.50 inches
Power Supply	+5VDC @ 1.0A (Max)	+5VDC @ 2.8A (Max)	+5VDC @ 0.5A (Max)	+5VDC @ 0.5A (Max)
Availability	NOW	NOW	NOW	NOW
OEM Price (U.S.)	$350	$580	$140	$158
COMMENTS				

Peripheral Concepts

MANUFACTURER	DATA TECHNOLOGY CORPORATION	DATA TECHNOLOGY CORPORATION	DATA TECHNOLOGY CORPORATION	EMULEX CORPORATION
MODEL NUMBER	Model 75-2	Model 86	Model 86-1	IBM01
HOST CHARACTERISTICS				
Host Bus Type	Apple II/II+/IIe	Multibus I	Multibus I	IBM-PC, PC/XT
Host Features	Supports DOS 3.3 and ProDOS	Supports variable Size Blocks	Supports up to Eight SCSI Targets	Up to 2.0 microsec/byte DMA Transfers
SCSI CHARACTERISTICS				
Level of SCSI	Single-Initiator	Single-Initiator	Single-Initiator	Reconnect/Disconnect
SCSI Transfer Rate	1.0 Megabytes/sec.	1.0 Megabytes/sec.	1.0 Megabytes/sec.	1.5 Megabytes/sec.
PHYSICAL CHARACTERISTICS				
Physical Dimensions	Length: 7.00 inches Width: 3.05 inches Height: 0.50 inches	Length: 12.00 inches Width: 6.75 inches Height: 0.50 inches	Length: 12.00 inches Width: 6.75 inches Height: 0.50 inches	Length: 8.00 inches Width: 3.90 inches Height: 0.50 inches
Power Supply	+5VDC @ 0.5A (Max)	+5VDC @ 2.0A (Max)	+5VDC @ 2.0A (Max)	+5VDC @ 1.1A (Max)
Availability	NOW	NOW	NOW	NOW
OEM Price (U.S.)	$195	$270	$270	$395
COMMENTS	FCC Approved External Mating Connector.			Also Available Without BIOS ROM.

MANUFACTURER	EMULEX CORPORATION	EMULEX CORPORATION	EMULEX CORPORATION	FORCE COMPUTERS
MODEL NUMBER	UC01/LX	UC03	UC13	SYS68K/SASI-1
HOST CHARACTERISTICS				
Host Bus Type	Qbus	Qbus	Unibus	VMEbus
Host Features	Emulates two RLV11/12 Controllers	Emulates MSCP	Emulates MSCP	Provides Four DMA Channels
SCSI CHARACTERISTICS				
Level of SCSI	Reconnect/Disconnect	Reconnect/Disconnect	Reconnect/Disconnect	Reconnect/Disconnect
SCSI Transfer Rate	1.5 Megabytes/sec.	1.5 Megabytes/sec.	1.5 Megabytes/sec.	1.5 Megabytes/sec.
PHYSICAL CHARACTERISTICS				
Physical Dimensions	Standard Qbus	Single Quad-size, Standard Qbus	Single Hex-size, Standard Unibus	Length: 9.20 inches Width: 6.30 inches Height: 0.80 inches
Power Supply	+5VDC @ 5.7A (Max)	+5VDC @ 4.8A (Max)	+5VDC @ 4.8A (Max)	+5VDC @ 2.1A (Max) +12VDC @ 100mA (Max) -12VDC @ 100mA (Max)
Availability	NOW	NOW	NOW	NOW
OEM Price (U.S.)	$1,500	$1,800	$2,200	$1,380
COMMENTS		Compatible with LSI-11 and MicroPDP-11.	PDP-11/04 thru 11/70, VAX-11/730/750/780.	Contains RS-232 port for Debug and Diagnostics mode.

Peripheral Concepts

MANUFACTURER	INTEGRATED SOLUTIONS INCORPORATED	MIZAR, INCORPORATED	NCR CORPORATION	NCR CORPORATION
MODEL NUMBER	VME-SCSI	VME8500	ADP-31A-01	ADP-32-01
HOST CHARACTERISTICS				
Host Bus Type	VMEbus	VMEbus	IBM-PC, PC/XT	Multibus I
Host Features	8-Block Data Buffer Capacity	Provides Two Vectored Interrupts	Supports DMA transfer Mode.	Up to 8 Concurrent I/O operations
SCSI CHARACTERISTICS				
Level of SCSI	Single-Initiator	Single-Initiator	Reconnect/Disconnect	Reconnect/Disconnect
SCSI Transfer Rate	1.2 Megabytes/sec.	1.0 Megabytes/sec.	1.1 Megabytes/sec.	1.5 Megabytes/sec.
PHYSICAL CHARACTERISTICS				
Physical Dimensions	Length: 9.20 inches Width: 6.30 inches Height: 0.80 inches	Length: 9.20 inches Width: 6.30 inches Height: 0.75 inches	Length: 7.08 inches Width: 4.20 inches Height: 0.60 inches	Length: 12.00 inches Width: 6.75 inches Height: 0.60 inches
Power Supply	+5VDC @ 3.1A (Max)	+5VDC @ 0.55A (Max)	+5VDC @ 0.6A (Max)	+5VDC @ 3.0A (Max)
Availability	NOW	NOW	NOW	NOW
OEM Price (U.S.)	$1,200	$350	$280	$620
COMMENTS	Automatic Defect And Bad Block Skipping		NCR ROM BIOS version is ADP-31A-02.	Single-ended SCSI I/O Lines.

MANUFACTURER	NCR CORPORATION	PEP MODULAR COMPUTER	PLESSEY MICROSYSTEMS	SCIENTIFIC MICRO SYSTEMS INCORPORATED
MODEL NUMBER	ADP-32-02	VDIO	PME SASI-1	510
HOST CHARACTERISTICS				
Host Bus Type	Multibus I	VMEbus	VMEbus	IBM-PC, PC/XT
Host Features	Up to 8 Concurrent I/O operations	DMA and Polling Modes Supported	Provides Four DMA Channels	
SCSI CHARACTERISTICS				
Level of SCSI	Reconnect/Disconnect	Single-Initiator	Single-Initiator	Single-Initiator
SCSI Transfer Rate	1.5 Megabytes/sec.	1.5 Megabytes/sec.	1.0 Megabytes/sec.	1.5 Megabytes/sec.
HYSICAL CHARACTERISTICS				
Physical Dimensions	Length: 12.00 inches Width: 6.75 inches Height: 0.60 inches	Length: 100 mm Width: 160 mm	Length: 9.20 inches Width: 6.30 inches Height: 0.75 inches	Length: 5.50 inches Width: 4.15 inches Height: 0.75 inches
Power Supply	+5VDC @ 3.0A (Max)	+5VDC @ 1.0A (Max)	+5VDC @ 1.8A (Max) +12VDC @ 300mA (Max) -12VDC @ 300mA (Max)	+5VDC @ 500mA (Max)
Availability	NOW	NOW	NOW	NOW
OEM Price (U.S.)	$685	$313	$1,077	$90
COMMENTS	Differential SCSI I/O Lines.		Contains an RS-232C Port for Diagnostics.	Socket provided for BIOS ROM

MANUFACTURER	SIGMA INFORMATION SYSTEMS	TD SYSTEMS, INCORPORATED	XEBEC CORPORATION	XEBEC CORPORATION
MODEL NUMBER	SDC-RLV112	TDL-12	Apple Adapter	IBM-PC Adapter
HOST CHARACTERISTICS				
Host Bus Type	Qbus	Qbus	Apple II+/IIe	IBM-PC
Host Features	Supports mixed capacity RL01 or RL02 drives	Emulates DEC RLV	Supports DOS 3.3, ProDOS and CP/M	DMA or Programmed I/O Modes Supported
SCSI CHARACTERISTICS				
Level of SCSI	Single-Initiator	Reconnect/Disconnect	XSASI	XSASI
SCSI Transfer Rate	1.0 Megabytes/sec.	1.5 Megabytes/sec.	1.0 Megabytes/sec.	1.0 Megabytes/sec.
PHYSICAL CHARACTERISTICS				
Physical Dimensions	Single dual-wide, Standard Qbus	Dual-wide, Standard Qbus	Length: 6.50 inches Width: 3.10 inches Height: 0.75 inches	Length: 8.73 inches Width: 4.23 inches Height: 0.60 inches
Power Supply	+5VDC @ 3.75A (Max)	+5VDC @ 5.0A (Max)	+5VDC @ 626mA (Max)	+5VDC @ 1.0A (Max)
Availability	NOW	NOW	NOW	NOW
OEM Price (U.S.)	$1,025	$695	$90	$90
COMMENTS	Supports S1410, ACB-4000, or 20C/20L	Compatible with standard DEC RL bootstraps.		"Bootable" (contains BIOS ROM).

FACTURER	ADAPTEC, INCORPORATED	ADAPTEC, INCORPORATED	ADAPTEC, INCORPORATED	ADAPTEC, INCORPORATED
PART NUMBER	AIC-010	AIC-010	AIC-100	AIC-250
FUNCTION	Controller Chip	Controller Chip	Winchester Controller	Encoder/Decoder
ELECTRICAL CHARACTERISTICS				
Features	Programmable, General Purpose Controller	Programmable, General Purpose Controller	NRZ Data Input, 8-Bit Parallel MPU Interface	NRZ to/from MFM Convertor
Clock/Data Rate	24 MHz	5/10/15 MHz	10 MHz	500KHz to 10 MHz
Technology	CMOS	CMOS	Silicon Gate NMOS	Silicon Gate NMOS
PHYSICAL CHARACTERISTICS				
ackage Size	40-Pin Dual-in-line and 44-Pin PLCC	40-Pin Dual-in-line and 44-Pin PLCC	40-Pin Dual-in-Line	24-Pin Dual-in-line
Power Supply	+5VDC +/-5%	+5VDC +/-5%	+5VDC +/-5%	+5VDC +/-5%
Temperature Range	0 to 70 C.	0 to 70 C.	0 to 70 C.	0 to 70 C.
Availability	1Q '86	NOW	NOW	NOW
OEM Price (U.S.)/QTY	$115.00/2,500	$50.00/2,500 (10Mhz)	$65.00/100'S	$16.25/100's
COMMENTS		"ROM-less" version of the AIC-100.		Requires external VCO/Phase Lock Loop.

MANUFACTURER	ADAPTEC, INCORPORATED	ADAPTEC, INCORPORATED	ADAPTIVE DATA SYSTEMS INCORPORATED	ADAPTIVE DATA SYSTEMS INCORPORATED
PART NUMBER	AIC-270	AIC-300	ADS-1000	ADS-3570
FUNCTION	Encoder/Decoder	Buffer Controller	Winchester Controller	Buffer Manager and SCSI support Logic
ELECTRICAL CHARACTERISTICS				
Features	NRZ to/from RLL (2,7) Convertor	Converts Static RAM into a Dual-Ported FIFO	Generic MPU interface/ 48-Bit ECC	256K addressing with 4 Ports
Clock/Data Rate	500KHz to 10 MHz	10 MHz	24 Mhz	15 Mhz
Technology	Silicon Gate NMOS	Silicon Gate NMOS	CMOS	CMOS
PHYSICAL CHARACTERISTICS				
Package Size	24-Pin Dual-in-line	40-Pin Dual-in-Line	68-Pin PLCC	68-Pin PLCC
Power Supply	+5VDC +/-5%	+5VDC +/-5%	+5VDC +/-5%	+5VDC +/-5%
Temperature Range	0 to 70 C.	0 to 70 C.	0 to 70 C.	0 to 70 C.
Availability	NOW	NOW	*	*
OEM Price (U.S.)/QTY	$23.50/100's	$21.25/100's		
COMMENTS	Requires external VCO/Phase Lock Loop.	Supports RAM sizes from 256 to 64K Bytes.	* Factory direct only through manufacturing license.	* Factory direct only through manufacturing license.

MANUFACTURER	ADAPTIVE DATA SYSTEMS INCORPORATED	ADAPTIVE DATA SYSTEMS INCORPORATED	ADVANCED MICRO DEVICES	ADVANCED MICRO DEVICES
PART NUMBER	ADS-4360	ADS-5050	Am9580	Am9581
FUNCTION	Tape Serdes	SCSI Bus Transceiver	Winchester/Floppy Controller	Winchester Data Separator
ELECTRICAL CHARACTERISTICS				
Features	QIC-11/24 compatible Formatter	Single-ended with power up/down protection	Auto ECC, built-in DMA and Buffer	FM and MFM VCO/PLL to NRZ data.
Clock/Data Rate	6 Mhz	N/A (9-Bit path)	15 Mbits/sec.	16 Mbits/sec.
Technology	CMOS	Bipolar	NMOS	Bipolar
PHYSICAL CHARACTERISTICS				
Package Size	68-Pin PLCC	24-Pin Dual-in-Line	68-Pin LCC	48 Pin Dual-in-Line
Power Supply	+5VDC +/-5%	+5VDC +/-5%	+5 VDC +/-5%	+5VDC +/-5%
Temperature Range	0 to 70 C.	0 to 70 C.	0 to 70 C.	0 to 70 C.
Availability	*	*	2Q '86	2Q '86
OEM Price (U.S.)/QTY			$65/5's	$20.00/5's
COMMENTS	* Factory direct only through manufacturing license.	* Factory direct only through manufacturing license.		Companion chip to Am9580.

MANUFACTURER	DATA TECHNOLOGY CORPORATION	DATA TECHNOLOGY CORPORATION	DATA TECHNOLOGY CORPORATION	HITACHI LTD.
PART NUMBER	DTC1505	DTC1506	DTC1507	63463
FUNCTION	Data Sequencer	Buffer Memory Controller	Data Separator	Winchester Controller
ELECTRICAL CHARACTERISTICS				
Features	SERDES, ECC and Format Control for NRZ Data	Buffer Manager and Data Transfer control	Internal VCO with MFM Encode/Decode	ST506 or SMD Interfaces
Clock/Data Rate	15 MHz	10 MHz	10 MHz	4/6/8 Mhz versions
Technology	CMOS	CMOS	CMOS	2-um CMOS
PHYSICAL CHARACTERISTICS				
Package Size	68-Pin PLCC	68-Pin PLCC	24-Pin Dual-in-Line	48-Pin Dual-in-line
Power Supply	+5VDC +/-5%	+5VDC +/-5%	+5VDC +/-5%	+5VDC +/-10%
Temperature Range	0 to 70 C.	0 to 70 C.	0 to 70 C.	-20 to 75 C.
Availability	$	$	$	NOW
OEM Price (U.S.)/QTY				$63.20 (8Mhz)
COMMENTS	$ 10K Minimum. Available only through factory licensing and contract.	$ 10K Minimum. Available only through factory licensing and contract.	$ 10K Minimum. Available only through factory licensing and contract.	68000 Compatible Host Bus, 2 Internal 256 Byte Buffers.

MANUFACTURER	INTEL CORPORATION	INTEL CORPORATION	NATIONAL SEMICONDUCTOR CORPORATION	NATIONAL SEMICONDUCTOR CORPORATION
PART NUMBER	82062-05	8272A	DP8451/55	DP8461/65
FUNCTION	Winchester Controller	Floppy Disk Controller	Data Separator	Data Separator
ELECTRICAL CHARACTERISTICS				
Features	ST506/412 Compatible, External ECC	Single/Double Density, IBM 3740 and System34	NRZ version of the 8461/65	Includes MFM Data Decoder
Clock/Data Rate	5.0 MBits/sec.	500 KBits/sec.	Up to 25 Mbits/sec.	Up to 25 Mbits/sec.
Technology	Silicon gate NMOS	Silicon gate NMOS	Oxide-Isolated Bipolar	Oxide-Isolated Bipolar
PHYSICAL CHARACTERISTICS				
Package Size	40-Pin Dual-in-line	40-Pin Dual-in-line	20-Pin Dual-in-Line	24-Pin narrow DIP
Power Supply	+5VDC +/-5%	+5VDC +/-5%	+5VDC +/-5%	+5VDC +/-5%
Temperature Range	0 to 70 C.	0 to 70 C.	0 to 70 C.	0 to 70 C.
Availability	NOW	NOW	NOW	NOW
OEM Price (U.S.)/QTY	$32.00/100's	$7.15/100's	$25.75/100's	$25.75/100's
COMMENTS	Compatible with the WD1010.	Compatible with the NEC 765A.	8455 has Phase-frequency comparison mode.	8465 has Phase-frequency comparison mode.

MANUFACTURER	NATIONAL SEMICONDUCTOR CORPORATION	NATIONAL SEMICONDUCTOR CORPORATION	NATIONAL SEMICONDUCTOR CORPORATION	NATIONAL SEMICONDUCTOR CORPORATION
PART NUMBER	DP8462	DP8463	DP8464	DP8466
FUNCTION	2,7 Code Synchronizer	2,7 RLL ENDEC	Pulse Detector	Winchester Disk Controller
ELECTRICAL CHARACTERISTICS				
Features	Contains PLL and VCO	IBM 2,7 and Xerox 2,7 RLL compatible	Accepts Inputs Directly From R/W Amplifier	Programmable Drive/Host Interfaces
Clock/Data Rate	Up to 25 Mbits/sec.	Up to 25 Mbits/sec.	Up to 25 Mbits/sec.	Up to 25 Mbits/sec.
Technology	Oxide-Isolated Bipolar	2-micron CMOS	Oxide-Isolated Bipolar	2-micron CMOS
PHYSICAL CHARACTERISTICS				
Package Size	24-Pin narrow DIP	18-Pin Dual-In-Line	24-Pin Dual-In-Line	48-Pin Dual-In-Line
Power Supply	+5VDC +/-5%	+5VDC +/-5%	+12VDC +/-5%	+5VDC +/-5%
Temperature Range	0 to 70 C.	0 to 70 C.	0 to 70 C.	0 to 70 C.
Availability	NOW	NOW	NOW	NOW
OEM Price (U.S.)/QTY	$25.75/100's	$30.00/100's	$22.00/100's	$350/Qty 25 (20Mhz)
COMMENTS	Three Versions Available For Different Window Error Margins.	Programmable Address Marks/Preamble Length.	Contains AGC Amplifier and Differentiator.	Speed versions available from 5 to 25Mhz.

MANUFACTURER	NCR CORPORATION	NCR CORPORATION	NCR CORPORATION	NCR CORPORATION
PART NUMBER	5380	5381	5385E	5386
FUNCTION	SCSI Protocol Controller	SCSI Protocol Controller	SCSI Protocol Controller	SCSI Protocol Controller
ELECTRICAL CHARACTERISTICS				
Features	Built-in Open Collector Bus Transceivers	Built-in Open Collector Bus Transceivers	DMA or Programmed I/O, Arbitration Interrupts	DMA or Programmed I/O, Arbitration Interrupts
Clock/Data Rate	10 Mhz	10 Mhz	10 Mhz	10 Mhz
Technology	NMOS	NMOS	NMOS	NMOS
PHYSICAL CHARACTERISTICS				
Package Size	40-Pin Dual-in-Line and 44-Pin PLCC	40-Pin Dual-in-Line	48-Pin Dual-in-Line and 68-Pin PLCC	48-Pin Dual-in-Line
Power Supply	+5VDC +/-5%	+5VDC +/-5%	+5VDC +/-5%	+5VDC +/-5%
Temperature Range	0 to 70 C.	0 to 70 C.	0 to 70 C.	0 to 70 C.
Availability	NOW	NOW	NOW	4Q '85
OEM Price (U.S.)/QTY	$17.75/100's	$19.75/100's	$29.50/100's	$23.60/100's
COMMENTS	Hardware Arbitration Support.	Same as 5380, except Support for external Differential Lines.	Post Rev. 10 timings supported. Replacement for 5385.	Superset of 5385E and recommended for new designs.

MANUFACTURER	NCR CORPORATION	NCR CORPORATION	NEC ELECTRONICS U.S.A.	NEC ELECTRONICS U.S.A.
PART NUMBER	5386S	8310	uPD7261	uPD765A
FUNCTION	SCSI Protocol Controller	Bus Transceivers	Winchester Disk Controller	Floppy Disk Controller
ELECTRICAL CHARACTERISTICS				
Features	DMA or Programmed I/O, Arbitration Interrupts	SCSI Bus Transcievers and Arbitration Logic.	SMD or ST506 interface at 6/12 Mbits/sec	IBM 3740/34 Compatible Single/Double Density
Clock/Data Rate	20 Mhz	10 Mhz	12 MBits/sec (SMD)	500 KBits/sec.
Technology	NMOS	NMOS	Silicon gate NMOS	Silicon gate NMOS
PHYSICAL CHARACTERISTICS				
Package Size	48-Pin Dual-in-Line	40-Pin Dual-in-Line	40-Pin Dual-in-line	40-Pin Dual-in-line
Power Supply	+5VDC +/-5%	+5VDC +/-5%	+5VDC +/-5%	+5VDC +/-5%
Temperature Range	0 to 70 C.	0 to 70 C.	0 to 70 C.	0 to 70 C.
Availability	1Q '86	4Q '85	NOW	NOW
OEM Price (U.S.)/QTY	$27.15/100's	$11.40/100's	$57.00/100's	$8.15/100's
COMMENTS	3 Megabyte/sec. SCSI synchronous version of 5386.	Companion chip for the 5385E.		

MANUFACTURER	SCIENTIFIC MICRO SYSTEMS INCORPORATED	SCIENTIFIC MICRO SYSTEMS INCORPORATED	SCIENTIFIC MICRO SYSTEMS INCORPORATED	SCIENTIFIC MICRO SYSTEMS INCORPORATED
PART NUMBER	5011	5027	5050	5060
FUNCTION	Differential Drivers/ Receivers	2,7 RLL Encoder	Disk Sequencer/SERDES	Memory Buffer Controller
ELECTRICAL CHARACTERISTICS				
Features	ST506 transceivers for Data cable signals	5/10 Megabits/second operation	8-64 Bits of ECC, NRZ Data input/output	4 Port DMA controller
Clock/Data Rate	5 Mbits/sec.	5/10 Mhz	10 Mbits/sec.	10 Mhz
Technology	CMOS	CMOS	CMOS	CMOS
PHYSICAL CHARACTERISTICS				
Package Size	16-Pin Dual-in-Line	16-Pin Dual-in-Line	68-Pin PLCC	68-Pin PLCC
Power Supply	+5VDC +/-5%	+5VDC +/-5%	+5VDC +/-5%	+5VDC +/-5%
Temperature Range	0 to 70 C.	0 to 70 C.	0 to 70 C.	0 to 70 C.
Availability	$	$	$	$
OEM Price (U.S.)/QTY				
COMMENTS	$ 10K Minimum. Available only through factory licensing and contract.	$ 10K Minimum. Available only through factory licensing and contract.	$ 10K Minimum. Available only through factory licensing and contract.	$ 10K Minimum. Available only through factory licensing and contract.

MANUFACTURER	SCIENTIFIC MICRO SYSTEMS INCORPORATED	SCIENTIFIC MICRO SYSTEMS INCORPORATED	SCIENTIFIC MICRO SYSTEMS INCORPORATED	SIGNETICS CORPORATION
PART NUMBER	5070	5080	5090	SCB68459
FUNCTION	Data Separator	SCSI Protocol Controller	IBM-PC Bus Controller	Phase-Lock Loop
ELECTRICAL CHARACTERISTICS				
Features	MFM Encoder/Decoder	Programmable Interface with Drivers/recvrs	Single-chip Host adapter for IBM-PC busses	VCO/Separator for ST506/412 (MFM)
Clock/Data Rate	5 to 7.5 Mbits/sec	10 Mhz	10 Mhz	up to 10 MBits/sec.
Technology	CMOS	CMOS	CMOS	Silicon gate NMOS
PHYSICAL CHARACTERISTICS				
Package Size	24 Pin Dual-in-Line	68-Pin PLCC	68-Pin PLCC	24-Pin Dual-in-line
Power Supply	+5VDC +/-5%	+5VDC +/-5%	+5VDC +/-5%	+5VDC +/-5%
Temperature Range	0 to 70 C.	0 to 70 C.	0 to 70 C.	0 to 70 C.
Availability	$	$	$	1Q '86
OEM Price (U.S.)/QTY				$8.00/100's
COMMENTS	$ 10K Minimum. Available only through factory licensing and contract.	$ 10K Minimum. Available only through factory licensing and contract.	$ 10K Minimum. Available only through factory licensing and contract.	Motorola has option to second source.

MANUFACTURER	SIGNETICS CORPORATION	STANDARD MICROSYSTEMS CORPORATION	STANDARD MICROSYSTEMS CORPORATION	STANDARD MICROSYSTEMS CORPORATION
PART NUMBER	SCN68454	FDC179X	FDC765A	FDC9216
FUNCTION	Winchester and Floppy Controller	Floppy Disk Controller	Floppy Disk Controller	Data Separator Chip
ELECTRICAL CHARACTERISTICS				
Features	256 Byte sector buffer internal	Single or Double Density	IBM 3740/34 Compatible Single/Double Density	Digital Data Separator
Clock/Data Rate	up to 10 MBits/sec.	125 to 500 KBits/sec.	500 KBits/sec.	125 to 250 KBits/sec.
Technology	Silicon gate NMOS	Silicon gate NMOS	Silicon gate NMOS	Silicon gate NMOS
PHYSICAL CHARACTERISTICS				
Package Size	48-Pin Dual-in-line	40-Pin Dual-in-line	40-Pin Dual-in-line	8-Pin Dual-in-line
Power Supply	+5VDC +/-5%	+5VDC, +12VDC +/-5%	+5VDC +/-5%	+5VDC +/-5%
Temperature Range	0 to 70 C.	0 to 70 C.	0 to 70 C.	0 to 70 C.
Availability	NOW	NOW	NOW	NOW
OEM Price (U.S.)/QTY	$55.00/100's	$35.20/100's	$8.00/100's	$6.10/100's
COMMENTS	Motorola has option to second source.	True/Inverted Host Data Bus versions available.	Compatible to the NEC uPD765A.	Companion chip to the 179X controller.

MANUFACTURER	STANDARD MICROSYSTEMS CORPORATION	STANDARD MICROSYSTEMS CORPORATION	STANDARD MICROSYSTEMS CORPORATION	STANDARD MICROSYSTEMS CORPORATION
PART NUMBER	FDC9225	FDC9226	FDC9229	FDC9266
FUNCTION	Buffer Manager	Winchester Data Separator	Floppy Disk Data Separator/Precompensator	Floppy Disk Controller
ELECTRICAL CHARACTERISTICS				
Features	Dual-Ported (32K DRAM) Control for Winchesters.	5 Mbit/sec. Digital Data Separator	Programmable Precomp Values.	Built-in Digital Data Separator
Clock/Data Rate	5 Mhz	5 Mhz	500 Kbits/sec.	500 Kbits/sec.
Technology	CMOS	CMOS	Silicon gate NMOS	Silicon gate NMOS
PHYSICAL CHARACTERISTICS				
Package Size	48-Pin Dual-in-line	24-Pin Dual-in-line	20-Pin Dual-in-Line	40-Pin Dual-in-line
Power Supply	+5VDC +/-5%	+5VDC +/-5%	+5VDC +/-5%	+5VDC +/-5%
Temperature Range	0 to 70 C.	0 to 70 C.	0 to 70 C.	0 to 70 C.
Availability	NOW	NOW	NOW	NOW
OEM Price (U.S.)/QTY	$20.90/100's	$12.25/100's	$10.60/100's	$13.25/100's
COMMENTS		Separator for 9224.	External "glue" logic for the 179X.	Software compatible with the FDC765A.

MANUFACTURER	STANDARD MICROSYSTEMS CORPORATION	STANDARD MICROSYSTEMS CORPORATION	SUNOL SYSTEMS	SUNOL SYSTEMS
PART NUMBER	HDC1100	HDC9224	DC1001	RB1002
FUNCTION	Winchester Controller Chip Set	Winchester/Floppy Controller	Winchester/Floppy Controller	RAM Buffer/Controller
ELECTRICAL CHARACTERISTICS				
Features	Requires Microprocessor.	ST506/412 and SA400/450 or SA800/850 Compatible	Programmable Interface, Internal 32-Bit ECC	Buffer Manager for the DC1001
Clock/Data Rate	5 Mbits/sec.	5 Mbits/sec.	15.0 MBits/sec.	10 Mhz
Technology	Silicon gate NMOS	Silicon gate NMOS	CMOS	CMOS
PHYSICAL CHARACTERISTICS				
Package Size	20-Pin Dual-in-line	40-Pin Dual-in-line	40-Pin Dual-in-line	40-Pin Dual-in-line
Power Supply	+5VDC +/-5%	+5VDC +/-5%	+5VDC +/-5%	+5VDC +/-5%
Temperature Range	0 to 70 C.	0 to 70 C.	0 to 70 C.	0 to 70 C.
Availability	NOW	NOW (Cer DIP)	NOW	NOW
OEM Price (U.S.)/QTY	$13.50/100's	$65.00/100's	$60.00/100's	$60.00/100's
COMMENTS	5-chip set.	Built-in DMA channel and IBM compatible Floppy Formats.	Sold as a Chip-Set With the RB1002.	Sold as a Chip-Set With the RB1002.

MANUFACTURER	WESTERN DIGITAL CORPORATION	WESTERN DIGITAL CORPORATION	WESTERN DIGITAL CORPORATION	WESTERN DIGITAL CORPORATION
PART NUMBER	WD1010A-05	WD1050	WD1100-19	WD11C00-22
FUNCTION	Winchester Controller	Winchester Controller	SCSI Protocol Controller	Buffer Memory Controller
ELECTRICAL CHARACTERISTICS				
Features	ST506/412 Compatible, External ECC	SMD Drive Interface	Address Gen, Arbitration R/W Control and Parity	Sector Buffer Management and control
Clock/Data Rate	5.0 MBits/sec.	9.6 Mbits/sec.	5 MHz	5 MHz
Technology	Silicon gate NMOS	Silicon gate NMOS	Silicon gate NMOS	CMOS
PHYSICAL CHARACTERISTICS				
Package Size	40-Pin Dual-in-line	68-Pin LCC	40-Pin DIP	84-Pin JEDEC 'A'
Power Supply	+5VDC +/-5%	+5VDC +/-5%	+5VDC +/-5%	+5VDC +/-10%
Temperature Range	0 to 70 C.	0 to 70 C.	0 to 70 C.	0 to 70 C.
Availability	NOW	NOW	NOW	NOW
OEM Price (U.S.)/QTY	$32.50/100's	$68.00/100's	$23.50/100's	$25.00/100's
COMMENTS	Compatible with the Intel 82062.		Designed for the board product WD1003-SCS.	Designed for the board product WD1002-WAH.

MANUFACTURER	WESTERN DIGITAL CORPORATION	WESTERN DIGITAL CORPORATION	WESTERN DIGITAL CORPORATION	WESTERN DIGITAL CORPORATION
PART NUMBER	WD1770-00	WD2010A-05	WD279X	WD3030
FUNCTION	Floppy Disk Controller	Winchester Controller	Floppy Disk Controller	Winchester Controller
ELECTRICAL CHARACTERISTICS				
Features	Built-in Digital Data Separator	ST506/412 Compatible, Auto ECC Correction	Built-in Analog Data Separator	Auto-ECC/built-in Data Separator
Clock/Data Rate	250 KBits/sec.	5.0 MBits/sec.	125 to 500 KBits/sec.	5 Mbits/sec.
Technology	Silicon gate NMOS	Silicon gate NMOS	Silicon gate NMOS	CMOS
PHYSICAL CHARACTERISTICS				
Package Size	28-Pin Dual-in-line	40-Pin Dual-in-line	40-Pin Dual-in-line	40-Pin Dual-in-line
Power Supply	+5VDC +/-5%	+5VDC +/-5%	+5VDC +/-5%	+5VDC +/-5%
Temperature Range	0 to 70 C.	0 to 70 C.	0 to 70 C.	0 to 70 C.
Availability	NOW	NOW	NOW	1Q '86
OEM Price (U.S.)/QTY	$14.88/100's	$50.00/100's	$15.30/100's	$60.00/100's
COMMENTS	WD1772- enhanced step rates, WD1773- Software compatible with WD279X.	ECC version of WD1010.	True/Inverted Host Data Bus versions available.	Data separator version of WD2010.

MANUFACTURER	WESTERN DIGITAL CORPORATION	WESTERN DIGITAL CORPORATION	WESTERN DIGITAL CORPORATION	WESTERN DIGITAL CORPORATION
PART NUMBER	WD5020	WD5027	WD5050	WD9216
FUNCTION	MFM Encoder/Decoder	RLL Encoder/Decoder	Winchester Controller	Data Separator Chip
ELECTRICAL CHARACTERISTICS				
Features	MFM to NRZ with ESDI serial mode support	MFM to 2,7 RLL Convertor	Controller with DRAM control lines	Digital Data Separator
Clock/Data Rate	5 MBits/sec.	7.5 MBits/sec.	5.0 MBits/sec.	125 to 250 KBits/sec.
Technology	CMOS	CMOS	CMOS	Silicon gate NMOS
PHYSICAL CHARACTERISTICS				
Package Size	40-Pin Dual-in-line	18-Pin Dual-in-line	68-Pin LCC	8-Pin Dual-in-line
Power Supply	+5VDC +/-5%	+5VDC +/-5%	+5VDC +/-5%	+5VDC +/-5%
Temperature Range	0 to 70 C.	0 to 70 C.	0 to 70 C.	0 to 70 C.
Availability	NOW	NOW	1Q '86	NOW
OEM Price (U.S.)/QTY	$48.00/100's	$29.00/100's	$78.20/100's	$5.95/100's
COMMENTS	Compatible with the WD1010 and WD2010.	Compatible with the WD1010 and WD2010.	DRAM version of the WDC2010A-05.	

MANUFACTURER	WESTERN DIGITAL CORPORATION			
PART NUMBER	WD9232			
FUNCTION	Data Separator Chip			
ELECTRICAL CHARACTERISTICS				
Features	Digital Data Separator			
Clock/Data Rate	125 to 250 KBits/sec.			
Technology	Silicon gate NMOS			
PHYSICAL CHARACTERISTICS				
Package Size	8-Pin Dual-in-line			
Power Supply	+5VDC +/-5%			
Temperature Range	0 to 70 C.			
Availability	NOW			
OEM Price (U.S.)/QTY	$9.35/100's			
COMMENTS	Improved performance Version of the 9216.			

MANUFACTURER	SASI/SCSI	IBM-PC/XT/AT	Host Adapter	LSI	DEC*	Other Mini*	Multibus*	VMEbus*
Adaptive Data Systems	X		X	X				
Advanced Elec. Design					X			
Advanced Storage Concepts	X							
Ampro Computers, Inc.	X							
Andromeda Systems					X			
Archive Corporation		X						
AVIV Corporation					X	X	X	
BASU, Inc.								X
Bytronix Corporation						X		
Centan Corporation	X	X						
Central Data Corporation							X	
Ciprico, Inc.							X	
Comark Corporation							X	
Computer Storage Technology					X	X		
Data Technology Corp.	X	X	X	X			X	
Data-Sud Systems								X
Distributed Logic Corp.					X			
Distributed Processing	X							
Dual Systems								X
DY-4 Systems, Inc.								X
Electronic Modular								X
Emulex Corporation	X		X		X			
Force Computers			X					X
Fujitsu America, Inc.	X							
General Micro Systems								X
General Robotics					X			
Hamilton Std. Dig. Systems								X
Hitachi Ltd.				X				
Integrated Solutions, Inc.			X					X
Intel Corporation				X			X	
Interphase Corporation		X					X	X
Ironics, Inc.								X
Konan Corporation	X	X					X	

MANUFACTURER	SASI/SCSI	IBM-PC/XT/AT	Hc Adap	LSI	DEC*	Other Mini*	Multibus*	VMEbus*
Macrolink, Inc.						X		
MDB Systems					X			
Micro Technology Inc.					X			
Microproject Corporation			X					X
Mini Computer Technology					X	X	X	X
Mizar, Incorporated			X					X
Motorola, Inc.								X
National Semiconductor				X				
NCR Corporation	X		X	X				
NEC Electronics USA				X				
PEP Modular Computer			X					
Plessey Microsystems			X		X			X
Qualogy					X		X	
Scientific Micro Systems	X	X	X	X	X		X	
Sigen Corporation		X						X
Sigma Information Systems			X		X			
Signetics Corporation				X				X
Spectra Logic Corporation					X	X		
Standard Microsystems Corp.				X				
Sunol Systems		X		X				
Sysgen Corporation	X							
TD Systems, Inc.			X					
Wangtek	X	X						
Webster Computer Corp.					X			
Wespercorp					X	X	X	
Western Digital Corp.	X	X		X				
Xebec Corporation	X	X	X					
Xylogics							X	X
Zetaco, Incorporated						X		

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MANUFACTURERS' PROFILES

Adaptec, Inc.
580 Cottonwood Drive
Milpitas, CA 95035
(408) 946-8600

Adaptec was founded in 1981 as a board-level controller manufacturer for the SCSI marketplace. The company now supplies IBM-PC controllers, Host Adapters, and OEM semiconductor products.

Adaptive Data Systems, Inc.
2627 Pomona Blvd.
Pomona, CA 91768
(714) 594-5858

Originally founded as Adaptive Data and Energy Systems, ADSI is a manufacturer of both controllers and subsystems for the SCSI market. The company has recently entered the controller chip-set market as well as the IBM-PC Host adapter segment.

Advanced Micro Devices
901 Thompson Place
Sunnyvale, CA 94086
(408) 749-4100

AMD will enter the winchester controller chip market in early 1986. The company is readying a data separator device and a combination winchester/floppy device.

Advanced Storage Concepts
9660 Hillcroft Avenue #325
Houston, TX 77096
(713) 729-6388

ASC is a recent start-up who has entered the controller market with an SCSI caching disk controller. The company also offers a sophisticated Host Adapter for the IBM-PC.

Peripheral Concepts

Ampro Computers, Inc.
PO Box 390427
Mountain View, CA 94039
(415) 962-0230

Ampro is a manufacturer of CP/M based single board computers and systems. The company currently offers an SCSI port (with an enhanced command set) and a floppy controller on their SBC products.

Archive Corporation
1650 Sunflower Ave.
Costa Mesa,CA 92626
(714) 641-0279

Archive is an OEM manufacturer of 1/4 inch streaming tape drives and subsystems. The company has entered the IBM-PC tape controller market this year.

Centan Corporation
1183 Bordeaux Drive
Suite 15
Sunnyvale, CA 94089
(408) 734-1006

Centan is a subsidiary of National Computers Ltd. of Chiyoda-Ku, Tokyo, Japan, an engineering and trading firm providing disk drives, disk drive compnents, subsystems, and controllers. The company is currently marketing both SCSI and IBM-PC controllers/subsystems in the United States.

Data Technology Corporation
2775 Northwestern Pkwy.
Santa Clara, CA 95051
(408) 496-0434

Data Technology is a manufacturer of SCSI and IBM-PC controllers, Host Adapters, and single-board computers. The company was a driving force in the development of the SASI interface in the late 70's.

Distributed Processing Technology
132 Candace Drive
PO Box 1864
Maitland, FL 32751
(305) 830-5522

DPT is a division of the S.I. Goldman Company, a manufacturer of SCSI controller boards. All of the company's SCSI products are built around large cache memories. The company is currently pursuing the standardization of caching commands in the SCSI specification with the X3T9.2 ANSC committee.

Emulex Corporation
3545 Harbor Blvd.
Costa Mesa, CA 92626
(714) 662-5600

Emulex is major manufacturer of DEC-compatible controllers and subsystems. The company has recently entered the SCSI controller/subsystems market, and also offers Host Adapters for Qbus, Unibus, and IBM-PC systems.

Force Computers, Inc.
2041 Mission College #150
Santa Clara, CA 95054
(408) 988-8686

Force is primarily a manufacturer of VMEbus systems. The company offers VMEbus Host Adapters, and remarkets Data Technology's controller products for use within VMEbus systems.

Fujitsu America, Inc.
3055 Orchard Drive
San Jose, CA 95134
(408) 946-8777

Fujitsu America is a U.S. subsidiary of Fujitsu Ltd. of Tokyo, Japan, a major manufacturer of high capacity rigid disk drives. The company has entered the controller business this year, with an SCSI product designed to operate with the company's line of SMD drives.

Hitachi America, Ltd.
1800 Bering Drive
San Jose, CA 95131
(408) 292-6404

Hitachi entered the winchester controller chip market at the beginning of this year. Their 63463 device is a winchester controller compatible with the 68000 microprocessor.

Intel Corporation
3065 Bowers Ave.
Santa Clara, CA 95051
(408) 987-8080

Intel is a major semiconductor manufacturer of microprocessor components and memories. The company offers a line of floppy disk and winchester controllers chips. Intel has also aquired manufacturing rights to Western Digital's WD1010/2010 controller chips. The companys' Hillsboro, Oregon facilities is responsible for the marketing and manufacturing of all Multibus I/II products.

Interphase Corporation
2925 Merrel Road
Dallas, TX 75229
(214) 350-9000

Founded in 1974, Interphase is a manufacturer of controllers and subsystems for Multibus, VMEbus, and most recently, the IBM-PC. The companys' subsystems feature very high capacity disk drives.

Konan Corporation
1425 North 27th Avenue
Phoenix, AZ 85009
(602) 269-2649

Founded in 1978, Konan is manufacturer of controller boards for the SCSI, Multibus, and IBM-PC markets, as well as offering a line of Host adapter products.

Mizar, Inc.
302 Chester Street
St. Paul, MN 55107
(612) 224-8941

Mizar is a full line supplier of VMEbus modules. The company offers a VME to SCSI Host Adapter as part of its product line.

National Semiconductor
2900 Semiconductor Drive
Santa Clara, CA 95051
(408) 721-5955

National has entered the disk controller semiconductor market with a line of products intended for use within disk drives and board products. The company's DP8451 device is one of the most widely used Data Separator chips in the industry.

NCR Corporation
OEM Products
3718 North Rock Road
Wichita, KS 67226
(316)688-8000

The OEM Products division of NCR manufacturers a line of SCSI disk and tape controllers as well as Host Adapters. The company has recently introduced a 1/4 inch streaming tape drive with an SCSI interface.

NCR Corporation
Microelectronics Division
1635 Aeroplaza Drive
Colorado Springs, CO 80916
(303) 595-5795

NCR's Colorado springs semiconductor division manufactures and markets a line of SCSI protocol chips and support devices for use within controllers, drives, or Host Adapters. Besides OEM sales, these products are used captively within the OEM products division on various board-level controllers.

Peripheral Concepts

NEC Electronics USA Inc.
Natick Technology Center
One Natick Executive Park
Natick, MA 01760
(617) 655-8833

NEC Electronics is the U.S. marketing and sales arm for the companys' line of floppy and winchester controller devices. The uPD765A floppy device is one of the most popular floppy controllers in use today, and is used within the IBM-PC/XT/AT computers.

PEP Modular Computers, Inc.
600 North Bell Avenue
Carnegie, PA 15106
(412) 279-6661

PEP Modular is a German manufacturer of industrial control systems. The company is currently marketing a VME to SCSI Host adapter as well as a complete family of VME modules in the United States.

Plessey Microsystems
One Blue Hill Plaza
Pearl River, NY 10965
(914) 735-4661

Plessey Microsystems is a subsidiary of Plessey PLC, a major supplier of telecommunications and defense electronics. The Microsystems subsidiary is currently manufacturing a family of VME products, including a VME to SCSI Host Adapter.

Scientific Micro Systems, Inc.
339 N. Bernardo
Mt. View, CA 94048
(415) 964-5700

SMS is a manufacturer of subsystems and controllers for the DEC-compatible and Multibus markets, as well as a controller supplier in the IBM-PC and SCSI markets. The company also manufactures Host Adapters and has a line of semiconductor products.

Sigen Corporation
1800 Wyatt Drive
Suite 6
Santa Clara, CA 95054
(408) 988-2527

Sigen Corporation has recently entered the IBM-PC controller market with winchester and tape controller products. The company also has a line of VMEbus products.

Sigma Information Systems
6505C Serrano Ave.
Anaheim, CA 92807
(714) 632-0474

Sigma is a manufacturer of DEC-compatible controllers and subsystems. The company has recently introduced a Qbus to SCSI Host adapter.

Signetics Corporation
811 E. Arques Avenue
Sunnyvale, CA 94086
(408) 739-7700

Signetics has entered the winchester/floppy chip business with a multifunction LSI controller called the SCN68454. Motorola has a second-source option, but has not exersized manufacturing rights at this time.

Standard Microsystems Corporation
35 Marcus Blvd.
Hauppauge, NY 11788
(516) 273-3100

SMC is a semiconductor manufacturer of storage and communications products. The company currently offers an extensive line of floppy and winchester controllers. In the near future, the company may enter the OEM controller board-level business.

Sunol Systems
1187 Quarry Lane
Pleasanton, CA 04566
(415) 484-3322

Sunol Systems is a subsystems and networking supplier for the IBM-PC and Apple MacIntosh systems. The company will enter the board-level and semiconductor controller market this year.

Sysgen Inc.
47853 Warm Springs Blvd.
Fremont, CA 94539
(415) 490-6770

Sysgen is a supplier of tape and winchester subsystems/controllers. The company has recently expanded its controller offerings in the SCSI area.

TD Systems, Inc.
24 Payton Street
Lowell, MA 01853
(617) 937-9465

TD systems is a manufacturer of high performance, emulating SCSI Host adapters. Their product line includes various Qbus products, and the company has recently introduced a Unibus to SCSI Host adapter.

Wangtek
41 Moreland Road
Simi Valley, CA 93065
(805) 583-5255

Wangtek is primarily an OEM supplier of 1/4 inch streaming tape drives. The company has recently entered the IBM-PC and SCSI tape controller market.

Western Digital Corporation
2445 McCabe Way
Irvine, CA 92714
(714) 863-0102

Western Digital is a leading supplier of semiconductor controllers for the floppy and winchester markets. Over the past four years, the company has also developed a series of SCSI and IBM-PC controllers boards, and is a major supplier of board-level controllers to IBM.

Xebec Corporation
1055 Gateway Place #600
San Jose, CA 95110
(408) 287-2700

Xebec is a leading supplier of winchester controller boards and subsystems. In recent years, the company has entered the disk drive business. Xebec is a major supplier of board-level controllers to IBM.