CORPORATE SYSTEMS CENTER

HARD DRIVE BIBLE

VII EDITION

CSC®

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HARD DRIVE BIBLE

Seventh Edition with SCSI Command Reference
April 1994

Written by: Martin Bodo

About the Author:

Martin Bodo is the founder and President of Corporate Systems Center, Inc. He has a degree in Physics from the University of Santa Clara. He has been an avid computer enthusiast since his early teens.

MARTIN BODO, PRESIDENT CSC

Acknowledgments:

We would like to thank all of the manufacturers who provided us with data for this publication. Without their cooperation this book would have been impossible. The following people deserve special recognition for their efforts in providing us with photos and background information.

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HAROLD MOOREHEAD, EDITOR

Special thanks to the entire CSC staff who have helped write, edit, sell and distribute the Hard Drive Bible to over 30,000 satisfied customers.

JODY COIL, TYPOGRAPHER

Dedication:

To my father, Joseph Bodo who sparked my interest in electronics at an early age.

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CSC's Corporate Headquarters is located in Sunnyvale, at the heart of Silicon Valley. This location puts CSC at the epicenter of the latest developments in data storage technology.

About CSC

CSC was founded in 1986 by our president, Martin Bodo. Since then, we have consistently grown by offering the best quality customer service in the disk drive industry. Our mission is to offer only the highest quality data storage products available and to back them up with professional service and support.

CSC's entire work force is here to ensure your satisfaction with your purchase.

CSC is proud to employ and work with many of the best, most experienced and technically qualified individuals in the disk drive industry. With our top notch sales and marketing team, first class technical service center, free customer support, and immediate shipping, CSC is proud to service the entire data storage market from end users to manufacturers.

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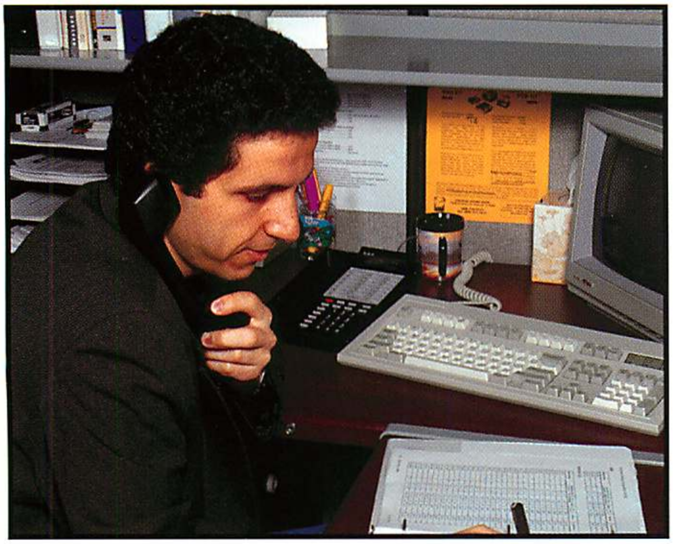

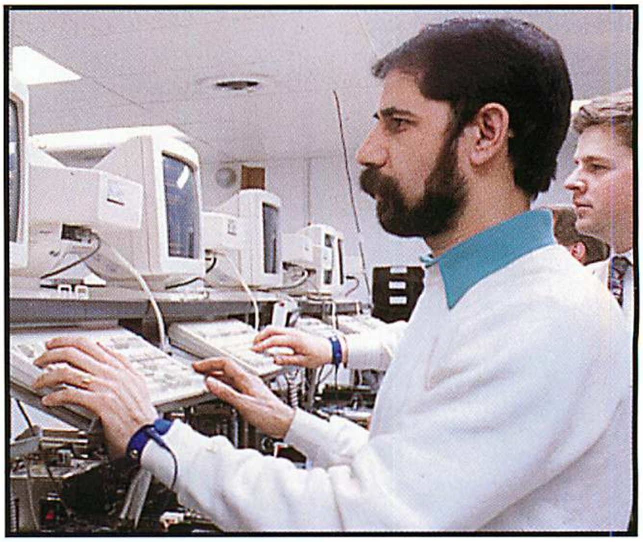

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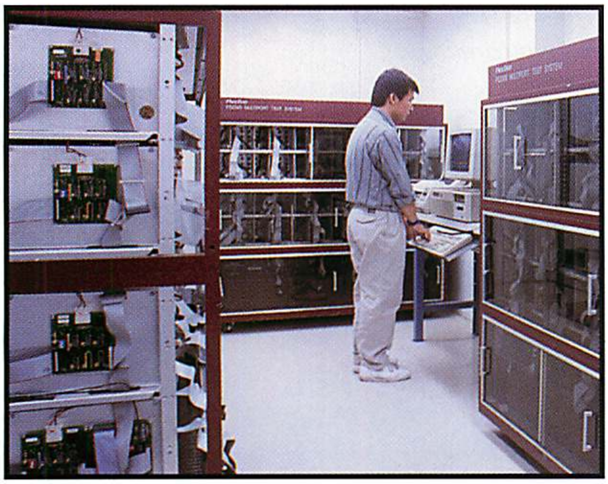
CSC offers complete lifetime technical support, at no charge, for all of our hardware customers. We have a staff of knowledgeable hardware and software experts who know the products we manufacture, service, and sell. Call our friendly sales staff today at (408) 734-3475 for a free disk drive price guide.



Clockwise, from upper left:
Call-in technical support; hardware setup and installation; software evaluation; CSC's Clean Room and on-site burn-in facilities.

CSC's drive service and data recovery facility is designed to provide complete support to our customers. Recent expansion of our repair division allows us to offer this same service to OEMs and hard disk drive manufacturers. Several large manufacturers have already chosen CSC's service facility for efficient high volume service of their current and end of life products.

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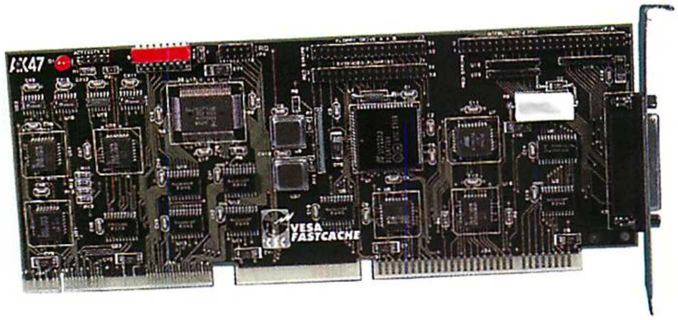
CSC FASTCACHE™ CONTROLLERS



The CSC FastCache™ AK47 is a VESA SCSI-II controller, featuring extremely high data transfer rates, up to 100Mbits/sec, and a user upgradeable on board Flash BIOS. Caching versions will soon be available.

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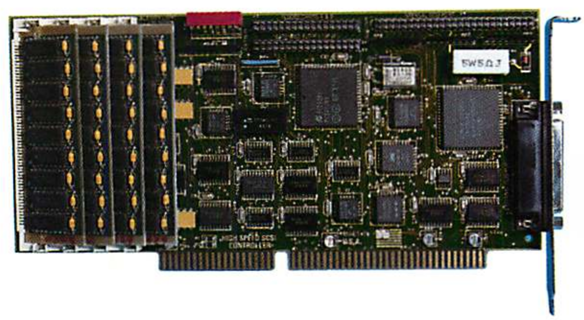

CSC started manufacturing SCSI controller cards in 1991. New products will include high performance caching VESA VL-BUS, WIDE SCSI, PCMCIA controllers, and much more. Call us today for information on these products.

CSC SCSI TOWER

The CSC FastCache™ SCSI Tower can accommodate up to eight SCSI devices.

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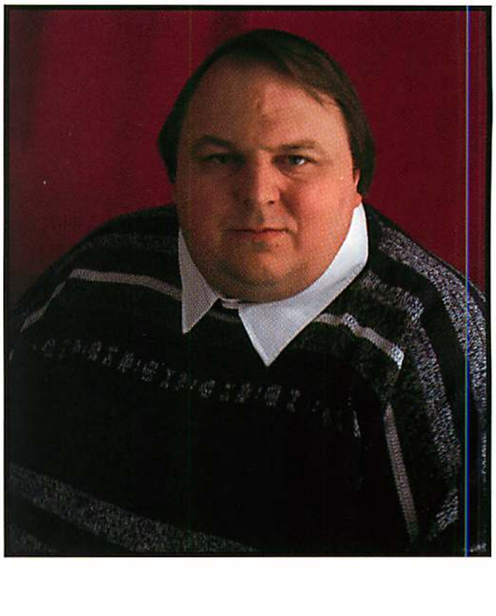
DISK DRIVE TECHNOLOGY ON DISPLAY

In response to customers' demands for a factory outlet, CSC opened the doors of The Disk Drive Depot in 1992, as the prototype of many stores to come. Centrally located on Lawrence Expressway in Sunnyvale, California, The Depot offers the comprehensive inventory of CSC in a convenient retail setting. Make it your next stop for hard drives, CD-ROMs, optical drives, DATs, or any other data storage product, when you are in the area. Our friendly and technologically skilled sales staff will be eager to assist you choosing the component you need at a price you can afford.

Disk Drive Technology Classes

Mike Machado's introduction to Disk Drive Technology is absolutely the best way to gain an in depth knowledge of disk drive technology. He has over 20 years experience in the data storage industry, and his reputation and technical expertise are unsurpassed. As a friend and former student of Mike's, I recommend this course to everyone who plans to work in the data storage industry. Contact Mike and Patty Machado's company, M5 Electronics at (303) 499-0976 for more information.



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Contents

The History of Disk Drives

The magnetic recording technology used in today's disk drives can be traced back to around 500 B.C. when the mineral magnetite was discovered. Magnetite is the naturally occuring magnetic material which was first used in compasses. Alchemists in the first century B.C. discovered the first magnetic compasses when they noticed that loadstones hung from a string always pointed the same way.

Several hundred years later, the connection between electricity and magnetism was discovered. Early scientists noticed a compass needle was deflected when it was put near a wire carrying electric current. It was in this era that magnetic technology was pioneered by experimental geniuses like Danish physicist Hans Christian Oersted and English scientist Michael Faraday who discovered the principles of electromagnetic induction.

The first practical magnetic recording device was the Telegraphone patented in 1898 by Danish telephone engineer and inventor Vlademar Poulsen. The Telegraphone was a crude audio recorder using a stretched magnetized wire. The Telegraphone attracted considerable curiosity when it was first exhibited at the Exposition Universelle in Paris in 1900. The few words that the Austrian emperor Franz Josef spoke into it at that exhibition are believed to be the earliest surviving magnetic recording.

As World War I approached, the German war effort assumed leadership in magnetic recording technology. The German firm AEG was the first to use plastic strips (tape) for magnetic recording.The Germans put magnetic recording to its first military application on submarines. Secret communications were recorded on crude reel to reel tape recorders at slow speeds. The tapes were then played back and retransmitted at high speeds to prevent Allied interception. The receiving station used another tape recorder to reconstruct the messages. By World War II the Germans had perfected the recording technology and manufactured high quality reel-to-reel tape recorders called Magnetophons. These tape recorders were nearly identical to today's high quality audio tape recorders.

In 1945 an American Signal Corps soldier, John T. Mullin, sent two of these captured machines home to San Francisco. The analysis of these units by American engineers at Ampex Corporation lead to the development of the Ampex Model 200 in 1948. The Model 200 was the first magnetic recorder to be manufactured in volume and used commercially. American Broadcasting Corporation had provided some of the financing for the Ampex recorder project, and was the first to use them in broadcasting the Bing Crosby Show in 1948. This same technology is used in today's high resolution audio and

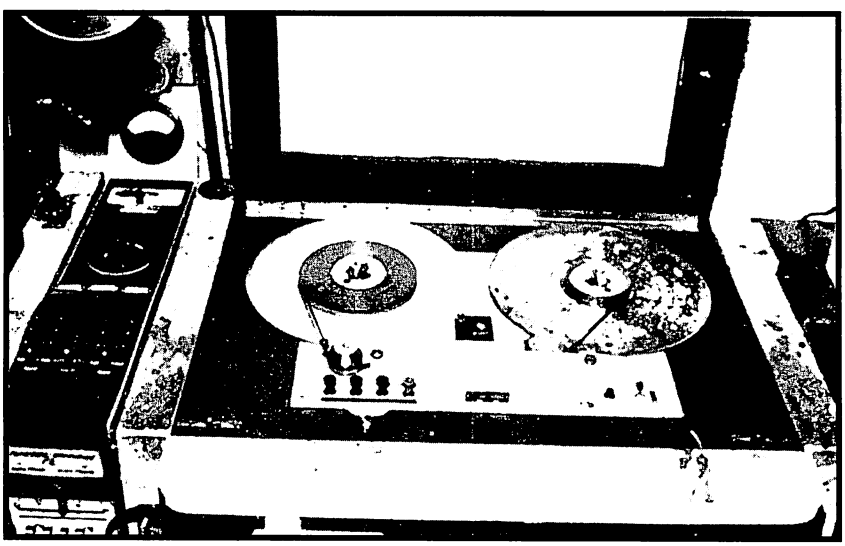


Figure 1 - Magnetophon Recorder

digital tape drives.

Reel to reel tape recorders and Hollerith punch cards were the main storage devices used in early computers. Paper Holerith cards and paper tapes were used to perform initial program loading when early computers were first powered up. Paper tapes were popularized by the Teletype Corporation who added paper tape readers and punches to many of their Teletype terminals. Paper tape remained popular for over 20 years, lasting until the early 1970's. It took the convenience and erasability of floppy disks to eliminate paper tapes.

In 1952, IBM, realizing the need for a random access method of data retrieval with faster access than magnetic tapes, sent Reynold B. Johnson to San Jose, California to head up a magnetic recording research team. Johnson was convinced that a disk based system was the way to go, but other engineers advised him to abandon the project. Following his intuition, Johnson designed the first commercially successful digital disk drive. In 1956, IBM announced the Model 350 RAMAC

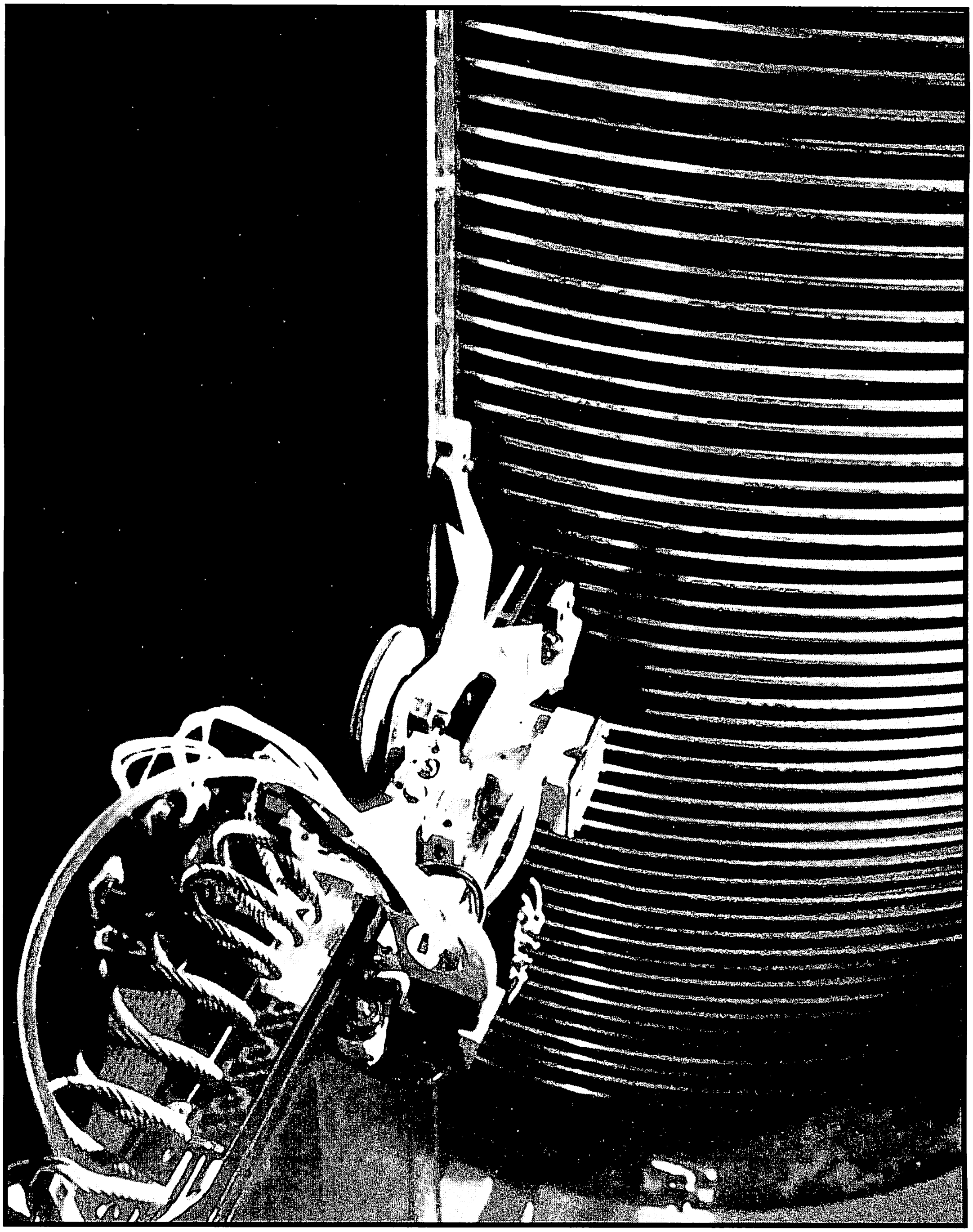


Figure 2 - The Baloney Slicer!

(Random Access Method of Accounting and Control). It was a quantum leap in disk technology for its time. The RAMAC stored 5 megabytes of data on fifty 24-inch disks, spinning at 1200 RPM, and had an access time of 600 milliseconds, the resulting data transfer rate was .10 Mbits per second. Compare that to the 15 to 50Mbits per second data rates typical today! The popular name for this huge stack of disks at IBM was the "baloney slicer".

In 1955, realizing that magnetic recording density was severely limited by the number of linear stripes (tracks) on the tape, two brilliant engineers, Charles Ginsburg and Ray Dolby at Ampex Corporation developed the helical scan recording system. Their ingenious scanning system uses a tiny spinning magnetic head with tape wrapped around it in a spiral. This design packed recording tracks much more tightly onto the tape than was previously possible. The helical scan recording technique provides an extremely high recording density with a single small head. Helical scan recording is now used in every video recorder (VCR), Digital Audio Tape drives (DATs), and all high capacity tape backup drives. I have read with respect several documents authored by Ginsburg and Dolby at Ampex. These engineers deserve more credit for their brilliant invention of the mechanisms and recording techniques copied in every modern VCR.

In 1961, IBM pushed disk data storage ahead by announcing the 1301 Disk Storage unit which used aerodynamically shaped recording heads that "flew" above the surfaces of the spinning disks, and enabling roughly 10 times as much information to be packed in each square inch of disk surface. This head design would eventually become the "Winchester disk drive".

The next year, IBM announced the 1311 Disk Pack unit which helped speed the end of the punched card era by providing removable and interchangeable "disk packs" containing six disks protected by a transparent plastic "cake cover." Each disk pack could store roughly as much data as 25,000 punched cards. Magnetic disks were finally becoming a practical storage medium for computers.

In 1964, my parents made the mistake of conceiving Martin Bodo. Little did they know how much trouble I would eventually cause them. My early fascination with computers would ultimately place CSC at the forefront of magnetic data storage technology.

In 1967, IBM assigned David L. Noble to head a research team to develop a convenient storage medium with which to store and ship microcode. In 1969 several engineers left the project to join Memorex. Memorex soon became an industry leader in magnetic media technologies, disk drive manufacturing, and magnetic media production.

In 1970, IBM announced the 3330 Disk Storage Facility which was the first disk storage product to use an electrical feedback system called a "track-following servo" to control a "voice coil" motor that could quickly position recording heads at desired positions over the disk. This combination provided better response time, higher track density, and more reliable operation than was previously attainable. Twenty years ahead of its time, this closed loop track following servo technology would eventually be used in every large capacity disk drive.

In 1971, the first "diskette" was produced by IBM as an ICPL (Initial Control Program Load) device. It was called the Minnow and was an 8-inch read-only model that stored 81,664 bytes. It caused paper tapes to become obsolete almost overnight.

While IBM and others were developing disk technology at home in America, Japanese companies like Sony and Japan Victor Corporation (JVC) were making rapid advances in consumer VCR technology. By the early 1980's, the Japanese had a lead in helical scan tape drive manufacturing technology which the US could never overcome.

In 1973, the first read-write floppy disk, the Igar (IBM 33FD), started shipping to customers, storing an incredible (for its time) 242,944 bytes. The original code

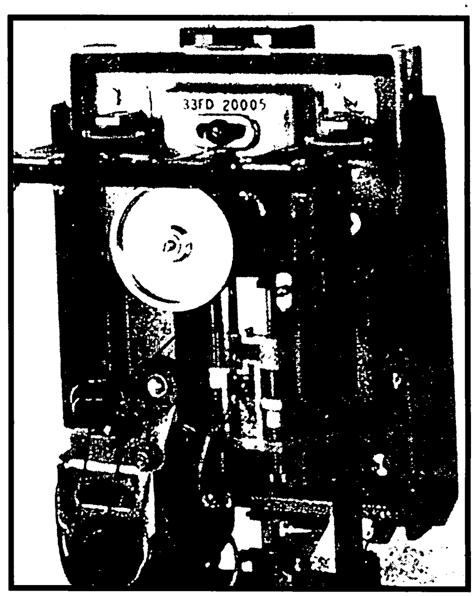


Figure 3 - IBM 33FD Floppy Drive

name of the read-write disk was Figaro, but the initial f and final o were removed as a symbolic removal of "fat" and "overhead". Memorex was the first company after IBM to produce floppy disk products and soon became a strong competitor in this field.

Also in 1973, IBM announced the 3340 Disk Storage Unit, which featured an ultra light-weight recording head that could "land" on and "take off" from a lubricated disk while it was still spinning. This eliminated the need for a mechanism to raise the heads off the disk surface before stopping, substantially reducing the cost of manufacturing. The 3340 also contained two spindles, each with a storage capacity of 30 million characters. Referring to this arrangement as a "30-30," engineers were reminded of the famous rifle and called their creation a "Winchester" file, a term that came to be used throughout the industry to identify this "floating head" design.

In 1975, IBM announced the 3350 Direct Access Storage Device, and marked an extension of Winchester technology and a return from the removable disk pack to fixed disks, permitting higher recording densities and lower cost per bit for on-line storage. The 3350 could store data at a density of more than 3 million bits per square inch, an increase of more than 1500 times the density of the RAMAC. By this time, competitors were catching up. Several companies, including Shugart, Magnetic Peripherals Incorporated, and PerSci were about to introduce competitive floppy disk drives.

In 1976, the success of the 33FD floppy disk led to the development of the 43FD using a dual-head drive, which could store 568,320 bytes. This was followed a year later by the double-density, double-sided, 53FD using MFM encoding and a capacity of 1,212,416 bytes. By 1977, nineteen companies were manufacturing floppy disk drives in the United States and MFM had become the encoding method of choice.

In 1979 Seagate Technology was founded and was the first company to mass produce an affordable hard disk drive (the 5 Megabyte ST506). Seagate has become the largest independent manufacturer of hard drives, having shipped over 35 million units to date.

I was a runny-nosed high school sophomore in 1979. While IBM was inventing thin-film recording heads, I was content with my first 5.25" 160K floppy drive. I was hooked, but I didn't know it.

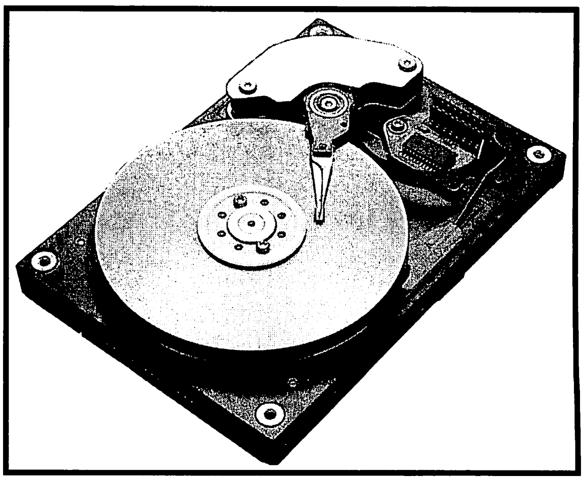
The data storage industry exploded in the early 1980's with the help of brilliant engineers who had business sense. Allen Shugart made the floppy disk the standard for data interchange and floppy drive sales soared. By 1982, hard disk drive sales had exploded and form factors were shrinking from 14" disks to 8" disks. The 5.25" form factor made popular by Seagate's ST506 was now an industry standard.

When I graduated from college in 1986, I made a living by modifying Alan Shugart's Model 712, 5.25" 10 megabyte hard drives so they would hold 20MB. I was starting to understand the equation for success in the hard drive industry. It was simple: Provide the Most Megs in the Smallest Size for the Least Bucks. I saw an opportunity for a company which would initially provide repair services for disk drives. CSC was born in 1986.

In 1989, IBM announced the 3390 Direct Access Storage Device, which could store as much as 21.5 billion characters in each storage unit -- the same capacity as its predecessor, the 3380 Model K, but at an increased density that required only one-third the floor space. Gosh, it weighed only 800 pounds.

As sales of Apple Computer's Macintosh line of personal computers began to grow, the industry was introduced to the idea of using the Small Computer Systems Interface (SCSI) interface as a standard port for desktop PC peripherals. SCSI at this point was basically a glorified 8 bit parallel port. But SCSI would eventually grow into one of the most popular standards for both low performance PC and higher performance workstation disk drives! Like the IBM-PC, SCSI caught on like crazy because it was hardware *with software standards included.*

In 1990, Conner Peripherals in partnership with Compaq computers had created and made popular both the IDE interface and the 3.5" disk drive form factor. An enormous volume market for IDE drives grew in the next few years as IBM compatible desktop systems grew in popularity.



Early Conner IDE Drive

By 1990, there was not one American company left producing helical scan tape recording mechanisms. The Japanese conquest in consumer electronics was about to pay off. Soon, all helical scan digital tape recording mechanisms for computer technology would come from Asia. In addition the American loss of consumer audio manufacturing technology would cost US companies dearly. All digital CD-ROM disk drives based on this technology would now come from Japan and the orient.

In 1991, we designed our first caching disk controllers at CSC. These cards would eventually sell by the thousands, as the size of CSC continued to double yearly.

In 1991, IBM boasted another first in drive technology, the MR head. IBM's 9340 drive became the first IBM disk to use magneto-resistive recording-head technology, and IBM could now boast of bit densities of >100Mbits per square inch.

In 1992, improvements in mechanical alignment and media had boosted the capacity of standard diskettes to 2.88MB and "floptical" diskettes to 20MB. Maxtor Corporation announced the "Magic" MXT series of disk 3.5" disk drives with capacities over 1GB and access times under 8ms. 5.25" disk drives were available in 1992 with over 3GB of formatted capacity.

It's 1994 now, as we write the update to the Hard Drive Bible. It's hard to predict the future, but I'll be glad to share a few thoughts on the data storage industry.

My friends in the floppy industry tell me that Floptical drives will soon be shipping with 80 MB capacity in a standard 3.5" form factor. I'm not sure what industry standards will develop, but other than "floptical" drives, I don't see much future for the floppy disk industry. Read the chapter on CD-ROM for more insight. CD-ROM and recordable CD-ROM drives are now about to revolutionize software distribution.

The hard disk industry, on the other hand, is moving faster than ever. Volumes are huge and a few manufacturing companies staying profitable despite intense competition. Technology is advancing faster than ever. My friends and I used to talk about "mini-mono" disk heads. Then it was "micro-sliders" and even "nano-sliders". Today we had a nerd's lunch and talked about "pico-sliders" that fly at 4 millionths of an inch above the disk. As far as I'm concerned, that should be called "contact recording"!

Will hard drive sales continue to grow? To be honest, there are some potential challengers for hard drives. Optical, and Flash technologies are improving. You can bet our friends at Intel think Flash will kill hard drives. But our friends in Japan working on optical disk drives feel that optical drives will win out in the long run. My opinion is unchanged. I've heard people tell me that something better will replace hard drives for the last ten years. Every time there's a technical advance in Flash or optical drive, there's a corresponding advance in disk drive technology. *Hard drives are here to stay.* As magnetic, optical, and semiconductor technologies advance together, hard drives continue to offer more storage for less money, with a better access time. Each technology has it's distinct advantages, but the magnetic recording technology used in hard drives is simple, mature and easy to manufacture. Hard drives will remain practical for at least several more years.

In 1993, only one major disk drive manufacturer was able to maintain profitability. I take my hat off to Alan Shugart, CEO of Seagate Technologies for that accomplishment. Seagate has a broad line of products from 8" drives to PCMCIA FLASH memory. They're quick on their feet and poised for the future.

But the majority of disk drive manufacturers continue to loose money! This is an omen of the largest potential problem facing the data storage industry: price competition. Severe price competition is forcing many companies to abandon research efforts and concentrate on high volume, low-tech products. Only the lean, high tech companies will survive the competition.

Some feel that magnetic recording technology has now begun to give way to optical technologies. I agree that optical technology has now become affordable and reliable enough to replace magnetic drives in some applications. In the past few years, optical recording techniques pioneered by the Japanese in consumer products have developed to the point where optical drives are manufactured at reasonable costs. Many companies like Hitachi, Sony, Ricoh, and MaxOptix do a brisk business selling fast, reliable, low cost optical drives. I feel the compelling advantage behind optical media is removability. Cartridge hard drives and hard drives with removable HDA's are not as large or convenient as optical media. The market for erasable optical drives will continue to grow.

Interface Standards

With every new developing technology comes the problem of standardization. The data storage industry has been influenced by standards from manufacturers and various groups including:

ANSI

American National Standards Institute
11 West 42nd Street, 13th Floor
New York, New York 10036-8002
(212)642-4900 (212)398-0023 Fax

NAB

National Association of Broadcasters
1771 North Street, N.W.
Washington, DC 20036-2891
(202)429-5300 (202)429-5343 Fax

IBM

First in standards for drives and computers
IBM Personal Computer Division
Route 100
Somers, NY 10589
(800) 772-2227

IRCC

International Radio Consultive Committee

IRIG

Interrange Instrumentation Group

Shugart Associates

Pioneer in floppy disk drives
Shugart Associates
9292 Geronimo, Building #103
Irvine, CA 92718
(714)770-1100

Seagate Technology

Pioneer in hard disk drives
Seagate Technology
920 Disc Drive
Scotts Valley, CA 95067
(408)438-6550 (408)438-6356 Fax

Some of the popular standards that have evolved are listed below:

"IDE" or "ATA" Interface

With the emergence of IBM compatible PCs as a hardware standard, drive manufacturers have recently started to integrate much of the IBM controller hardware onto their disk drives. These drives are called "Intelligent Drive Electronics" or "Integrated Drive Electronics" (IDE) drives. This interface is often referred to as the "ATA" or "IBM Task File" compatible interface. Drives with an 8-bit IDE interface are often called “XT Interface” drives, and drives with a 16-bit interface are often called “AT Interface” drives. By imbedding an AT controller card into the drive, a significant manufacturing cost savings occurs. Many parts (including line drivers and even a microprocessor) may be eliminated.

Early "XT Interface" drives use a BIOS ROM on the paddleboard and cannot be interchanged with "AT Interface" drives. An XT Interface controller and drive may be used in an AT class computer if the CMOS is set to "no drive installed".

Conner Peripherals and Compaq Computer were among the first companies to ship IDE drives in volume. Since then, acceptance of the IDE interface based on their original design has grown.

Since the imbedded controller on an IDE drive is optimized to run efficiently with the drive it is attached to, IDE interface drives often operate with improved performance over their comparable MFM or RLL counterparts. Some sacrifices were made in MFM/RLL controller and drive design to ensure compatibility with a large range of drives. Imbedded controllers are usually faster due to optimization.

It is clear that IDE drives have rapidly replaced the original MFM and RLL drives used in early IBM-AT compatible applications. Since most new disk drives use zoned recording techniques to increase drive capacity, all of these drives must use imbedded controllers. The only practical interface alternative for imbedded controllers on small disks are IDE or SCSI.

One disadvantage of the IDE interface is the 528MB limitiation. Although the most popular IDE drives sold today are less than 528MB, disk sizes continue to grow. A modification to the IDE interface software standard is now proposed so that drives over 528MB can be supported. See the Enhanced IDE chapter for more information on how the IDE interface will be improved in the future.

Another minor problem with the IDE interface is hardware incompatibility. Some IDE drives may be incompatible with each other or with some paddle boards, mostly due to different buffering or decoding. See the pinout in the Connector Pinouts section for more information on IDE drives.

ST-506/ST-412 Interface

Seagate Technology is the world's largest manufacturer of hard drives. Their first ST506 five megabyte full-height 5.25" disk drive was one of the first hard drives manufactured in volume. This drive used a 5 Mbit/second MFM encoded interface. The standard interface copied from this drive was used in all "ST-506 compatible" MFM and RLL drives.

MFM and RLL Encoding

Modified Frequency Modulation (MFM) encoding was first patented by Ampex Corporation in 1963. MFM encoding is often called "double density" and is used to code data on floppy and hard drives. MFM is an attractive coding scheme mainly because it is simple to encode and decode. MFM is now the standard coding technique for floppy disk drives and some small capacity hard disk drives.

Run Length Limited (RLL) encoding is a group coding technique which provides an increase in data density over MFM encoding. In RLL encoding, streams of data are grouped together and each group of data produces a recording pattern which depends on the bits which came before it. RLL encoding eliminates high frequency flux transitions and permits an increased data density within a fixed recording bandwidth.

The most common RLL coding (RLL 2,7) provides a 50% improvement in recording density over MFM coding. For example, a drive which stores 100MB of data at 5Mbit/sec MFM data rate can be made to store 150MB of data using RLL encoding. The data transfer rate increases to 7.5Mbit/sec using RLL 2,7, while the recording bandwidth stays at 5 Mhz.

Other RLL codings can provide even higher recording densities. RLL 3,9 (commonly called ARRL) provides a 100% improvement in recording density. Longer codes can provide even greater increases. Because RLL coding does not require an increased read/write channel bandwidth when compared to MFM encoding, RLL is now a popular coding technique used to increase capacity in many hard disk drives. Most modern ESDI, ST506-RLL and SCSI drives use RLL encoding. For a more detailed description of how RLL data is coded and decoded, see the next chapter.

Since RLL encoding provides higher data density in the same recording bandwidth, the data capture window is reduced. To accurately reproduce data in this smaller capture window, RLL encoding requires an improved data separator, an accurate read channel, and better PLL circuitry. The rotational speed of the disk drive must also remain more constant. Simply put, there is less margin for error using RLL encoding. Because of this, only drives specifically designed for ST506 RLL encoding should be used with RLL controllers. Connecting an ST506 RLL controller to a drive designed for MFM applications can result in a loss of data integrity. Before RLL'ing a drive, check with the manufacturer to insure that the drive is RLL certified. Be very careful when using ARRL controllers.

ESDI Interface

The Enhanced Small Device Interface (ESDI) is basically an improved, high speed ST-506 interface. This interface was pioneered by Maxtor. The combination of a 34-pin control cable and a 20-pin data cable from the ST-506 interface are retained, but the ESDI interface features improved actuator commands and data transfer rates.

The ESDI interface uses a data separator located on the disk drive itself. Older ST-506 designs used a data separator on the controller card instead. Moving the data separator to the drive improves compatibility and makes the ESDI interface independent of data rate. Providing the maximum data transfer rate of the controller is not exceeded, any speed ESDI drive can be connected to any controller. ESDI drives are available with rates up to 28 Mbits/sec.

The ESDI interface offers less command overhead than the SCSI interface. However, ESDI is not particularly well suited to zoned recording, and is really only useful for fixed disks. ESDI remains a useful, fast interface for hard disks, but SCSI has won out in popularity. The attraction of being able to daisy chain peripherals like CD-ROM and SCSI tape drives has ultimately driven the industry away from ESDI and toward SCSI.

SCSI Interface

The Small Computer Systems Interface (SCSI) first became popular as the interface used for Apple Macintosh peripherals. Actually, SCSI has been used for quite some time in workstation applications and is rapidly gaining popularity in the PC marketplace. SCSI offers the ability to daisy chain up to seven devices (hard, optical, tape, etc.) to a single controller with a single cable.

SCSI is basically a high-speed bidirectional 8-bit parallel interface that has been standardized in terms of both hardware and software by ANSI. The SCSI bus allows addition of up to 7 devices using a daisy-chained cable. Unfortunately, though most manufacturers of SCSI peripherals adhere to the basic ANSI hardware specifications, the level of SCSI software compatibility varies from manufacturer to manufacturer. A new ANSI standard, SCSI-II has been announced in an attempt to standardize the SCSI software interface. The ANSI SCSI-II specification adds features like disconnect/reconnect, and messaging while maintaining downward compatibility with SCSI-I devices. A recent copy of the SCSI specification may be obtained from ANSI or the CSC BBS.

Good termination and shielding allow a "single wide" SCSI bus to operate at speeds in excess of 10MB/sec. Since most existing SCSI peripherals only sustain data rates of around 2-3MB/sec, the SCSI interface has the data bandwidth to handle higher speed drives in the future.

The new SCSI-II standards for Wide SCSI and Fast SCSI offer a wider bus and sustained transfer rates up to 40MB/sec. These new versions of SCSI offer more than adequate throughput for any storage device that might appear in the near future.

The SCSI interface offers the flexibility and room for future expansion, but brings with it all the problems of a developing technology.

WIDE SCSI

Currently, the terms "wide SCSI" and "double wide SCSI" are used to refer to a SCSI interface with a 16 bit wide data path. This interface uses a 68 pin connector, and the electrical handshaking and data transfer system is identical to the more common 8 bit "single wide" SCSI bus. The ANSI SCSI specification provides a method for negotiating with peripherals to determine if they offer "wide SCSI" capabilities. Theoretically, the wide SCSI bus is downward compatible with standard "single wide" SCSI devices.

FAST SCSI

"FAST SCSI" refers to SCSI handshaking system which reduces hardware overhead during data transfers. Peripherals which support this feature will transfer data at higher burst rates if they are connected to a controller which also supports FAST SCSI. If either the peripheral or the controller does not support FAST SCSI, the burst data transfer rate is unaffected.

SMD Interface

The Storage Module Device (SMD) interface is the most popular interface for the 8" drives used in mainframe, minicomputer, and workstation applications. Variations include an improved data transfer rate (HSMD). SMD drives are gradually being replaced by SCSI in most applications. Bridge controllers are now available to adapt newer ESDI drives to the SMD interface.

IPI Interface

The Intelligent Peripheral Interface (IPI) is a mainframe disk drive interface standard used mainly on 8" and 14" drives. It is popular in IBM and Sun workstation and minicomputer applications. Many drives are available with dual IPI ports.

QIC-02 Interface

This QIC-02 interface is a software standard for tape drives. Most PC based 1/4" tape controllers use a QIC-02 command set.

QIC-40 Interface

This interface uses an standard floppy controller to store data on minicartridge data tapes. Although they are relatively slow, these drives are popular in PC applications due to their low cost. Drives are now available with up to 250MB (500MB compressed) capacities and data transfer rates up to 1Mbit/sec.

QIC-36 Interface

This 50-pin tape drive interface standard was pioneered by companies like Wangtec and Archive. The pinout is listed in the Pinout Section.

SA-400 Interface

As with Seagate and the ST-506 Interface, the SA-400 interface is named after the originator of the first mass produced floppy disk drive. Shugart Associates manufactured the SA-400 in 1978 and the SA-400 was the first disk drive to gain wide acceptance. The interface used a simple 34-pin cable with the 17 odd numbered pins connected to ground for noise reduction and shielding.

This 34-pin interface was modified to create the ST-506 hard disk drive interface discussed earlier in this section. The pinout of the interface used in modern floppy disk drives is shown in the Pinout Section. Although additional functions have been added since the original SA-400 drive (mainly DISK_CHANGE, SPEED_SELECT, and DRIVE_READY), this pinout is still affectionately referred to as the SA-400 interface.

Future Standards

Currently the most popular disk drive interface for small capacity hard drives is the IDE (or AT) standard. In the immediate future, the PC market will continue to be dominated by IDE drives.

The most popular interface for high performance, large capacity drives in now SCSI. In the future, as SCSI software standards evolve and the costs of SCSI drives and controllers come down, much of the IDE market will be displaced by SCSI.

In workstations and high-end PC applications, it seems clear that SCSI is the interface of the future. For example, all of the popular optical and DAT drives use the SCSI interface. We look forward to the time when small computer peripheral interfacing is simplified as manufacturers all begin to conform to the new SCSI-III and future SCSI-IV standards.

Basic Drive Operation

All disk drives perform three basic functions. They spin, seek, and transfer data. The disks inside a hard drive are mounted and rotated by a motor normally located in the center of the disks called the spindle motor. The read/write heads are held and moved in a head carriage which also usually holds the preamplifier electronics. Disks and heads are stacked vertically on the spindle motor, and the head stack assembly is positioned on-track by a servo system. Raw read data flows from the preamplifier and is encoded and decoded by the drive electronics. The heads read and write this "encoded" data to the disks (media). Data encoding and decoding circuitry is designed to pack as much information as possible into the smallest area. Read/write circuits move the encoded data to and from the magnetic recording heads. When writing, the heads convert the electric currents from read/write circuits into highly concentrated magnetic fields. These magnetic fields are stored in miniature magnetic groups called "domains" on the surface of the disk. When reading, the magnetic domains stored on the media are converted into electric currents as the heads pass by a second time, this time operating in reverse. The heads convert the changing magnetic fields from the disk into electric currents as the read data is recovered. The sections below describe the operation and purpose of the basic components of a disk drive: the spindle motor, the servo system, heads and media, and the data encoding circuitry.

Spindle Motors

The motor used to rotate the disks in a drive is called a spindle motor. Disk drives use many different types of spindle motors. The type used determines the spin-up time of the disk and torque as well as the heat dissipation inside the drive. A motor with a high start-up torque is necessary since the extremely flat heads and disks used in modern drives tend to stick together when power is removed and the heads land on the disk. At the same time, the spindle motor must operate efficiently with a minimum power consumption. Heat dissipated inside a disk drive causes the mechanical parts in the actuator and disk assembly to expand. Because modern drives require extremely precise mechanical alignment, it is essential that thermal expansion caused by spindle motor power dissipation be kept to a minimum. Some early drive designs were plagued with stiction or heat problems caused by inadequate spindle motors. Newer designs have resolved these problems by providing spindle motors with higher start-up torques and lower power consumption. All modern drives use microprocessor controlled spindle motor drive circuitry with pulse width modulation to minimize power consumption once the drive reaches operating speed.

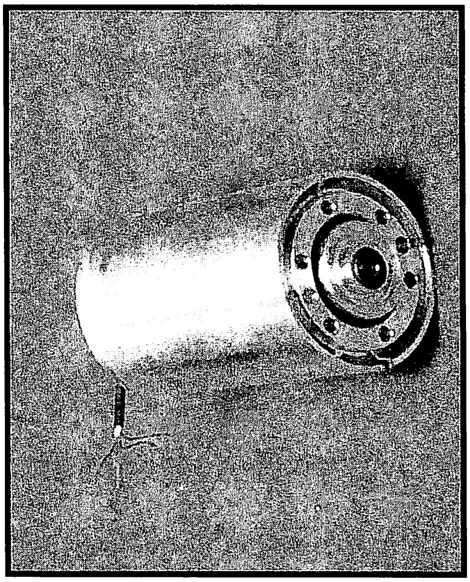


Figure 4 - Spindle motor used in high-capacity Maxtor drives.

In high capacity disk drives the quality of the bearings used in the spindle motor assembly is becoming increasingly important. As the concentric tracks in a drive are pushed closer and closer together in an effort to gain higher storage capacities, spindle bearing "runout" becomes a consideration. The smallest amount of wobble in a modern disk assembly can throw a head assembly slightly off track, resulting in reduced data integrity. Drive manufacturers have gone to great lengths to find affordable spindle motor bearings which offer the lowest amount of runout while still providing long life.

Early hard drives spun at 60 revolutions per second (3600 RPM) because synchronous motors were used which locked to the 60 Hz AC line frequency. Some newer designs now offer "fast spin" rates of up to 7000

RPM. At these higher spin speeds, improved spindle motor bearing quality and balancing is essential. Faster responding servo systems are also required to track data at higher spindle speeds.

Head Carriage

The mechanical engineer asked to design a modern head carriage is faced with a difficult task: Design a perfectly balanced mechanism to hold the heads firmly and rigidly using existing bearing and actuator technology. And management wants it for free! The head carriage must have the lowest moving mass possible, enabling it to be moved hundreds of time a second.

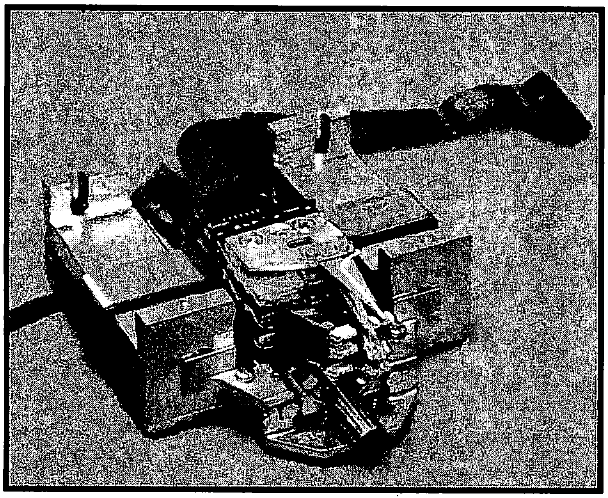
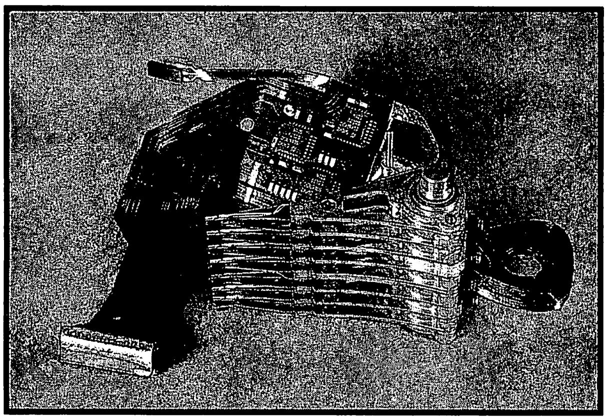


Figure 5 Head carriage with linear actuator

The head carriage pictured above uses a linear actuator. The advantage of this type of actuator is that the heads always stay parallel to the recording track. The disadvantages are more complexity and moving parts (higher cost) and higher mass than a rotary actuator.



Head carriage with rotary actuator

The head carriage above is typical of a modern rotary actuator. This actuator system has become standard in modern hard disk drives for two main reasons. Rotary actuators are cheap and reliable. Typically only two ball bearings are needed at the top and bottom of the actuator.

Media and Heads

The ultimate limiting factors in the push for higher and higher data densities in today's drives are the heads and media. Hard disk media was originally manufactured by spin depositing iron oxide (rust) particles on machined aluminum disks. Modern disks

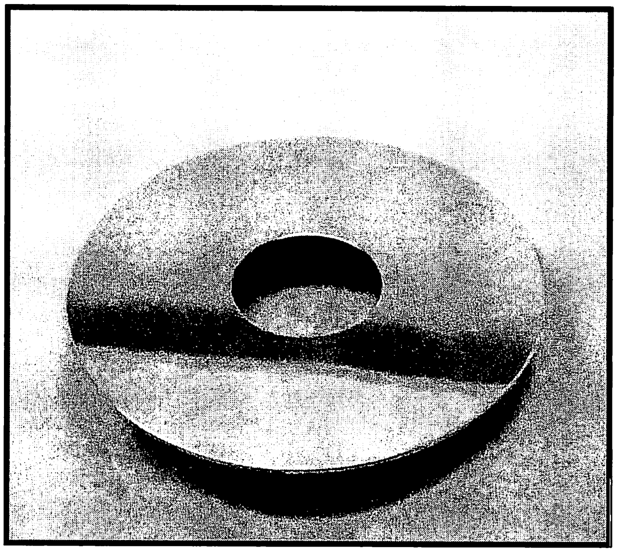


Figure 6 - 5.25" Plated media

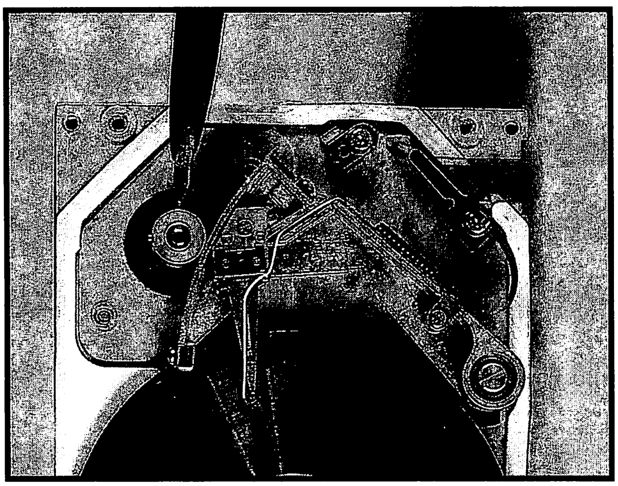
are made of annealed aluminum which is sputtered and plated with magnetic coatings, then coated with rugged lubricated coatings. Disk media is classified by the amount of magnetic field in Oersteds (Oe) required to produce enough magnetic dipole reversals in the disk coating to be detected by a magnetic head. Earlier media was easily magnetized using fields of 600 Oe or less. Newer high density media requires fields of 1800 Oe or more to achieve sufficient magnetic penetration.

Head technologies have also evolved over the years. As head gaps become smaller, the size of the magnetic coils used must shrink accordingly. New heads must handle higher write currents and be more sensitive when reading. Head gap sizes are constantly shrinking and because of this, the drive industry is moving toward the thin film and magneto-resistive heads of the future and away from monolithic heads of yesterday. Head flying heights are now just a few millionths of an inch to enable efficient magnetic coupling with miniscule gap widths.

Stepper Motor Servo Systems

Stepper motors are rotary actuators that rapidly move in small discrete steps (usually .8 to 4 degrees per step). Stepper motors provide a simple, reliable positioning system that is easy to use and inexpensive to manufacture. The stepper motor shaft is usually connected to a small metal band that converts the rotary shaft motion into a linear or rotary motion of the head carriage. Stepper motors are ideal positioners for floppy drives and low capacity hard drives due to their low cost.

A low cost stepper motor servo system has two major disadvantages. The mass of the rotor in a stepper motor is generally high. Using stepper motors as actuators in disk drives produces low access times because the heavy rotor must be moved along with the head carriage.



Stepper Motor Servo

The number of concentric tracks recorded per inch on a disk drive is referred to as the "track density". The second disadvantage in a stepper motor servo system is limitations on track density. High track densities are difficult to achieve with stepper motor servo systems because most stepper motors move only in large discrete steps. The electronics required to "fine tune" the position of a stepper motor servo system are expensive to manufacture. It is easier to adjust the position of a voice coil and keep the heads on track than it is to fine tune a stepper motor.

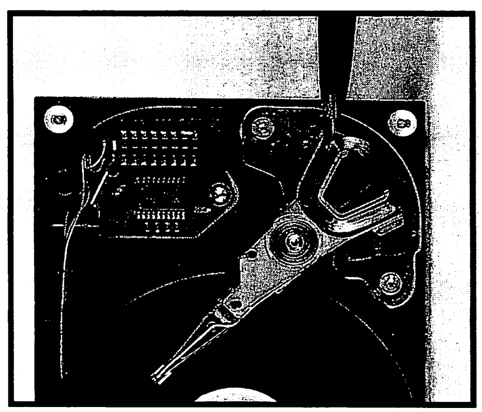
The future of stepper motors remains in low cost open-loop servo systems, like floppy disk drives. They have become yesterday's technology, and there's no reason to use them in hard disk drives today.

Voice Coil Servo Systems

It's hard to imagine a mechanism that can move to any position over an inch in less than 1/100th of a second and come to a complete stop within 0.0001" of its target. Modern voice coil actuators are capable of doing this over 1,000,000,000 times. The voice coil servo system is the key component in all newer high performance disk drives. A voice coil actuator is simply a coil of copper wire attached to the head carriage. This coil is surrounded by high energy permanent magnets which are attached to the HDA casting. To move the head carriage and "seek" to a track, the control electronics apply a current to the voice coil. The current applied induces a magnetic field in the coil which attracts or repels the stationary permanent magnets. The amount of torque induced to move the head carriage is directly proportional to the amount of current applied to the voice coil.

Many drives use an ASIC control chip in the voice coil servo system which contains a D/A converter. The output of the D/A converter usually drives a MOSFET power amplifier which provides the current required by the voice coil. The circuitry which moves the head from track to track is simple compared to the circuitry which decodes the servo information recorded on the drive. In order to control the voice coil, the servo electronics must know precisely where the head is positioned on the drive. The positioning information fed back to the electronics to control the voice coil positioner is called "servo feedback". Several different servo schemes are used to provide position feedback information to the drive electronics and "close" the servo loop.

Some large capacity drives use a "dedicated" voice coil servo feedback system. If you see a drive in the drive



Voice Coil Servo

table with an odd number of read/write heads, it probably uses a dedicated servo system. In a dedicated system, the entire surface of one disk is reserved for use by the servo system. Position information is recorded on the reserved (dedicated) disk so that the drive electronics can determine the exact position and velocity of the head carriage. Assuming that the head carriage holds the entire head stack rigidly together, the position of the read/write heads will track along with the dedicated servo head. A dedicated servo system offers fast positioning and is simple to design. One of the only disadvantages to this system is that since only one head is used for servo, a dedicated servo system is unable to compensate for thermal warpage of the head stack assembly.

A more popular voice coil servo feedback system is called "embedded" servo. An embedded servo system works in a manner similar to the dedicated system except for the physical location of the servo position information. An embedded system interleaves servo and data information by placing servo positioning bursts between the data recorded on the disk. Embedded servo systems have advantages and disadvantages over dedicated servo systems. Advantages of an embedded system include the ability to accurately position each individual head by sensing the position information directly under that head. A dedicated servo system positions all of the heads together. Disadvantages of an embedded servo system are increased servo electronics complexity (which translates to higher cost), and the requirement for seek and settling delays when switching between heads.

Many new drives employ a "hybrid" servo system which combines both a dedicated servo for fast, coarse positioning, and an embedded servo to finely position the head on track. Hybrid servo systems offer the best access and positioning of any system, but their cost is also the highest. One disadvantage this system shares with dedicated servo systems is that an entire surface is used for servo. This dedicated surface could have been used to store more data.

Keeping it Clean

When a drive is running, Winchester heads "fly" or "float" on a cushion of air. There is virtually no wear on the disk surface when the drive is running and the heads are stationary. Almost all the wear on a drive occurs when the drive is turned off and the heads "land" and touch the disk.

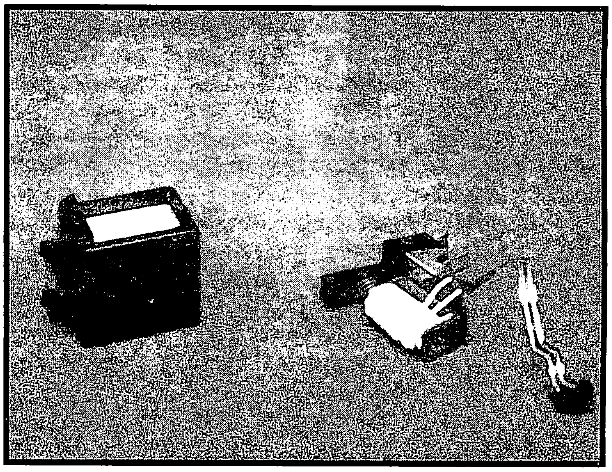


Figure 7 - Drive Filter and Latch Components

All modern voice coil servo drives use an electronic or mechanical mechanism to move the heads away from the data area of the disk to a "landing zone" when power is removed. Better drives also use a mechanical latch mechanism to park and lock the heads in the landing zone.

As the media wears in a drive, microscopic particles flake off from the disk surface. A quality hard drive designed for long life contains a circulating air system which catches these particles in a filter.

Most disk drives have filtered vents which permit outside air to enter and exit the HDA. These vents help if a pressure differential develops between the HDA and the ambient air. Some newer drive designs (notably Conner and Maxtor drives) have eliminated the outside air filter.

Data Encoding and Decoding

Data encoding is the technique used to convert a stream of binary data into a varying current which drives a magnetic head. The varying current which drives the head produces magnetic flux reversals in the head. These flux reversals orient the molecular magnetic dipole moments of the media. The media is thus "magnetized" in a pattern which stores the data. The magnetic head has a maximum frequency limitation which determines how close the magnetic flux reversals can be placed on the disk while still maintaining acceptable reliability. There is also a minimum frequency limitation imposed by the drive electronics.

The difference between the minimum and maximum frequency limitations is called the recording bandwidth. One goal in manufacturing disk drives is to provide the highest data recording rate as possible. A higher data recording rate translates to higher capacity per track and higher data transfer speeds. The magnetic recording bandwidth of a drive is limited by several factors including head and media design and positioning accuracy.

The goal in designing data encoding and decoding circuitry thus becomes placing the maximum amount of data bits within a fixed recording bandwidth while maintaining acceptable reliability.

Disk drive data encoder circuitry removes the need to place clock information on the track by combining the data bits to be recorded with as few clock signals as possible. The decoder circuitry regenerates the clock from the recorded signal and synchronizes the clock to the decoded data. The encoder and decoder circuitry in a drive are usually combined into a chip called and "ENDEC".

Encoding and Decoding Codes

The following encoding and decoding codes are commonly used in disk drives:

NRZ (Non-Return to Zero)

This code was originally used in telecommunications and its encoding and decoding are simple to understand. Instead of discrete pulses for each data bit, the signal rises or falls only when a one (1) bit in the incoming data stream is followed by a zero (0) bit or when a zero (0) bit is followed by a one (1) bit.

This coding technique has a serious flaw because certain data patterns can be generated which will result in a fixed logic state output (i.e. the output of the encoder will be static, stuck at zero or one). The "worst-case" condition can violate the minimum recording bandwidth of the drive electronics. In practice, this would rarely happen, but it's a serious strike against NRZ coding.

PE (Phase Encoded)

This coding is used in credit cards and instrument recorders. It is also simple to understand. The direction of a flux reversal in the middle of each cell indicates whether the encoded bit is either a zero or a one. This effectively shifts the phase of the output signal each time there is an NRZ type transition between zeros and ones.

FM (Frequency Modulation)

This coding technique was used in the earlier floppy drives (including 8" drives). These older drives were called single density "SD" drives. The FM method of encoding is basically equivalent to the PE method. FM coding is no longer widely used in disk drives.

MFM (Modified Frequency Modulation)

With available heads and media, MFM is by far the easiest coding technique to implement MFM encoding is used in all modern floppy drives and many small capacity hard drives. MFM doubles the data capacity of FM encoding (MFM floppy drives are called Double Density). MFM works by eliminating the clock pulses in FM encoding and replacing them with data bits. Clock pulses are still used, but they are written only when a one (1) data bit is not present in both the preceding and the current data cell (Fig. 8)

To decode MFM data, a data separator must generate a clock signal based on several flux transitions. In

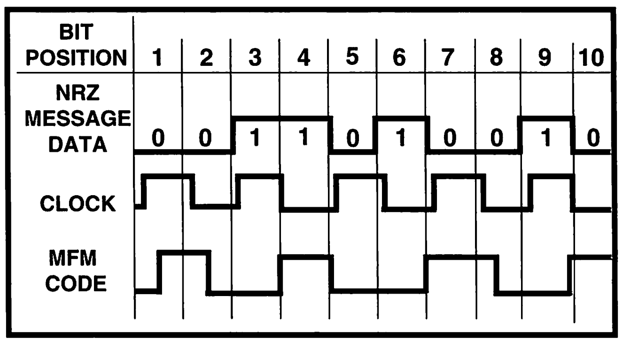


Figure 8 - MFM Encoding

order to maintain a low error rate, the speed of data flowing into the encoder must remain steady, and the decoder must lock onto this stream. In practice, the rotational speed of hard and floppy drives is easily controlled within the tolerances required for reliable MFM recording.

RLL (Run Length Limited Encoding)

This encoding scheme was first used in 14" drives from IBM, CDC, and DEC. It is now used in almost all high capacity 3.5" and 5.25" hard drives. Common RLL coding techniques are RLL 1,7 and RLL 2,7. 1,7 and 2,7 refer to the maximum number of consecutive zeros in the code. RLL 2,7 offers a 50% improvement in data transfer rate and data recording density as compared with MFM within the same fixed recording bandwidth.

The easiest way to understand RLL encoding is by examining Figure 9. Bits are encoded by following the tree, starting at the root. When you reach the end of a branch, the stream of bits at that branch correspond to the encoded data to be written to the drive.

RLL encoding has two main disadvantages. The first is that RLL requires significantly more complex encoding and decoding circuitry than MFM. This has

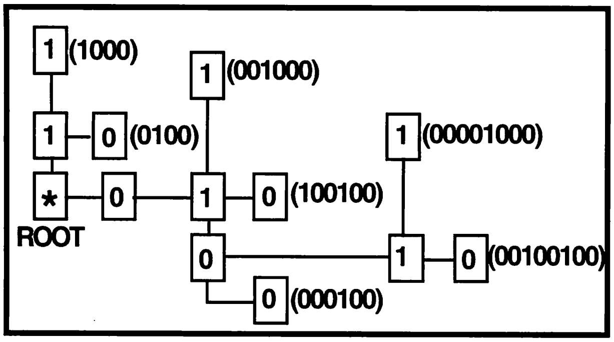


Figure 9 - RLL 2,7 Encoding Tree

been overcome in part by single ENDEC chips from companies like SSI and National Semiconductor. The second disadvantage with RLL encoding is that a small defect can produce a long stream of data errors. To combat this, drive manufacturers are improving the design of read/write heads and media and lowering the flying height of these heads to improve signal to noise ratios. Longer, improved error correcting codes are also used with RLL encoded drives.

Spindle motors are now driven by crystal controlled microprocessors to improve rotational speed accuracy. The quality of the heads, media, and spindle control circuits used to manufacture today's hard disk drives are more than adequate for reliable RLL encoding

Future Codes

Many other coding and encoding techniques have been developed which offer higher data rates and recording densities than RLL within the same fixed recording bandwidth. All of these codes are more susceptible to timing jitter and large error bursts than RLL coding. At present, nearly all ESDI, SCSI, and IDE drives use RLL coding. We expect that RLL will continue to be the most commonly used coding in magnetic mass storage devices for the next few years. The recent advent of PRML techniques to improve read channel performance will take some time to implement.

CD-ROM

CD-ROM

*C*ompact *D*isk *R*ead *O*nly *M*emory is the future of software distribution. Programs which were once shipped on dozens of floppy disks can now be reproduced inexpensively on a single CD-ROM disk.

With over 600 Megabytes of capacity, CD-ROM technology provides a medium for full motion multimedia games, movies, and educational software. This new technology will replace the floppy disk for information distribution in the near future, and may eventually replace some magnetic tape technologies, such as video tape. Well established standards insure media interchange between different CD-ROM drives, platforms, and operating systems.

At the time of this writing, the cost of mass producing a CD-ROM in Hong Kong had dropped to around 50 cents per disk. On a per megabyte basis, CD-ROM is the most inexpensive way to distribute data.

CD MEDIA

CD-ROM disks are built on a transparent polycarbonate plastic substrate. This substrate is coated with a thin aluminum layer. Recordable, write once CD media is identical to mass produced disks, except that the aluminum layer is replaced with gold. CD's store information using microscopic pits in the metal layer which are detected by a minute laser beam. Each pit is approximately 5 by 3 micrometers in size, and there are over a billion pits per disk. Since these pits are much smaller than dust particles, CD's must be manufactured in a clean room environment. To provide an immunity from smaller dust particles and unavoidable scratches, the optical recording layer is placed away from the surface of the plastic disk.

To mass produce CD-ROM's. CD masters are first made using a photo lithography process. These masters are then used to press thousands of disks. Smaller quantities of disks can also be produced on a desktop using a CD-R drive. A CD-R drive uses write-once media and is similar in operation to a WORM drive.

CD-ROM DRIVE OPERATION

Unlike hard disk drives, CD-ROM's are not segmented into multiple tracks of data. Technically, a CD-ROM disk has only one track! The CD-ROM uses a single track of data over three miles long which is wound 50,000 times in a spiral, similar to an LP record. On a CD, data is recorded from the inside of the spiral outwards. A single speed CD-ROM drive spins the disk at varying speeds, starting at 550RPM and working down to about 220RPM. It takes about 75 minutes to read the entire disk at this "single" speed.

Data is encoded using an "EFM" modulation scheme which isn't the ideal way to pack data on an optical disk, but it was chosen to keep the complexity and cost of the drives down. As the disk spins, a tiny low power laser is focused through a lens onto the surface of the disk. The reflected light from this laser is detected using a photo diode, and the EFM encoded data is detected and sent to the drive electronics. Because a scratch or dust particle can cover thousands of bits of data, a special error correcting system called CIRC (for Cross Interleaved Reed Soloman Code) is used to correct any errors detected by the drive electronics.

Two closed loop servo systems are used in CD-ROM drives. The first system moves the small focusing lens located above the laser to focus it on the disk. The second system moves the entire laser, lens, and photo diode assembly to place it correctly on the spiral.

CD ROM STANDARDS

ISO 9660

IS0-9660 is the current International Standards Organization technical specification which defines the physical format of CD-ROM data. The major contributors to this specification were DEC, Phillips and Sony. This specification evolved from the "High Sierra" format, and is now used in almost all mass produced CD-ROM disks to insure compatibility in the wide range of available drives and systems. The ISO 9660 specification defines file and directory formats, interchange levels, and recording formats. A copy of the ISO 9660 specification can be ordered from ANSI by calling (212) 642-4900.

MODE 1

Two "modes" or formats are used to record data on

CD-ROM disks. Mode 1 uses more error correction and is the most popular format used today. Each sector recorded in Mode 1 is 2048 bytes, with an additional 280 bytes of error correction data stored at the end of the sector. This error correcting code is in addition to the CIRC codes mentioned above. By adding multiple layers of error correction, MODE 1 significantly increases the reliability of the CD media.

MODE 2

The Mode 2 format is identical to Mode 1, but the error correcting codes are removed. Removing the ECC's yields about 15% more data storage area on the CD by increasing the sector size to 2,336 bytes. Mode 2 disks are also more susceptible to errors. A new Mode 2 disk will typically have three or four errors when played in an average drive. In most audio applications, the Mode 2 format is fine, since the human ear is usually unable to detect these errors. Mode 2 is also often used with graphic files and imaging applications.

CD-ROM XA

The XA format was developed by Microsoft, Sony and Phillips. The XA format has two modes, called FORM 1 and FORM 2. XA FORM 1 is almost identical to MODE 1 format. XA FORM 2 is a new format used for recording compressed audio, video, or graphics. XA FORM 2 is designed so that errors will cause only minute clicks in sound or a tiny dot (pixel) change in a photograph.

CD-I

MPEG is a data compression technique developed by the Motion Pictures Experts Group. CD-I uses MPEG to compress full motion video down to CD-ROM compatible data rates. With CD-I, a complete 74 minutes of video can be recorded on a CD. CD-I players may someday compete with video recorders, since the CD media is less expensive and easier to produce than video tape. At the time of this writing, Phillips was the only manufacturer commercially mass producing a CD-I player for home use. Experts estimate that the cost of a CD-I player will soon be lower than the cost of an equivalent video cassette player. When this happens, CD-I will challenge video tape for commercial distribution of movies.

PHOTO CD

Photo CD is a standardized recording system developed by Kodak for storing high resolution images on CD-ROM disks. Photo CD "service bureaus" are now available across the country. These service bureaus will take your 35mm or professional format film, scan it, and translate it into images on CD. Each image is scanned at high resolution, color corrected, and stored in a proprietary compressed format called YCC, then placed on CD-R disks. The recorded images can be reconstructed in several image resolutions, ranging from 128x192 pixels to 2048 by 3072 pixels in 24 bit color. For fast access, three image formats are stored in uncompressed formats at resolutions up to 512x768 pixels. Kodak's photo CD software converts their 24 bit YCC chroma and luminance data into a 3 by 8 bit RGB format usable in your machine. To save costs, you can use your photo CD disk more than once. If your disk isn't completely full, you may return it to Kodak for additional "multisession" images. The term "multisession" refers to more than one photo CD recordings on a single disk. To use a multisession disk, you will need a CD-ROM drive with multisession compatible firmware.

QUICK TIME

Apple Computer developed Quick Time as a multi platform multimedia format standard. Quick time uses a program called the Movie Manager to combine sound, animation, and video from compressed files. Quick Time movies are low resolution (160x120), but their low data rate is ideal for CD-ROM storage. Quick Time offers a choice of software and hardware compression through a program called Image Compression Manager.

CHOOSING A CD-ROM DRIVE

Insist on the following before purchasing a CD-ROM drive:

- You must have full MPC compliance.
- You must have full XA compliance.
- You must have MODE-1 and MODE-2 compatibility.
- You may want Multisession Photo CD compatibility.
- You may want double, triple, 4X or 6X spin speeds.
- You may want sub 200ms access times.
- You may want a SCSI interface.
- You may want a "caddyless" drive mechanism.

Here's why: You need MPC, XA, MODE 1, and MODE 2 to play the wide range of available CD-ROM disks. You need Multisession if you plan to use Kodak Photo CD's. You'll want double spin or faster if you are running multimedia games. A faster access time will help if you're transferring a volume of small files from CD-ROM. A SCSI interface is essential for your Mac, and gives more upgradability for your PC. A "caddyless" drive saves you money, by storing disks in jewel cases instead of caddies.

THE MPC STANDARD

A committee of manufacturers including Microsoft, Intel, and others has developed two standards called MPC level 1 and MPC level 2. These standards the minimum hardware required to run multimedia programs. These standards are significantly less than we recommend below.

MPC level 1 standard requires:

- A CD-ROM with access time less than 1000ms.
- A 386SX CPU with 2MB RAM.
- VGA, 1.33MB Floppy, and an 8 or 16 bit sound card.

MPC level 2 requires:

- A 486SX CPU with 20MHz or better clock speed.

As you can see, almost any modern PC or CD ROM drive exceeds the MPC level 2 compliance recommendations. So when a drive is touted as "Fully MPC Compliant!", they really aren't saying much.

BUILDING A REAL MULTIMEDIA PC

To build a multimedia PC, or to upgrade your existing PC, you'll need the following:

- A fast 486 or Pentium processor.
- A VESA or PCI video card.
- A Sound Blaster 2.0 compatible sound board.
- A double spin or faster CD drive (SCSI is pre ferred)
- A large hard disk if you plan to manipulate images.

Stay within your budget, but the faster the processor the better. If you're manipulating images in a program like Adobe PhotoShop, you may need 16MB or more memory. Full resolution Kodak Photo CD images are 4.5MB each! A VESA or PCI 32 bit video board with a Windows accelerator is recommended. A double spin or faster CD-ROM will help give you smooth video motion. Most multimedia programs require a Sound Blaster 2.0 compatible sound card.

CD-R and CD-WO

CD-R is the new desktop technology which enables you to write a CD-ROM disk. A CD-R drive plugs right into your PC, Mac, or SparcStation, and allows you to burn your own CD's.

CD-R drives use the gold media described above and a high power laser to burn pits into the metallic layer and write disks. These disks are available in all formats and lengths, up to 74 minutes. The blank disks are inexpensive (around $20 in volume). Of course, these disks can be written only once.

Depending on the mastering software you use, you may be able to create disks one track at a time, or you may need to create a complete mastered image on your hard disk (650MB or more of space is required) and then copy this image to the CD-R disk. CD-R writers are available in speeds up to 6X, and they are surprisingly affordable. CD-R drives are available from CSC and other suppliers.

MASTERING YOUR OWN CD-ROM

Yes! The technology is here today to master your own CD-ROM. At the time of this printing, publishing about 100 disks cost less than $1000. To master your own CD, first read about the available formats. You will need to understand them and organize your data to be compatible with them.

Next, shop for CD mastering software. This software is available in all costs and qualities, from free public domain programs to professional programs costing several thousands of dollars. Using this CD mastering software, you can organize your data in the correct file and directory formats required for CD-ROM. Once your data is ready for mastering, you will need to make a "One Off" to test your programs. A "One Off" is made using a CD-R machine as described above. If you plan to mass produce your disk, it would be better to have the same company which will mass produce your disk manufacture the "one off". Your data may be transported to this manufacturing company on Erasable Optical disks, DAT, on 8MM tape, or by actually shipping them a hard drive (not recommended). The following companies are excellent CD-ROM manufacturers:

3M Optical Recording Department
3M Center Building 223
St. Paul, MN 55144-1000
(612) 733-2142

Disk Manufacturing, Inc.
1409 Foulk Road, Suite 202
Wilmington, DE 19803
(416) 298-8190

Sony Electronic Publishing Company
Recorded Media Division
1800 N. Fruitridge Ave.
Terra Haute, IN 47804
(812) 462-8100

US Optical Disk, Inc.
Eagle Drive
Sanford, NE 04073
(207) 324-1124

INSTALLATION CAUTION!

CD HANDLING HAZARDS

Contrary to popular opinion, CD disks are not as rugged as they look. While small scratches on the data side of the disk may not damage data, you can destroy a disk completely by bending it, writing on the top of the disk with a ball point pen, or deeply scratching either side of the disk.

Some data errors can be caused by dust, dirt, or greasy material on the surface of the disk. A spray bottle of lens cleaner and a soft lint free rag can be used to correct this. Treat your CD's with care and they will last a lifetime. Consider buying a caddy for each of your disks, or at bare minimum, store your disks in plastic jewel boxes.

CD drives are also susceptible to contamination with microscopic dust particles. When installing an internal drive, choose the location furthest away from the fan in your computer to prevent the flow of dust into the drive.

PRML Technology

PRML Technology

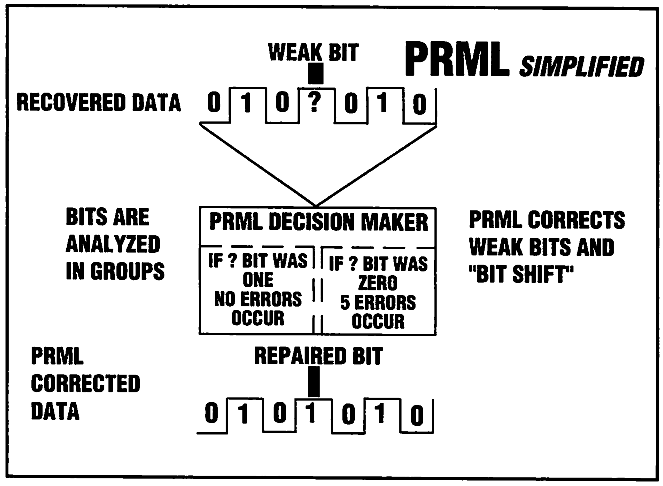
PRML is an acronym for Partial Response Maximum Likelyhood. PRML is a new solution to an old problem. Since disk drives were first designed, there has been a push to pack the largest amount of data possible into the smallest possible disk area. To understand PRML, let's first take a look at the problem PRML is designed to overcome.

As data is packed closer and closer on the magnetic media, the recorded bits tend to blur together. The blurring is mainly caused by "bit shift" and by the unavoidable introduction of noise in the read channel.

PRML read channels differ from conventional analog read channels in the way they detect and separate recorded data. Analog read channels typically look at the position of the recorded peaks and use only the peak position information to recover the recorded data. PRML channels digitize the height of each peak and compare it to an average peak value. Once the PRML read channel has extablished a values for the size and shape of the peak, it adds this information to the values of peaks which are read subsequently. The PRML circuit looks at the combination of the bit read and the subsequent bits, and then decides which interpretation of bits will produce the least amount of errors. If a weak or slightly shifted bit is detected, the PRML read channel can determine what the weak bit should have been by analyzing it in combination with its neighboring bits.

The net effect is that bits can be placed closer together on the magnetic recording media. This means increased disk capacities without significantly increased costs.

So how soon will PRML technology actually affect the performance of available hard drives? Sooner than you might expect. Mid range drives will be the first to take advantage of the new technology. Cirrus Logic and VTC are currently shipping silicon which fully implements PRML. IBM and others have parts in the design phase. The current bottleneck seems to be data rate. Analog read channels are still much faster than their available PRML counterparts. When this gap closes, expect PRML to add 30% to 50% more to existing disk drive capacities!



PRML Encoding

Enhanced IDE

The Enhanced IDE standard proposed by Western Digital provides a solution to IDE's three biggest problems: capacity, performance, and expandability. The original IDE drives developed by Conner and Compaq were designed to be compatible with IBM's early MFM controller card used in the original IBM AT's. When this "register level" compatibility was copied, some limitations went along with it.

The existing IDE interface has a total drive capacity limitation of 528MB. This constraint comes from the original IBM MFM controller design which supported a maximum of 1024 cylinders, 16 heads, and 63 sectors per track. The original MFM controller used 10 bits to address the cylinder count, 4 bits to select the head, and 6 bits to select the sector number (which started with #1). This means that all existing PC applications which write directly to the IBM compatible disk controller registers have a total of 20 bits available to control the logical block address of an IDE disk drive. Since a sector number of zero is disallowed in the IDE interface, a total of 1,032,192 blocks can be addressed. With a standard block size of 512 bytes per sector, IDE is limited to a 528MB maximum capacity.

IDE LIMITATIONS

Heads - 16 Maximum (Numbered 0 through 15)
Sectors - 63 Maximum (Numbered 1 through 63)
Cylinders - 1024 Maximum (Numbered 0 through 1023)
Total Blocks - 1,032,192
Maximum Capacity - 528MB with 512 byte sectors

To bypass this limitation, the proposed Enhanced IDE standard uses a 28 bit logical block address which can address a total of 26,8435,456 blocks. This provides a maximum drive capacity of over 13 Gigabytes, which is enough for the near future. A standard IBM compatible BIOS has it's own capacity limitations. BIOS is limited to 1024 cylinders, 256 heads, and 255 sectors per track. This results in a BIOS maximum capacity of 8.4GB.

BIOS LIMITATIONS

Heads - 256 Maximum (Numbered 0 through 255)
Sectors - 63 Maximum (Numbered 1 through 63)
Cylinders - 1024 Maximum (Numbered 0 through 1023)
Total Blocks - 16,515,072
Maximum Capacity - 8,4GB with 512 byte sectors

Without a device driver, the maximum capacity of the proposed enhanced IDE standard is 8.4GB. This is not currently an issue for hard disks, but for larger capacity drives, like helical scan tape backup units, it would be a limitation if other workarounds were not provided. One way to bypass this may be to switch to a larger block size for these larger devices, such as the 2048 byte per sector block size used in CD-ROM drives another is through the ATAPI system described below.

The original IDE standard is also limited in terms of performance. This is mainly due to the speed of 16 bit programmed I/O (PIO) data transfers. SCSI host adapters can transfer data faster than IDE by using bus mastering processes programmed memory moves, or Direct Memory Access. IDE drives must wait for the CPU to move data, two bytes at a time. An instruction execution and an I/O cycle are required as each pair of bytes to be moved from the IDE registers into main memory. This PIO process is significantly slower than other methods. When the original MFM drives were introduced, these slower data rates were adequate, but with higher performance drives they are a serious bottleneck.

To increase performance, Enhanced IDE offers the option of using faster DMA transfers. To maintain compatibility, the enhanced IDE drive starts out in PIO mode, and switches to DMA mode only after a software driver is loaded. This software driver is specific to the operating system being used, i.e. OS/2, DOS, or Windows NT™.

The original IDE interface supports a maximum of two drives. Removable drives, Optical drives, Tape Drives, and CD-ROM drives were not provided for in the original IBM AT. Western Digital's proposed solution to this in Enhanced IDE is called ATAPI. ATAPI stands for ATA Packet Interface, and it's design is suspiciously similar to SCSI. In fact, ATAPI appears to have been copied from SCSI so that existing manufacturers of SCSI drives could easily convert their drives to run on Enhanced IDE systems. ATAPI provides support for tape, optical, and CD-ROM drives through a packet messaging system.

At the time of this printing, Enhanced IDE drives were being produced only by Western Digital. ATAPI drives were announced, but not yet available. Enhanced IDE is really a great ides for breathing new life into a tired interface. We can only hope that the Enhanced IDE will catch on, removing the limitations of the original IDE interface.

Controller Setup & Jumpering

In PC applications,controller jumpering is often the first step in installing a new drive and controller. To correctly jumper the controller, you will need the controller board manual, as well as documentation on the other boards installed in the system. Settings for some controllers are provided in the Controller Information section of this manual.

You may need to jumper the controller board for one or more of the following settings:

ISA Bus Base I/O Address

The base I/O address of your controller can normally be left at the factory default setting unless you are installing two controller boards in the same system. If you are installing two boards, the first board must be set at the primary I/O address, and the second board can use any available I/O address. Be sure to check for conflicts with network boards, tape drive controllers, and video boards before selecting your secondary address.

If you are installing an IDE disk drive, the primary port address used are 1F0-1F7H and 3F6-3F7H. At the time of this printing, MS-DOS 6.2 did not support the use of more than one IDE controller at an alternate (secondary) address. IBM's OS/2 Version 2, however, does support a secondary IDE controller.

If you are designing an I/O mapped controller card which must coexist with an IDE or similar board, I recommend using a base address of 180H or 320H. These areas are almost never used by other peripherals.

ISA Bus Base BIOS Address

If your controller card has a ROM BIOS, you will need to select a starting address. When selecting a starting BIOS address, add the starting address of the card and the length of the required I/O space. Make sure that the address you select will not cause a ROM address conflict with any other boards (particularly VGA and network boards). If you are unsure of the length of the BIOS ROM on the controller, use DEBUG to dump the third byte of the ROM. This corresponds to the length of the BIOS in 512 byte blocks. Every system configuration is different, but most IBM compatibles have room for a 16K or 32K BIOS starting at C800H or D000H.

Note: Not all motherboard BIOS ROMs will support controller card BIOS addresses over E000H. If you experience problems, try choosing a BIOS address between A000H and DFFFH.

ISA Bus DMA Channel

Most controller cards do not use third party DMA. Exceptions to this are some high performance SCSI and ESDI controllers. You may share a DMA channel with another device only in the rare case that your software and hardware support it. Make sure to set both DREQ and DACK jumpers identically.

ISA Bus Controller Interrupt

Most controller boards do not use interrupts in DOS applications, but a hardware interrupt is required for all Novell and most UNIX applications. Select any available interrupt, but be sure to define it correctly when running NETGEN. Interrupts 14 and 15 are generally available on most PC's. IRQ 14 is normally used by the primary IDE controller. Lower interrupt numbers have higher CPU priority.

Floppy Address

A secondary floppy address must be selected for two floppy controllers to peacefully coexist in the same system. OS/2 users will find support for two floppy controllers built into the operating system. If you are running DOS, you will not be able to use the second floppy controller without a device driver installed in your CONFIG.SYS file. If your floppy controller is compatible with the original IBM-XT architecture (copied in all clones from 8088's to P5's), you can use DOS DRIVER.SYS to control your extended floppies.

DOS DRIVER.SYS parameters are listed below. Enter all necessary parameters on the DEVICE = DRIVER.SYS line in your CONFIG.SYS file. For example, if you have one hard disk installed and wish to use a 1.44MB floppy as your third (i.e. D:) drive, add the following line to your CONFIG.SYS:

DEVICE=DRIVER.SYS /F:7 /C

The following switches are supported by MS DOS 5.0:

/T:x x = number of tracks

/C indicates that disk change is supported by the drive
/F:x x = drive form factor code
0 = 360K
2 = 720K
1 = 1.2MB
7 = 1.44MB
9 = 2.88 MB

/H:x x = number of heads
/S:x x = number of sectors per track

More detailed information on CONFIG.SYS can be found in your DOS manual.

Controller cards with well written BIOS codes (like the CSC FastCache™ series) will operate extended floppy drives without software drivers. If you have one of these cards, modifications to your CONFIG.SYS will not be needed in most cases.

2.88MB drives are now supported as primary (boot) drives by most new motherboard BIOS ROM's, including AMI, and M.R. BIOS.

A Tip for ISA Motherboards With "Extended Chipset" Setup

If you are using a motherboard based on the Chips & Technology 3 chip LSI chips, the newer OPTI chips or other programmable chipset, congratulations! The speed of your RAM and I/O channel can be altered to increase overall system performance by "fine tuning" your motherboard. You can select I/O clock speed and wait states by running the extended setup program that came with your motherboard and using the information in Table A. Be careful when setting I/O channel wait states on these motherboards. It is easy to outrun many controller boards by selecting SYSCLOCK/2 without wait states.

$\frac{\text{SYSCLOCK}}{\text{N}}$	I/O Channel Read/Write Wait States	16-Bit Bus Wait States
Over 8 MHz	1 wait state	2 wait states
8 MHz or less	0 wait states	1 to 2 wait states

Table A *- Recommended C & T, OPTI and ETQ Wait States*

Once your controller is jumpered correctly, proceed to CMOS setup and then low-level format. See the following section that corresponds to your drive type for set-up and low-level formatting instructions.

Note: SYSCLOCK is the CPU clock frequency of your motherboard. Use extended setup to choose between

$\frac{\text{SYSCLOCK}}{3}$, $\frac{\text{SYSCLOCK}}{4}$, or $\frac{\text{SYSCLOCK}}{5,6,\text{etc.}}$

to adjust your bus clock frequency.

For example, a system clock of 50MHz and an extended setting of:

$\frac{\text{SYSCLOCK}}{5}$

will provide a bus clock speed of

$\frac{50}{5} = 10$ MHz.

Most Floppy Controllers will work at bus speeds up to about 10MHz. Many Hard Drive Controllers may not operate reliably much over 10 MHz. These estimates include 2 wait states. Note that I/O operations on the PC bus have one extra wait state when compared to memory operations. This is why memory mapped cards generally transfer data faster than I/O mapped cards.

Your C&T or OPTI motherboard extended setup may also permit disabling the ISA bus REFRESH line. REFRESH is a signal necessary for proper operation if your system contains any expansion cards that use dynamic memory. Cards which require this signal include: EMS cards, laser printer direct video boards, caching controller cards, and several other peripherals. Disabling this line will improve bus throughput by between 1% and 3%. Go ahead and disable it if you need this small performance increase, but be warned of compatibility problems down the road.

Drive Setup and Jumpering

Typical IDE Drive Installation

CSC's technical support department is constantly asked: "What drive parameters should I use to install my IDE drive?" All modern IDE drives use what is called "automatic translation". This translation helps the drive to match itself to the parameters you choose. For example, a 80-megabyte drive might have 6 heads, 17 sectors per track, and 1230 cylinders. This same drive could be installed using a CMOS configuration of 12 heads, 17 sectors per track and 615 cylinders. Doubling the number of heads and halving the number of cylinders has no effect on the formatted capacity of the drive. The drive automatically translates the "logical parameter" of cylinder 0 head 6, sector 17 into the "physical" parameter of cylinder 1, head 3, sector 17. In fact, for DOS to access the full capacity of a drive, it should be set-up with a configuration of 1024 cylinders or less.

The system BIOS informs the imbedded drive controller of the CMOS settings on power up, and the drive then mimics this logical configuration.

This means you can choose any parameters for an IDE drive as long as the CMOS settings do not exceed the physical capacity of the drive. There are also a few other practical limitations to the logical parameters you choose. For reasons described in the next few chapters, the maximum number of cylinders you should use is 1024. The maximum number of sectors per track is limited to 63, and the number of heads should not exceed 64.

To select drive parameters for any IDE drive in the drive list, simply choose a CMOS type with a formatted capacity less than or equal to the drive you are using. If you are using a system with a "user definable" drive type, enter the physical parameters of the drive from the drive list. If the physical parameters exceed 1024 cylinders, double the number of heads and halve the number of cylinders.

HOT TIP

If you have a copy of CSC's IDSCAN software, ignore the drive tables and just boot from floppy. Run IDSCAN and we'll take care of setting CMOS for you.

Some newer system board BIOS ROM's have ID Scan programs built in! Selecting the correct CMOS configuration parameters may be as easy as running the "automatic configuration" utility in your ROM BIOS setup program!

Once you CMOS is set correctly, proceed to the DOS partitioning and high-level format instructions in the following chapters. If you are using the drive for Novell, a Compsurf may be necessary. Low-level formatting is not required or recommended for any IDE drive.

IDE Drive Jumpering

Most IDE drives have one or more of the following jumpers:

HOST SLV/ACT, C/D, DSP, and ACT.

HSP, when jumpered, grounds the HOST/SLAVE/ACTIVE signal on the IDE interface. This signals the system that a slave drive is present in a two drive system. You need to add this jumper only if you have two IDE drives installed.

C/D is also sometimes labeled DS and is the drive select jumper. This jumper is set on the master (i.e. C:) drive and removed on the slave (i.e. D:) drive.

DSP should only be jumpered on the first drive (i.e. C:) if two IDE drives are installed in the same system. This jumper tells the master (i.e. C:) drive that there is another drive present on the IDE cable.

The ACT jumper connects the -ACTIVE signal to the -HOST SLV/ACT signal on the interface. This signal is used to drive an external LED which indicates drive activity. If the hard drive activity LED doesn't work on your system, chances are you need to add an ACT jumper.

DS0 or DS1 Confusion

Drive select jumpers are often a source of confusion and frustration. It seems that some manufacturers label their four drive-select jumpers DS0, DS1, DS2, and DS3. Others label them DS1, DS2, DS3, and DS4. We will use the more common convention DS0, DS1, DS2, and DS3 throughout this manual.

MFM, RLL, and ESDI Drive Jumpering

If you are installing a single MFM, RLL, or ESDI drive in your system, choose DS0 if your jumpers start with DS0 or choose DS1 if your jumpers start with DS1. These are actually the same jumpers, just numbered differently by the drive manufacturer. What you need in a single drive MFM/RLL installation is the first available drive-select jumper.

If you are installing a second MFM or RLL drive in your system with a twisted cable, choose DS1 if your jumpers start with DS0 or choose DS2 if your jumpers start with DS1. What you really want in this case is the second drive select jumper.

Always connect drive C: to the last connector (after the twist). Connect D: to the middle connector (before the twist).

If your drives have select pins numbered:	And you are installing:		
	1 Drive with a flat cable	2 Drives with a twisted cable	2 Drives with a flat cable
DS0 to DS3	Set C: to DS0	Set C: to DS1 Set D: to DS1	Set C: to DS0 Set D: to DS1
DS1 to DS4	Set C: to DS1	Set C: to DS2 Set D: to DS2	Set C: to DS1 Set D: to DS2

Table B *- MFM, RLL, and ESDI Drive Jumpering*

SCSI Drive Jumpering

SCSI drive jumpering is an altogether different story. SCSI drives usually use three jumpers for addressing. The eight possible on/off configurations of these jumpers represent eight SCSI addresses. Normally these jumpers follow a straight-forward binary sequence with the lowest numbered jumper being the LSB. Check your drive manual or the Connector Pinout section to be sure before jumpering your SCSI drive.

SCSI drives usually have a jumper which selects the source of terminator power. This jumper is important if your controller or system does not supply terminator power. In this case, you will need to jumper the drive so that terminator power is supplied from the drive.

Many SCSI drives also have a jumper for power up spin. This jumper is changed to permit the system to control spin-up of the drive. Many Seagate and Maxtor drives also have jumpers which permit spin up delays based on the SCSI ID jumper. Since each drive has a different SCSI ID, this means that each drive will spin up at a different time. This option is provided because the power requirements are much higher during spin-up than it is when the drive is running. Many disk arrays and large systems with multiple drives are set up to take advantage of this option. Longer power supply life is the result.

If you have an Adaptec™ controller, you will need to set your boot drive to ID 0. Your second drive should be set to ID 1. If you want to use more than two drives under DOS, you will need to load ASPI4DOS.SYS and ASPIDISK in your CONFIG.SYS file. ASPIDISK will also be necessary if you are running any protected mode software. The driver installation process with these cards can become quite involved.

If you are using a CSC FastCache™, you will need to run FCSETUP when you first install your hard drive or when you make any changes to your SCSI hardware configuration. Once you have run the setup program, NO DRIVERS will be necessary for running up to 7 SCSI hard drives under DOS. Erasable optical drives can also be run without drivers. No changes to your CONFIG.SYS are necessary, and you can set the card to boot from any ID. Also, no drivers are needed for protected mode programs (like Windows™ in 386 Enhanced Mode). Just add an exclude statement to your memory manager so that the memory range of the FastCache is left unchanged. Nice, huh?

Most other SCSI controllers such as the CSC AK-47™ VESA SCSI-II board will scan the SCSI bus each time the system is powered up, adding support for the extended drives at that time.

Drive Cabling

IDE Drive Cabling

IDE (Imbedded Drive Electronics) interface disk drives use a 40-pin interface cable. This cable connects the drive logic (with imbedded controller) to a bus adapter card. This adapter is usually called a "paddle board". The paddle board buffers (amplifies) the signals from the drive and provides enough power to drive the PC bus.

Cabling an IDE drive is simple. Connect a 40-pin flat cable from the drive to the controller, being careful to observe pin 1 orientation. If the drive supports it, a second IDE drive can usually be connected to the same cable. To do so, jumper the boot drive in "master" mode, and jumper the second drive as a "slave" as described in the Drive Setup & Jumpering section. Since the IDE interface transfers data and control signals at full bus speed, IDE cable lengths are critical. As a rule of thumb, try to avoid using a cable longer than 18" in any IDE drive installation.

What Are These Twisted Cables?

Why do many drive installations use twisted cables? Simply because IBM used them in the first PC's. In an effort to simplify installation, IBM decided to jumper all of their hard and floppy drives on the second drive select. This eliminated the need for technicians to jumper the drives. The first floppy drive (A:) was connected to the end of the cable (after the twist). The second floppy drive (B:) was connected before the twist. The twist in the cable simply flipped the first and second drive select lines so that all drives could be jumpered identically.

The floppy and hard drive cables in a standard AT look suspiciously similar. Be careful not to interchange them. A significant number of installation problems are a result of interchanged hard and floppy cables. Each cable has a different twist, and they are often not marked. If you are using twisted cables, make sure the floppy drive cable has seven conductors twisted. A twisted cable used with MFM or RLL hard drives must have only five conductors in the twist. See the cable chart at the end of this section.

Single Drives (MFM, RLL or ESDI) Cables

Cabling a single drive MFM, RLL, or ESDI system is easy. Use a standard 20-pin flat data cable and a 34-pin control cable with no twist. A word of caution: watch out for pin one. Pin one is identified by a red stripe on one side of the cable. This side of the cable must be connected closest to pin one of both the drive and controller. Check the controller card for a small number 1 or a square dot on the silk screen near one edge of the connector. Pin 1 on the drive is nearest a notch in the edge connector. Reversing the data cable can cause damage to the drive, controller, or both. The differential line drivers on the drive and controller are easily damaged by reversed cables. If you are not sure which is pin 1, check the manual, don't try to guess!

Multi Drive MFM and RLL Cabling

Three cables are required when installing two MFM or RLL drives using one controller. Two flat 20-pin data cables and one twisted 34-pin cable will be necessary. The 34-pin control cable should have only the drive select and ground pins twisted (5 conductors twisted). Set both drives to the second drive select position (This position is marked DS1 or DS2 as described in the Drive Setup & Jumpering section). Terminate the control cable on the last drive only.

Termination

In MFM, RLL, and ESDI installations, terminating resistors for the control signals should be installed only in the drive located at the physical end of the control cable. Terminating resistors should be installed at the end of every data cable in these installations. Since most drives come from the factory with terminators installed, you will need to remove terminators in a dual drive installation. See the SCSI installation section for more information on SCSI termination.

Multi Drive ESDI Cabling

Three cables are required when installing two ESDI drives using one controller. Two flat 20-pin data cables and one flat 34-pin cable with two drive connectors are necessary. Set the first ESDI drive jumpers to drive select 0. Set the second drive to drive select 1. Terminate the control cable on the last drive only.

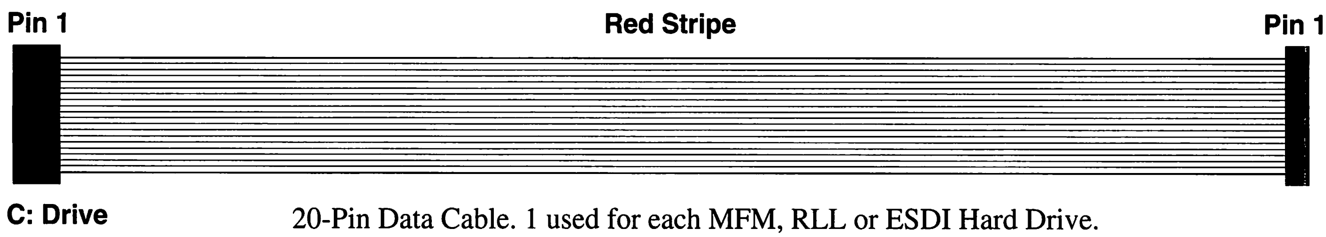
A flat cable is required for applications with more than two ESDI drives. If only two drives will be installed. ESDI drives may also be cabled with a twisted 34-pin cable in a manner identical to MFM cabling.

Although most ESDI controllers support only two drives, the ESDI interface provides the ability to daisy-chain up to 8 drives. If you are installing more than two ESDI drives, use a flat 34-pin cable and set the select jumpers sequentially. A separate 20-pin data cable is required for each drive.

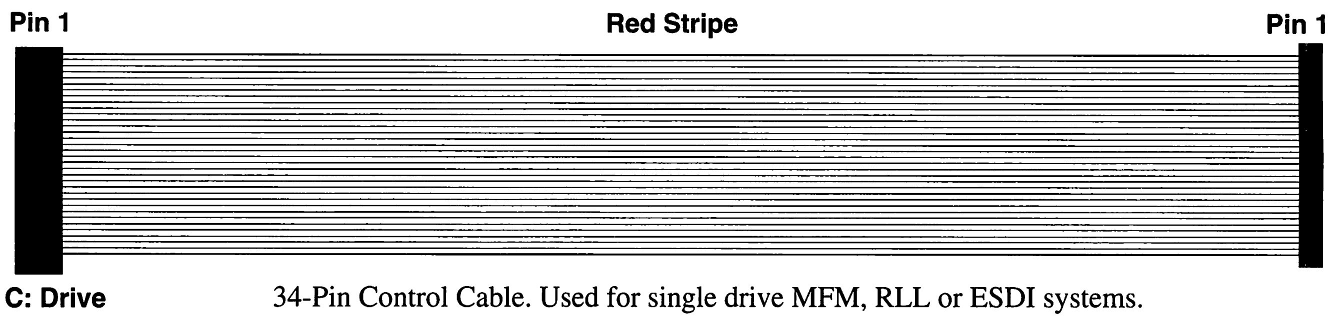
SCSI Drive Cabling

Internal SCSI drives are connected to the controller with a 50-pin ribbon cable. Be extremely careful to observe the pin 1 location when connecting cables to SCSI drives. Reversing SCSI cables on drives often causes a loss of termination power which can result in marginal data transfer or no transfer at all. Some external SCSI drives are connected to the controller with a 25-pin D-type connector, others use a 50-pin Amphenol connector.

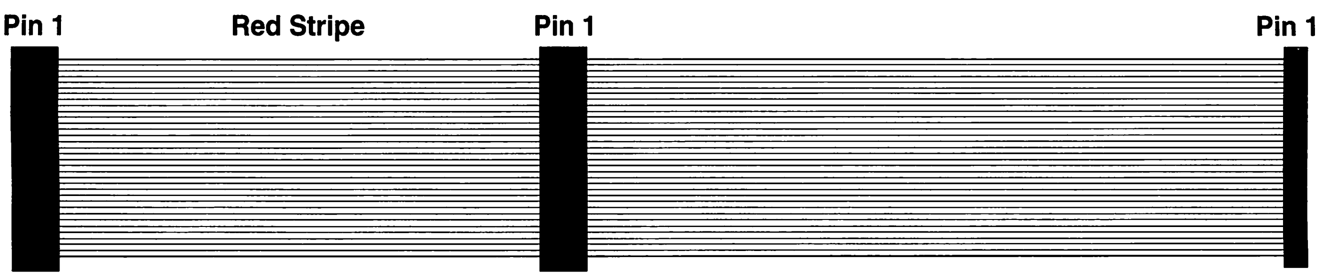
The SCSI bus must have a total of 2 terminators - no more and no less. If you are using the controller with one internal hard disk, for example, termination will be installed on the internal hard drive and on the controller card. If you are installing one internal and one external drive, the terminators must be removed from the controller card and installed on the internal and external drives. Check the manual included with your SCSI drives and controller board for terminator installation and removal.



20-Pin Data Cable. 1 used for each MFM, RLL or ESDI Hard Drive.



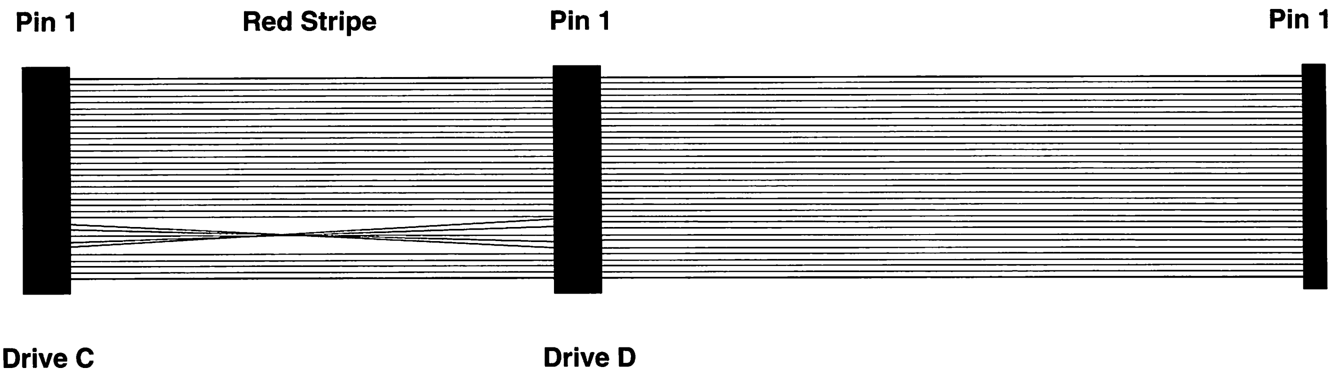
34-Pin Control Cable. Used for single drive MFM, RLL or ESDI systems.



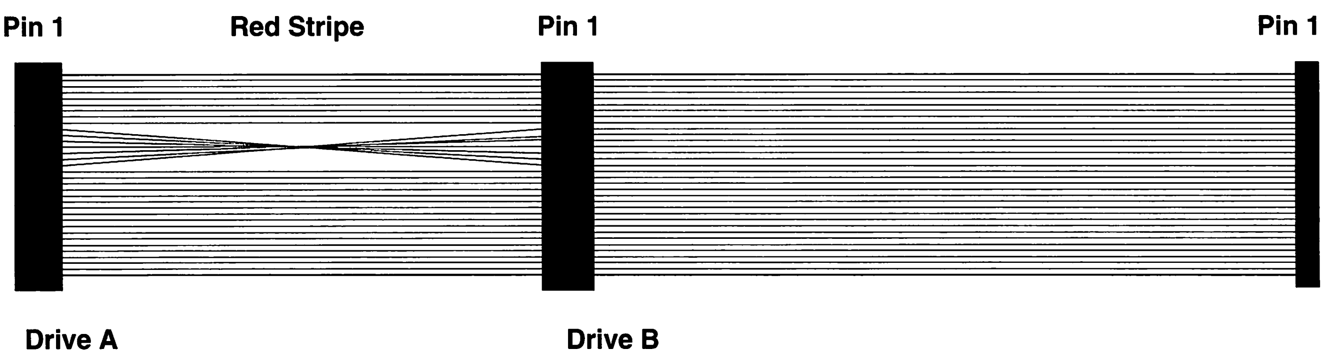
Dual Drive straight 34-Pin Control Cable. Used for MFM, RLL, or ESDI drives.

Note: *When using this cable with 2 drives, one must be set to Drive Select 0 and the other for Drive Select 1 (see Table B in previous chapter).*

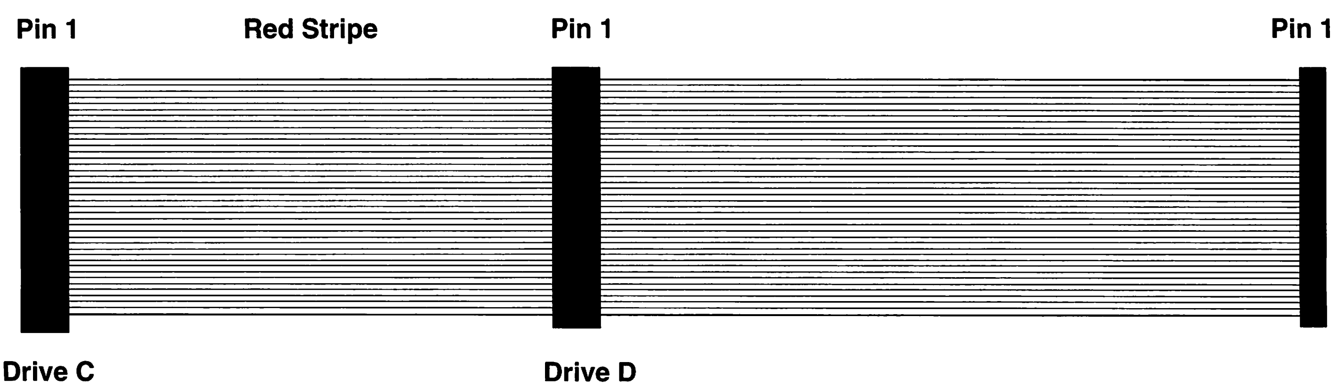
Figure 10a *- Drive Cables*



Dual Hard Drive twisted (5 wires) 34-Pin Control Cable. Used for MFM, RLL, and ESDI drives.
Note: *When using this cable with 2 drives, both drives must be set to Drive Select 1*



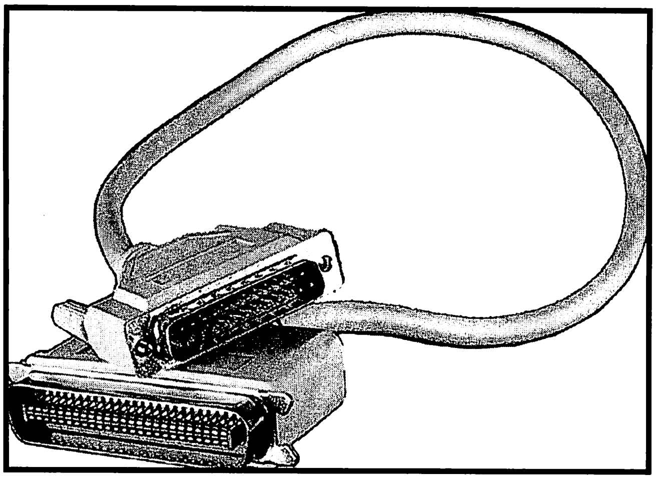
Dual Floppy Drive twisted (7 wires) 34-Pin Cable. Used for one or two Floppy Drives
Note: *Both floppy drives should be set to Drive Select 1.*



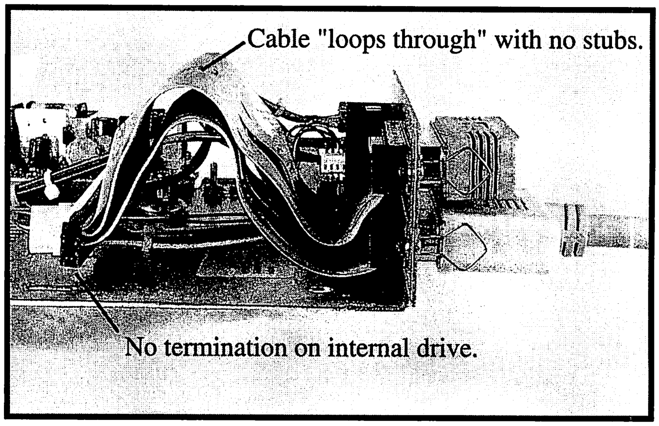
40-Pin IDE cable for one or two hard drives

Figure 10b *- Drive Cables (continued)*

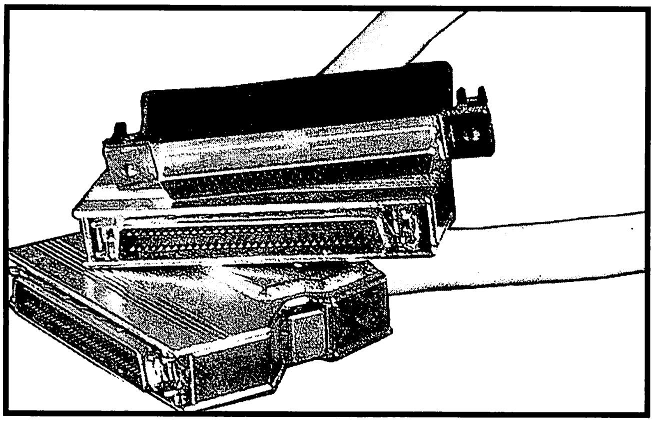
SCSI CABLE IDENTIFICATION



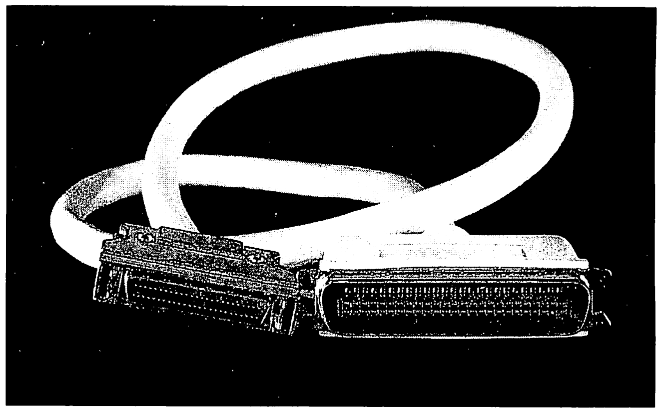
MAC Style DB-25 to Centronics Cable



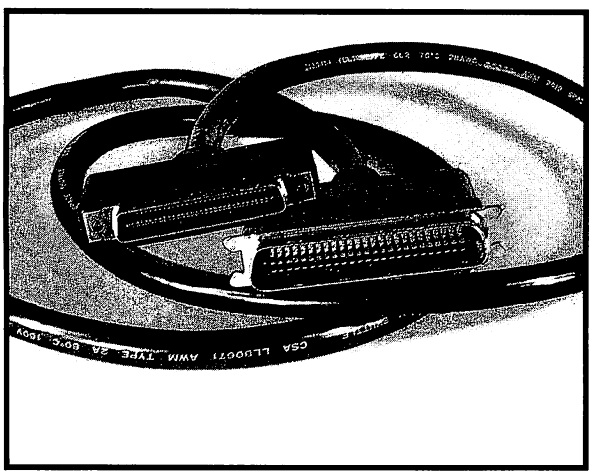
Correct Enclosure Cabling for External Drives



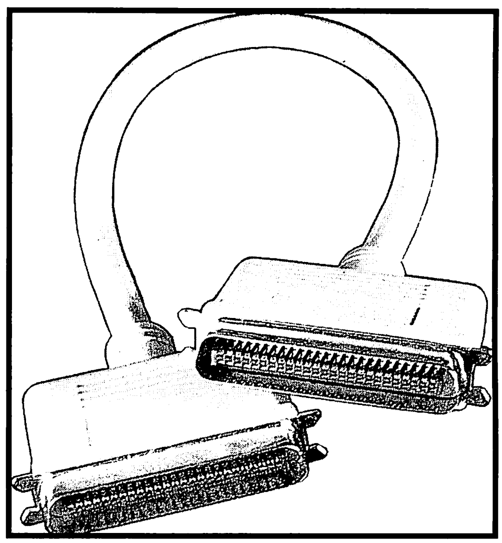
Wide SCSI Cable and Mating Connector



SCSI-II Amp Style to Centronics Cable



PS/2 to Centronics SCSI Cable



Centronics to Centronics SCSI Cable

Low-Level Formatting

Unlike floppy disks which are low-level formatted at the same time as they are high-level formatted, all hard disks are low-level formatted separately because of the differences in the various types and styles of controller cards, the encoding format and the interleave that can be used with a hard drive.

If you decide to use a different controller card, or to use a different interleave on the hard disk, it will have to be low-level formatted again. Once the low-level format is completed properly, it will not have to be done again unless the controller card is replaced, the interleave is changed, or there is a hard disk failure. Low-level formatting destroys all the data written on the hard disk. Be sure to back-up all data before a hard disk is low-level or high-level formatted.

What is DEBUG?

DEBUG is a program provided on the DOS disks (DEBUG.COM) that is primarily used by programmers, service technicians or computer hacker nerds. The operation of DEBUG is described in detail in the DOS manual. In order to use DEBUG for low-level formatting, only two commands are generally necessary, the G (GO) command, and the Q (QUIT) command. In the following paragraphs, commands such as G=C800:5 will be used to start the ROM based low-level formatting program stored on the hard drive controller.

To start the program, insert a disk containing the DEBUG.COM program into the floppy drive and type DEBUG at the DOS prompt. When the DEBUG prompt (-) is displayed type G= followed by the starting address of the ROM based program (G=C800:5) for example. This means go to ROM address C800:5 and run the program contained in the ROM. After the program is finished, it will usually return you to the DOS prompt (>). If the program returns you to the DEBUG prompt (-) type Q to quit DEBUG and return to the DOS prompt.

What is CSCFMT?

CSCFMT is a low-level format utility supplied on the enclosed diskette. CSCFMT works with all MFM and most RLL, ESDI, and IDE drives. Low-level formatting is the only way of changing the interleave of a hard drive. CSCFMT is useful if you are installing a hard drive for the first time, or if you need to change the interleave of an installed drive to optimize its performance. For most common DOS installations, CSCFMT is the only program you'll need in addition to DOS FDISK and FORMAT.

Warning: As with any low-level format,CSCFMT will destroy all existing data. Don't use CSCFMT unless you have a verified backup of all data.

To low-level format, just type CSCFMT at the DOS prompt. CSCFMT will ask for the interleave you wish to use. Check the interleave information section for the optimum value for your system configuration.

Choosing a Drive Type

Early IBM ATs only provided 14 (MFM) or so drive types to choose from in the CMOS. The Middle-aged AT's usually have up to 46 (based on the original MFM) types. If you are installing an IDE drive and you find a CMOS drive with a matching total drive capacity, go ahead and use it.

Most new machines have a "User Definable" or "Custom" drive type that can be created and saved in the CMOS, thus providing a standard drive type. "User Definable" drive types are used in most IDE drive installations.

IDE Drive Types

This idea of translation schemes bring us to the AT or IDE (Imbedded Drive Electronics) interface. These drives are intelligent in that they will "mimic" other drive geometries that equal or are very close to the same number of logical blocks. If a "custom" drive type option is not available for an AT drive, simply pick one from the list of available choices that has the same number of total megabytes.

NOTE: Translated LBA's are always less than or equal to Native LBA's.

WARNING! All IDE drives are already low-level formatted at the factory. Low-level formatting an IDE drive could erase the factory recorded defect tables. Defects on these drives are usually mapped out using a factory burn-in process, not through the interface.

MFM Drive Types

Unlike the newer IDE drives, MFM drive configurations must match the drive geometry **exactly!!** If the CMOS drive type table lists the exact geometry, great. If not, then check to see if a "Custom" or "User Definable" CMOS option is available.

The last resort is to choose a drive type match that is close but not exceeding either the cylinder or head values. This option will not usually provide the full formatted capacity of the drive. An exact match in the head count is definitely preferred when getting a "close" match. When there is no direct match in the internal drive type tables, a partitioning program may be needed to provide a software driven translation solution in order to achieve full capacity. Keep in mind that the drive will format out only to the capacity of the chosen drive type when not using third-party driver software. Also, some AT 16-bit MFM controllers provide an onboard BIOS which will allow the unique geometry of the drive to be dynamically configured.

RLL and ESDI Drive Types

RLL and ESDI drives are usually not represented at all in the internal drive tables, and consequently the controllers for these drives need onboard a ROM BIOS which either contains its own internal list of choices for the geometry or else provides the ability to dynamically configure (define) the controller to the specific geometry of the drive. In the case of the ESDI interface, the controller gets parameters directly from the drive with the equivalent of a SCSI "Mode Sense" command. Most RLL and ESDI controllers require that CMOS be set to "Type 1". This setting is then overwritten by the controller BIOS after power-up.

A special note on ESDI and other drives that have more than 1024 cylinders. Since DOS cannot access cylinders above this limit, a translation scheme may be elected in the controller's BIOS. As the total number of Logical Blocks Available (LBA's) is defined as CYLINDERS*HEADS*SECTORS PER TRACK, translations that equal the same number of logical blocks with the cylinder count below the 1024 limit will be devised. The controller BIOS will need to be ENABLED in order to utilize translation schemes.

SCSI Drive Types

Almost all SCSI drives use DRIVE TYPE 0 or NONE, as the host adapter BIOS and the drive communicate together to establish the drive geometry. The SCSI controller "Scans" the SCSI bus shortly after power-up and installs BIOS support for any attached SCSI devices.

Formatting MFM Drives

The first step in a low-level format of an MFM drive is correct CMOS setup. Check the drive geometry list for the heads and cylinders configuration of your drive. Then check your motherboard manual (or ROM based setup program) for a CMOS drive type that matches your drive geometry. If you find an exact match, set the CMOS to that drive type number and skip the next paragraph.

Table Overrides

If your drive geometry does not match a CMOS drive type, you will need to perform a CMOS type table override. Use Speedstor or Disk Manager software to do this. These programs add a software device driver to the drive that overrides the CMOS drive type settings on power-up, enabling you to use a drive not listed in your setup program.

Check the Tune-Up section for the correct default interleave for your system, then low-level format the drive. If you have a late AMI BIOS, you may have low-level formatting routines built in ROM. If not, use either the setup disk that came with your computer, CSCFMT, IBM Diagnostics, Speedstor, or Disk Manager to low-level format.

Once the drive is low-level formatted, proceed to the partitioning and high level formatting instructions in the following sections.

Formatting RLL Drives

Most 16-bit and all of the 8-bit RLL controllers we have found have low-level formatting routines in ROM firmware on the board. The default address segment for XT controller boards is C800 hex. To find the starting address, enter DEBUG and type U C800:3. The jump instruction is usually found at C800:5 or C800:6. The first two bytes of the ROM are a 55 and AA hex which identify the BIOS ROM. The third byte represents the length of the BIOS ROM in 512 byte blocks.

To format the drive, first select the correct CMOS setup. Consult the manual that came with your RLL controller for the correct setup value.

After setting CMOS, proceed to the low-level format. If you have a ROM based low-level formatting routine available, use it. Otherwise, use CSCFMT, Speedstor, or Disk Manager. Be sure to use the /SECS:26 option if you are using Speedstor.

When formatting lower capacity (i.e. 30MB) RLL drives, be sure to enter the write precompensation cylinder correctly. Write precomp is important to these drives, since RLL encoding leaves less margin for error. Write precomp is handled automatically on almost all newer drives.

Once the drive is low-level formatted, proceed to the partitioning and high-level formatting procedures described in the following sections.

Formatting ESDI Drives

All of the PC-bus ESDI controllers we have come across have low-level formatting routines in ROM firmware. The formatting procedures for these drives vary from controller to controller, so the best advice we can give you here is follow the instructions that came with the card.

In addition to the interleave, you may be asked if you want to use sector sparing when you format. Sector sparing reduces the number of available sectors per track from 36 to 35 or from 54 to 53. This will reduce the available formatted capacity of your drive. Choose sector sparing only if your drive has a large defect map. Sector sparing will allow the controller to remap defective sectors to the spare sector on each track. This means that your application will “see” less defects. Sparing will reduce the capacity of your drive by 1/36th. If your drive has a small error map, sector sparing won’t gain you much. If you are running an application that requires a "Defect Free" drive, enable sector sparing to "Hide" the drive's defects.

Many ESDI controllers may also ask you for head and track sector skewing values. These values offset the position of sectors relative to the index so that as the drive steps from track to track and changes from head to head, the next sequential sector is immediately available. To calculate the optimum track skewing value, divide the track-to-track seek time of your drive by 16.6ms. Then multiply this number by the number of sectors per track (rounding up). This will give you the optimum track skewing value. Select 0 when asked for head skew.

You may notice that your large capacity ESDI drive contains a large number of factory defects. Don't sweat it. These defects are mapped by a factory analog tester that is extremely sensitive compared to your controller. Most of these defects could never be detected using your controller. They are usually just small analog spikes or dropouts that are corrected by the ECC on your controller. The factory maps these defects because they are the most likely areas to cause problems as the drive wears over time.

Once your ESDI drive is low-level formatted, proceed to the partitioning and high-level formatting procedures in the following sections.

Formatting SCSI Drives

Most SCSI controllers require that the CMOS setup on X86 machines be set for “no drive installed”. On power up, the SCSI BIOS on the adapter card scans the SCSI bus to detect attached devices. Once detected, these devices are added to the list of available drives. Most SCSI controllers support up to seven SCSI devices. More than two drives usually require third party device driver for use with DOS versions before 5.0.

Almost every SCSI controller includes a low-level format program that is specific to that particular board. The low-level format routines in programs like Speedstor and Disk Manager don’t usually work well with SCSI controllers. This is because the controller card BIOS does not translate an interrupt-13h format command into a SCSI format command. In this case, you’ll most likely need to use the low-level format program that came with the card.

Once the low-level format is completed, FDISK, Speedstor, or Disk Manager can be used for partitioning and high-level formatting.

NOTE: Several SCSI drives including some made by Quantum will return almost immediately from a SCSI low-level FORMAT command. These drives report that they have successfully completed a low-level format but don't actually format the disk. A SCSI FORMAT (04h) command does not erase data on all drives. In many cases, data written to the disk is not erased until it is overwritten with a WRITE command.

Low Level Formatting IDE Drives

Most IDE drives operate in two modes, “native” and "translation". To use an IDE drive in native mode, set CMOS to the actual number of heads and cylinders on the drive, then proceed to partitioning and high-level format.

If the IDE drive you are using has physical characteristics (i.e. heads, cylinders, and sectors/track) which are not listed in your ROM BIOS, and you do not have a BIOS which offers a user defined drive type, you will need to use translation mode. Translation mode remaps the drive’s physical characteristics into characteristics that match a common drive type. For example, most 40MB IDE drives offer a translation mode that matches the physical characteristics of the early Seagate 251. Since this type is included in almost all ROM BIOS drive type tables, compatibility is improved.

Most new IDE drives automatically enable translation mode based on CMOS settings. Select a drive type that is close to but does not exceed the megabyte capacity of the drive. The drive will translate to the megabyte capacity you have selected. Some older type IDE drives require a jumper. Like SCSI drives, all IDE drives are low-level formatted at the factory.

***Caution:** Unless you need to change interleaves, we don't recommend reformatting your IDE drive. Imbedded factory defect maps on older drives could be accidentally erased by low-level formatting.*

Once CMOS and translation mode is set correctly, FDISK, Speedstor, or Disk Manager may be used for partitioning and high-level formatting.

SCSI Command Reference

When we asked CSC customers what they wanted added to The Hard Drive Bible, the answer was unanimous. You asked for a complete SCSI command set specification. Although printing the entire ANSI specification is beyond the scope of this book, this chapter describes the most common SCSI commands and their command blocks.

The following commands are supported by nearly all SCSI drives:

COMMAND	OP CODE (HEX)
FORMAT UNIT	04
INQUIRY	12
MODE SELECT	15
MODE SENSE	1A
READ	08*
READ CAPACITY	25
READ EXTENDED	28*
READ LONG	3E*
REASSIGN BLOCKS	07
RELEASE	17
REQUEST SENSE	03
REZERO UNIT	01
SEEK	0B
SEEK EXTENDED	2B
START DIAGNOSTICS	1D
START/STOP UNIT	1B
TEST UNIT READY	00
VERIFY	2F
WRITE	0A*
WRITE EXTENDED	2A*
WRITE LONG	3F*

* Note: 99% of the active time on the SCSI bus is spent executing these commands. Most average systems execute 8 or more read commands for each write command.

Format Unit

The **FORMAT UNIT** command ensures that the media is formatted so that all initiator addressable data blocks can be addressed. The medium will be certified and control structures will be created for the management of the medium and defects.

Note that successful completion of a FORMAT UNIT command does not necessarily mean that data has been erased.

BIT / BYTE	7	6	5	4	3	2	1	0
0	Operation Code 04 H							
1	LUN			FmtDat	CmpLst	Defect List Format		
2	Reserved							
3	Interleave (MSB)							
4	Interleave (LSB)							
5	VU		Reserved				Flag	Link

Inquiry

. The **INQUIRY** command requests that information regarding parameters of the target to be sent to the initiator.

BIT / BYTE	7	6	5	4	3	2	1	0
0	Operation Code 12 H							
1	LUN			Reserved				
2	Reserved							
3	Reserved							
4	Allocation Length							
5	VU		Reserved				Flag	Link

Mode Select

The **MODE SELECT** command provides a means for the initiator to change the drive's operating parameters.

BIT / BYTE	7	6	5	4	3	2	1	0
0	Operation Code 15_H							
1	LUN			Reserved				SP
2	Reserved							
3	Reserved							
4	Parameter List Length							
5	VU		Reserved				Flag	Link

Mode Sense

The **MODE SENSE** command provides a means for the drive to report its medium or peripheral to the initiator. This command is a complementary command to the MODE SELECT command.

BIT / BYTE	7	6	5	4	3	2	1	0
0	Operation Code $1A_H$							
1	LUN			Reserved				
2	PCF		Page Code					
3	Reserved							
4	Allocation Length							
5	VU		Reserved				Flag	Link

Read

The **READ** command requests that the drive transfer data to the initiator.

Bit/Byte Definition:

Logical Block Address - Specifies the logical block where the read operation will begin.

Transfer Length - Specifies the number of contiguous logical blocks of data to transfer. A transfer length of zero indicates that 256 logical blocks will be transferred. Any other value indicates the number of logical blocks that will be transferred.

BIT / BYTE	7	6	5	4	3	2	1	0
0	Operation Code 08_H							
1	LUN			Logic Block Address (MSB)				
2	Logic Block Address							
3	Logic Block Address (LSB)							
4	Transfer Length							
5	VU		Reserved				Flag	Link

Read Capacity

The **READ CAPACITY** command provides a means for the initiator to request information regarding the capacity of the drive.

BIT / BYTE	7	6	5	4	3	2	1	0
0	Operatin Code 25_H							
1	LUN			Reserved				RelAdr
2	Logical Block Address (MSB)							
3	Logical Block Address							
4	Logical Block Address							
5	Logical Block Address (LSB)							
6	Reserved							
7	Reserved							
8	VU		Reserved					PMI
9	VU		Reserved				Flag	Link

Read Extended

The **READ EXTENDED** command requests that the drive transfer data to the initiator.

Bit/Byte Definition:

Logical Block Address - Specifies the logical block where the read operation will begin.

Transfer Length - Specifies the number of contiguous logical blocks of data to transfer. A transfer length of zero indicates that 256 logical blocks will be transferred. Any other value indicates the number of logical blocks that will be transferred.

BIT / BYTE	7	6	5	4	3	2	1	0
0	Operation Code 12_H							
1	LUN			Reserved				RelAdr
2	Logical Block Address (MSB)							
3	Logical Block Address							
4	Logical Block Address							
5	Logical Block Address (LSB)							
6	Reserved							
7	Transfer Length (MSB)							
8	Transfer Length (LSB)							
9	VU		Reserved				Flag	Link

Read Long

The **READ LONG** command will transfer the specified sector of data and ECC bytes to the initiator. The drive will not correct the data field or the ECC bytes. This command is intended for diagnostic purposes.

The number of bytes transferred to the initiator wil be the sector size plus the mnumber of bytes contained in the ECC field.

BIT / BYTE	7	6	5	4	3	2	1	0
0	Operation Code $3E_H$							
1	LUN			Reserved				RelAdr
2	Logical Block Address (MSB)							
3	Logical Block Address							
4	Logical Block Address							
5	Logical Block Address (LSB)							
6	Reserved							
7	Reserved							
8	01_H							
9	VU		Reserved				Flag	Link

Reassign Blocks

The **REASSIGN BLOCKS** command requests the drive to reassign the defective logical blocks to an area on the drive's medium reserved for this purpose

The initiator transfers a defect list that contains the logical block addresses to be reassigned. The drive will reassign the physical medium used for each logical block address in the list. The data contained in the logical blocks specified in the defect list may be altered, but the data in all other logical blocks on the medium will be preserved.

Specifying a logical block to be reassigned that was previously reassigned will cause that block to be reassigned again. Thus, over the life of the medium, a logical block can be assigned to a multiple physical addresses until no more spare locations remain.

BIT / BYTE	7	6	5	4	3	2	1	0
0	Operation Code 07_H							
1	LUN			Reserved				
2	Reserved							
3	Reserved							
4	Reserved							
5	VU		Reserved				Flag	Link

Reassign Blocks Defect List

The **REASSIGN BLOCKS** defect list contains a four byte header followed by one or more defect descriptors. The length of each defect descriptor is four bytes.

Defect List Length: Specifies the total length in bytes of the defect descriptors that follow. The defect list length is equal to four times the number of defect descriptors.

The defect descriptor specifies a four byte defect logical block address that contains the defect. The defect descriptors must be in ascending order.

If the drive has insuffilcient capacity to reassign all of the defective logical blocks, the command will terminate with a CHECK CONDITION status and the sense key set to MEDIUM ERROR. The logical block address of the first logical block not reassigned will be returned in the information bytes of the sense data.

REASSIGN BLOCKS Defect List

BYTE	Defect List Header
0	Reserved
1	Reserved
2	Defect List Length (MSB)
3	Defect List Length (LSB)

BYTE	Defect Descriptor(s)
0	Defect Logical Block Address (MSB)
1	Defect Logical Block Address
2	Defect Logical Block Address
3	Defect Logical Block Address (LSB)

Release

The **RELEASE** command is used to release a previously reserved drive. It is not an error for an initiator to attempt to release a reservation that is not currently active.

BIT / BYTE	7	6	5	4	3	2	1	0
0	Operation Code 17_H							
1	LUN			3rd Pty	Third Party Device ID			Extent
2	Reservation Identification							
3	Reserved							
4	Reserved							
5	VU		Reserved				Flag	Link

Requests Sense

The **REQUESTS SENSE** command requests that the target transfer sense data to the initiator.

The sense data is valid for a CHECK CONDITION status returned on a prior command. The sense data is preserved by the drive for the initiator receiving the CHECK CONDITION status until a REQUEST SENSE command or any other is issued to the drive. Sense data will be cleared upon receipt of any subsequent command to the drive from the initiator receiving the CHECK CONDITION.

The REQUEST SENSE command will return the CHECK CONDITION status only to report fatal errors for this command. For example.

* The target receives a non-zero reserved bit in the command descriptor block.
* An unrecovered parity error occurs on the data bus.
* A target malfunction prevents the return of sense data.

BIT / BYTE	7	6	5	4	3	2	1	0
0	Operation Code 03_H							
1	LUN			Reserved				
2	Reserved							
3	Reserved							
4	Allocation Length							
5	VU		Reserved				Flag	Link

Rezero Unit

The **REZERO UNIT** command requests that the drive position the actuator to cylinder zero.

BIT / BYTE	7	6	5	4	3	2	1	0
0	Operation Code 01_H							
1	LUN			Reserved				
2	Reserved							
3	Reserved							
4	Reserved							
5	VU		Reserved				Flag	Link

Seek

The **SEEK** command requests that the drive position itself to the specified logical block.

BIT / BYTE	7	6	5	4	3	2	1	0
0	Operation Code $0B_H$							
1	LUN			Logical Block Address (MSB)				
2	Logical Block Address							
3	Logical Block Address (LSB)							
4	Reserved							
5	VU		Reserved				Flag	Link

Seek Extended

The **SEEK EXTENDED** command requests that the drive position itself to the specified logical block.

BIT / BYTE	7	6	5	4	3	2	1	0
0	Operation Code $2B_H$							
1	LUN			Reserved				
2	Logical Block Address (MSB)							
3	Logical Block Address							
4	Logical Block Address							
5	Logical Block Address (LSB)							
6	Reserved							
7	Reserved							
8	Reserved							
9	VU		Reserved				Flag	Link

Send Diagnostic

The **SEND DIAGNOSTIC** command requests that the drive perform diagnostic tests on itself. There are no additional parameters for this command.

BIT / BYTE	7	6	5	4	3	2	1	0
0	Operation Code $1D_H$							
1	LUN			Reserved		Slf Test	Dev of 1	Unit of 1
2	Reserved							
3	Parameter List Length (MSB)							
4	Parameter List Length (LSB)							
5	VU		Reserved				Flag	Link

Start/Stop Unit

The **START/STOP UNIT** command requests that the drive either start the spin motor and position the read/write heads to cylinder zero or stop the spin motor and position the read/write heads in the landing zone.

BIT / BYTE	7	6	5	4	3	2	1	0
0	Operation Code $1B_H$							
1	LUN			Reserved				Immed
2	Reserved							
3	Reserved							
4	Reserved							Start
5	VU		Reserved				Flag	Link

Test Unit Ready

The **TEST UNIT READY** command provides a means to check if the drive is ready. This is not a request for a self-test. If the drive will accept a medium-access command without returning a CHECK CONDITION status then this command will return a GOOD status.

BIT / BYTE	7	6	5	4	3	2	1	0
0	Operation Code 00_H							
1	LUN			Reserved				
2	Reserved							
3	Reserved							
4	Reserved							
5	VU		Reserved				Flag	Link

Verify

The **VERIFY** command requests that the drive verify the data on the medium.

BIT / BYTE	7	6	5	4	3	2	1	0
0	Operation Code $2F_H$							
1	LUN			Reserved			BytChk	RelAdr
2	Logical Block Address (MSB)							
3	Logical Block Address							
4	Logical Block Address							
5	Logical Block Address (LSB)							
6	Reserved							
7	Verification Length (MSB)							
8	Verification Length (LSB)							
9	VU		Reserved				Flag	Link

Write

The **WRITE** command requests that the drive write the data transferred by the initiator to the medium.

BIT / BYTE	7	6	5	4	3	2	1	0
0	Operation Code $0A_H$							
1	LUN			Logical Block Address (MSB)				
2	Logical Block Address							
3	Logical Block Address (LSB)							
4	Transfer Length							
5	VU		Reserved				Flag	Link

Write Extended

The **WRITE EXTENDED** command requests that the drive write the data transferred by the initiator to the medium.

BIT / BYTE	7	6	5	4	3	2	1	0
0	Operation Code $2A_H$							
1	LUN			Reserved				RelAdr
2	Logical Block Address (MSB)							
3	Logical Block Address							
4	Logical Block Address							
5	Logical Block Address (LSB)							
6	Reserved							
7	Transfer Length (MSB)							
8	Transfer Length (LSB)							
9	VU		Reserved				Flag	Link

Write Long

The **WRITE LONG** command will transfer a sector of data and ECC bytes to the drive. The bytes transferred to the drive are written in the data field and the ECC bytes for the particular sector specified in the logical block address. This command is intended for diagnostic purposes.

The number of bytes transferred to the drive will be the sector size plus the number of bytes contained in the ECC field.

BIT / BYTE	7	6	5	4	3	2	1	0
0	Operation Code $3F_H$							
1	LUN			Reserved				RelAdr
2	Logical Block Address (MSB)							
3	Logical Block Address							
4	Logical Block Address							
5	Logical Block Address (LSB)							
6	Reserved							
7	Reserved							
8	01_H							
9	VU		Reserved				Flag	Link

DOS Partitioning

DOS partitioning and high-level formatting can be tricky. This may be done using DOS FORMAT and FDISK or using a third-party program such as SpeedStor or Disk Manager. Although these menu driven programs are convenient, DOS and its included utilities are all that's necessary. It's important to understand the following DOS partition constraints before beginning.

Old DOS Limitations

Versions of MS DOS and PC DOS before 3.30 have a 32MB storage limitation. There is no way to access over 32MB per physical drive without a device driver, if you are using an old version of DOS. If you are stuck with DOS 3.2 or earlier, you will need SpeedStor or Disk Manager to fully utilize a drive larger than 32MB. The best solution is to upgrade to 3.30 or later version.

The 32MB Barrier

Versions of MS DOS and PC DOS after 3.30 but before 4.0 have a 32MB per partition barrier. Using these DOS versions, you cannot access more than 32MB per logical partition without using a third-party device driver. Both Speedstor and Disk Manager provide a device driver which can be installed in your CONFIG.SYS to bypass this limitation. We recommend use of DOS 4.01 or later if you desire more than 32MB per partition.

The 1024 Cylinder Barrier

All versions of DOS have a 1024 cylinder limitation. This is becoming more and more of a problem as larger capacity drives are introduced with more cylinders. To access more than 1024 cylinders, you will need a device driver or a controller card that offers a "translate mode". Some ESDI and most SCSI controllers (like the CSC FlashCache™64) offer translation mode.

Controllers which feature a translation mode will logically remap a drive's physical parameters so that the system "sees " less cylinders and more heads or sectors per track. For example, an ESDI drive with 1224 cylinders, 15 heads, and 36 sectors per track might be mapped into a configuration of 612 cylinders, 30 heads, and 36 sectors per track. The physical configuration of the drive will remain the same, but the controller card will remap the drive so that DOS will recognize the entire disk.

Translation mode is usually enabled during the low-level format procedure. If your controller does not support translation mode, the only way to bypass the 1024 cylinder limitation is with a device driver.

Once you have decided how you want to partition the drive, use either Speedstor, Disk Manager, or FDISK to do the work for you. Divide the disk into as many partitions as you desire. After you have set the partitions, you will have to reboot the system before any partition changes are recognized. Be sure to mark the partition you want to boot from as the ACTIVE partition. Then proceed to the high-level format procedure described in this section.

Partition Compatibility

All versions of DOS 5.0 and later have the ability to access partitions created under older versions of DOS. Most, but not all, older versions of DOS will access partitions created under newer DOS versions. For example, a system booted under DOS 3.3 will recognize a hard drive partition created under DOS 3.2, but not an extended partition created under DOS 4.0. If you're partitioning a drive with a later versions of DOS and using partitions larger than 32MB in size, be aware that you are limiting your compatibility with earlier versions of DOS. If you plan to reformat a drive originally formatted with a late version of DOS, you must use the later version of DOS FDISK to erase the existing partition.

HOT TIP

The 2000MB Partition Limit

DOS 6.X is currently limited to 2000MB per partition. In most cases, this is an adequate partition size. Although software is available to bypass this limitation, I don't recommend using it. If you can't partition your data to fit in 2GB partitions, the best solution is another operating system with a high performance file system like OS/2™ or Windows NT™. As partition sizes increase, the efficiency of DOS decreases. DOS cluster sizes are typically 8K or more in large partitions. Since the minimum allocation size for each file is one cluster, even small files (i.e. 1K) will require 8K of disk space per file. If you have many small files, switching to a smaller partition which decreases your cluster size will improve efficiency.

DOS Format

DOS format (or high-level format) is simple. Use the DOS format program with the /S option or use FORMAT and SYS C: to initialize your bootable partition. If you are using a device driver, install it next and reboot the system before formatting any remaining partitions.

You may also use Speedstor or Disk Manager for high-level formatting. Be sure to copy COMMAND.COM and invoke SYS C: to copy the DOS system to the active partition after using these programs.

Congratulations! You are now ready to run. Proceed to the tune-up section for tips on optimizing your software setup.

Novell Compsurf

Novell's COMPSURF program is a tricky beast. It is one of the most rigorous and intensive test programs available. It's also a necessary prerequisite to installing some versions of Novell Netware on a hard drive. Compsurf was first written in 1984 when large capacity drives were not as reliable as they are today. It uses an intensive random and sequential read/write test to certify the drive. Compsurf takes around one hour per 20MB of disk space to run. After testing, Compsurf partitions the drive for use with Novell, and writes a defect table to the drive.

Before running COMPSURF, make sure you have all the necessary software drivers. ELS level I or level II Netware is designed to support IDE compatible drives only. ELS Compsurf will only work with IDE, MFM, RLL, or ESDI controllers that bear a close resemblance to the original IBM-AT MFM controller. If you are running Netware Lite, Advanced 286, SFT 286, or Netware 386, you have more options. Drivers for SCSI, ESDI, and SMD controllers are available for these versions of Netware. To use a Netware driver, you must follow the Netware installation instructions to the letter, and link the device driver with Compsurf. This will create a custom formatting and testing program that will operate with your controller.

If you are running a SCSI drive with Compsurf, be sure to answer NO when Compsurf asks if you wish to format the drive. Use the low-level formatting program provided with the controller card instead. Compsurf can't format SCSI drives because the SCSI interface only supports a 'format drive' command, and the 'format track' command is normally ignored by SCSI controllers.

NOTE: When running Compsurf on SCSI drives, be sure to low-level format the drive first, then answer NO to the following prompts:

FORMAT THE DRIVE: NO (Enter)
MAINTAIN DEFECT LIST: NO (Enter)

Many newer controllers offer a "watered down" version of Compsurf in ROM BIOS. We have yet to find a controller card BIOS that tests as well as the real Compsurf. Our feelings are that the reliability demands of most network users justify the time it takes to run the real Compsurf.

To save time and effort, it's a good idea to ask your drive dealer if he can Compsurf your drive for you. If he's reputable and confident in his product, this service should be available at no extra charge.

Whatever you do, choose a well built, heavy duty hard drive for your fileserver. Novell applications are extremely disk intensive and demand a reliable disk.

Choosing a Hard Drive and Controller

With so many different drives and controllers on the market, where do you start? Begin with software requirements. Narrow down your choices by eliminating drive interfaces or controllers which are not compatible with your software application. For example, an IDE drive might not offer sufficient performance for your network software, or the 528MB size limitation of standard IDE might be too small for your XENIX system. In general IDE drives are the most compatible since nearly all operating systems will run an IDE drive without additional software drivers. In terms of performance and flexibility, SCSI is always the best choice. Unfortunately, almost all advanced operating systems like OS/2™ and Windows NT™ require software drivers for full support of SCSI controllers. Check on the availability of software drivers for your applications before choosing SCSI.

Consider future expandability and upgradability. SCSI controllers offer the most flexibility and expandability in the long run. With a SCSI controller, you can daisy-chain up to 7 devices, including SCSI hard drives, CD-ROMs, erasable optical drives, DAT and 8mm SCSI tape drives from the same controller. If you are upgrading an existing system with an ESDI controller already installed, an ESDI drive may be the most economical choice. ESDI still offers decent performance and compatibility, but a limited supply of drives make it a good choice only for upgrading an existing system.

If you are building a new IBM compatible system, you also have a choice of motherboard bus configurations. The most popular choices are ISA, EISA, VESA (or VL-bus) and PCI. Each bus has its advantages and limitations.

ISA refers to the original 16-bit bus which IBM designed into the first 80286 based AT computers. The IBM ISA specification strictly limited bus speed to 8MHz and set firm rules about bus timing. Newer "clone" motherboards violate this specification and permit operation up to 16MHz. The ISA bus design is capable of accommodating most hard drives and I/O cards without a bottleneck. Its main limitation is video. With the advent of programs like Microsoft Windows™, large amounts of data must be transferred quickly to the video card as windows are opened, closed, and scrolled. The original AT bus lacks the bandwidth for acceptable video performance.

To solve this problem, a committee called the Video Electronics Standards Association was formed. The VESA local bus standard was established to improve video performance while maintaining compatibility with ISA bus peripherals.

VESA bus motherboards have two or three local bus slots which are connected directly to the 32 bit bus of the Intel compatible CPU chips. This permits up to three VESA peripherals to operate at any speed up to the full speed of the processor. The main problem with the VESA bus design is bus loading. As VL-bus speed is increased (VESA bus speed is linked directly to processor speed), the number of adapter cards which can be used decreases. For example, most 50MHz VESA motherboards will support only one or (maybe) two cards.

Despite this limitation, The VESA bus is rapidly gaining popularity due to it's low cost to manufacture. Since the only two peripherals which can really take advantage of this high speed bus are disk controllers and video cards, the two or three slot limitation is normally not an issue.

In an effort to solve this problem, many "clock doubling" and "clock tripling" CPU chips like the Intel 80486DX2-66 have become popular. These chips operate the VESA bus at a lower speed (ie. 33MHz) and perform calculations internally at a multiple of this speed (ie. 66MHz). The VL-bus becomes more robust when used in conjunction with this type of CPU. A VESA/ISA motherboard with VL-bus disk and video controllers and a clock doubling or tripling CPU is an excellent choice for building a new system.

EISA is a 32 bit bus standard popularized in 1991. This bus runs at 8MHz and is software configurable (most EISA cards have no jumpers to set). This bus offers two to four times the performance of the ISA bus, but is slower than the VESA bus. EISA is a conservative, reliable bus design that does not suffer from the two or three slot limitation of the VESA bus. The main disadvantage of EISA is cost. EISA connectors, chip sets, and adapter boards are all more expensive than their VESA counterparts.

Unless you have a specific need for more than three fast I/O cards (there aren't many applications that do), I would not recommend building a new system around the EISA bus.

PCI is another high performance bus alternative. PCI bus speeds blow past ISA and EISA and rival VESA bus speeds, but PCI motherboards are more costly to manufacture. At the time of this printing, the availability and cost of PCI peripherals was also an issue. PCI does not suffer from a limited number of supported slots as VESA does. PCI boards are also autoconfiguring (an advantage over VESA). As more PCI peripherals become available, and prices drop, the price/performance ratio of PCI will make it a viable alternative to VESA.

Once you have selected a motherboard, it's time to make sure the controller board you have in mind will be compatible. The EISA bus is so strictly defined that we have seen very few compatibility issues arise. ISA compatibility problems usually occur only when the bus speed is increased over 10MHz or the bus timing is irregular.

With standard IDE controllers, bus speed is normally not an issue. With memory or I/O mapped SCSI controllers, you will need sufficient address space in the base 640K memory to support the footprint of the controller BIOS, and an available interrupt. Bus mastering controllers of any type can be a nightmare. Bus on/off times, and refresh release rates often need to be adjusted to get things working. With a negligible performance difference between bus mastering and memory mapped controllers, you are best off steering clear of bus mastering controllers. ISA bus mastering controllers may also have compatibility problems or performance limitations in machines with more than 16MB of memory.

Our overall recommendations: A fast VESA or PCI SCSI controller for new systems. Couple this controller with the largest SCSI drive you can afford. If you are interested in a small capacity drive and controller a small IDE drive will offer the most for the money. Weigh your storage and speed requirements. For Network server applications, go with the fastest voice coil drive you can afford. For workstations or light database applications, a larger capacity drive with a slower access time and lower cost may be preferable. In notebook and portable applications, insist on a drive with good shock tolerance. When selecting a drive capacity be sure to think to the future. It's better to start with a large capacity drive now than to replace the entire drive in the near future.

In summary, for most low capacity applications, we recommend a small, inexpensive IDE drive with an imbedded controller. For maximum software compatibility in sizes below 528MB standard IDE drives are a good choice. For top performance and upward compatibility with the ability to daisy-chain additional peripherals, choose a SCSI drive and controller.

Fine Tuning

This section contains a few hints on how to get the most out of your hard disk subsystem. There are several ways of measuring disk performance. In the PC world, the most common utility program for comparing hard disks is CORETEST from Core International. Running CORETEST on your drive yields a crude performance rating based on the average seek time and data transfer rate of the drive reported by the system BIOS.

If you do not specify any command line options when running CORETEST, the program defaults to a block size of 64KB. The performance rating you get based on a 64K block size is only part of the picture. Many common operating systems (including DOS) often transfer data in blocks smaller than 64KB. To get an idea of how your system performs with these smaller block sizes, use the command CORETEST/B:xx where xx is the size of the block you would like to test. Making a graph of the performance ratings you get for different block sizes gives a more complete picture.

CSC Test

HOT TIP

CSC offers its own performance test program called CSCTEST which is supplied on the enclosed diskette. Since this program is larger than will fit on the disk in uncompressed format, it is supplied in a self extracting compressed archive format. To uncompress it, first change to the directory on your hard drive where you would like to install the test program. Once you are in that directory, type A:CSCTEST, and the program will automatically unpack and transfer itself to your hard disk. To view the results, you will need an EGA, VGA, or Hercules compatible monitor.

CSCTEST gives an evaluation of system performance by accurately measuring the number of seeks per second and 512 byte blocks transferred per second. These ratings are combined to give an overall performance rating. This rating can then be compared with the rankings of other popular systems.

There are several ways of increasing your system performance by optimizing software setups and not changing hardware.

The two most important steps to a tuneup are optimizing interleave and defragmenting files. The optimum interleave for your hard disk system is a function of both the hardware and software in your system. Contrary to popular opinion, 1:1 is not the optimum interleave for ALL applications. If the controller you are using does not feature a full track read-ahead cache (most older MFM, RLL, and some imbedded controllers don't), selecting the optimum interleave will make a significant difference in data transfer rate.

After extensive testing, we have come up with the following rules-of-thumb regarding interleaves for MFM and RLL controllers:

Use 4:1 Interleave With:

Older 4.77MHz XT class machines.

Use 3:1 Interleave With:

Older XT class machines with DOS applications
Older 6MHz and 8MHz AT class machines running.

Use 2:1 Interleave With:

Older 10MHz to 16MHz 286/386 machines running DOS.

Use 1:1 Interleave With:

All 20MHz or faster 386 machines running Netware
All 20MHz or faster 386 machines running DOS
All newer 486 and Pentium machines.

It's interesting to note that a 20MHz 386 machine running DOS can operate faster with a 2:1 interleave controller than a 1:1. This is because many DOS applications can't operate fast enough to take advantage of the 1:1 interleave. By the time the DOS application requests the next sequential sector of disk data, the 1:1 formatted disk has already spun past that sector, and DOS must wait for the disk to spin another revolution. Fortunately, if you are building up a new system with a clock speed of 20MHz or faster, the choice is clear. Most modern clone boards with 8MHz I/O channels and fast CPU's work best with 1:1 interleave. If you are tuning up an older system with a clock speed of 20MHz or less, 2:1 interleave may be the optimum choice.

There is really only one way of exactly determining the actual optimum interleave for your system. Test it. Popular programs like OPTUNE or SPINRITE let you determine the optimum interleave based on hardware considerations only. Unfortunately, these programs do not take into account the software overhead that DOS and other operating systems create. Format the drive with an interleave value one sector larger than suggested by SPINRITE or OPTUNE. Then load your applications and make your own performance tests. Record the results and then reformat with the interleave recommended by the test program. If performance increases, you have chosen the optimum interleave. If not, the software overhead of your applications is causing the system to operate better at the higher interleave.

Defragmenting files is the next step in increasing system performance. As a disk is used over time, files become fragmented. The simplest way to defragment files is with a program like Central Point Software's COMPRESS. Alternately, the files can be copied to another drive and then restored. Defragmenting files will significantly increase your system performance.

Buffers and FASTOPEN

Appropriate use of the DOS BUFFERS and FASTOPEN commands will also improve system throughput.

The DOS buffers command allocates a fixed amount of memory which DOS uses to cache data while reading and writing. As many buffers as possible should be installed in your CONFIG.SYS file. Each buffer will take a total of 548 bytes of memory (512 bytes for data and 36 for pointers). If you have extended memory available, use the /X option to store buffers in extended RAM and keep your base 640k free and clear. If you are using a caching controller, set the DOS buffers command as low as possible for best performance.

The DOS FASTOPEN program tracks the locations of files on a disk for fast access. Access to files in a complex directory structure can be time consuming. If you run applications that use several files (such as dBASE, Paradox, or other database programs), FASTOPEN records the name and physical location on the drive. When the file is reopened, access time is significantly reduced. If you are using disk intensive programs without FASTOPEN, your disk performance is suffering.

One of the nicest features of FASTOPEN is its ability to use extended memory. For example adding the line FASTOPEN C:100,10/X to your AUTOEXEC.BAT file would automatically make FASTOPEN load using extended memory to track up to 100 files with a 10 entry extent cache. Unfortunately, once FASTOPEN is loaded, its setup cannot be changed. To change FASTOPEN settings, reboot the computer.

Cache Programs

Caching programs such as DOS SMARTDRV.SYS dramatically improve disk system performance. Another benefit of using a good caching program is extended drive life. Drive life is based not only on the number of power on hours (POH), but also on the number of seek operations. Adding even a small RAM cache will prolong drive life significantly by reducing the number of seeks necessary. If you are using DOS 5.0 or later, we recommend you try the SMARTDRV.SYS program included with DOS. It offers good performance, particularly with expanded memory. You can improve drive performance dramatically without buying extra software by adding SMARTDRV to your CONFIG.SYS file.

For a few dollars more, many excellent third-party caching programs are available which offer improved performance over SMARTDRV. Two of the best cache programs we have found are PC-Cache from Central Point Software and Speed Cache from Storage Dimensions. Both of these programs enable disk caching using extended or expanded system memory. If you purchased IBM DOS 6.1 or later, you received PC-Cache and a degragmenting program free with DOS - smart buy. PC-Cache has an adjustable read-ahead feature which improves sequential access on large files.

HOT TIP

If you are running Unix, Database programs, or other extremely disk intensive programs, the ultimate solution (if you can afford it) is a caching controller card. A caching controller can provide reduced data access times, improve throughputs, and improve your hard drive's life span. A quick Windows performance boost can be had by moving the swap file. If this swap file is located near frequently used data, performance will be increased. If the swap file is moved to a separate drive, performance is even better. For DOS and Microsoft Windows users, a caching controller frees system memory for applications. Due to the large number of requests for an inexpensive, high performance caching controllers, CSC has designed the CSC FastCache™ 64 ISA SCSI controller. We are now designing both caching and non caching VESA VL-Bus and PCMCIA versions. A number of other Fast SCSI caching and non-caching controllers are available, and if disk I/O is a bottleneck, they are all worth considering.

To sum up the fine tuning of your DOS hard drive, perform the following five steps for better disk performance:

1. Find the optimum interleave
   (Reformat if necessary)

2. Compress and defragment

3. Set buffers correctly

4. Install FASTOPEN

5. Use SMARTDRV, PC-CACHE, or another cache program if you do not have a caching controller.

6. Move swap files to a physical area near data files, or to another drive.

HOT TIP

Hardware Compatibility Problems

Unfortunately, not all controller cards are compatible with all computers and not all disk drives work with all controller cards.

Some of the major hardware compatibility problems we have come across are listed below.

SCSI Arbitration on Bus Scan

On power-up, a SCSI controller communicates with the attached devices to determine if the device is operating in synchronous or asynchronous mode. Many SCSI controllers do not perform this arbitration process correctly. This failure usually causes the system to hang. The solution is an upgraded controller BIOS or a different controller/drive combination.

SCSI Command Set Issues

SCSI command set problems occur because SCSI commands differ among device manufacturers. These problems can usually be resolved with a firmware upgrade on the SCSI device or controller. Be sure to check for command set compatibility before purchasing any SCSI devices.

In some cases, after market products are available to relieve SCSI compatibility problems. My personal favorites for the Apple Macintosh include FWB's Silverlining and Spot On. Corel makes an excellent set of SCSI disk drivers for ASPI compliant PC controllers. Storage Dimension's Speedstor is a great integration program for Sun platforms.

ISA Bus I/O Channel Ready Timing

Slow devices connected to the AT bus must assert a signal called I/O CHANNEL READY to force the motherboard to wait for data. Many faster motherboards do not conform to the original IBM AT bus timing specs. Because they don't, a controller card requesting a wait state delay using this line may not operate correctly. If you have a Chips & Technology based motherboard, this can be corrected by adding a bus wait state using extended setup. Otherwise the only solution is a new controller card.

ISA Bus 16-Bit Memory Transfers

This problem often occurs in older motherboards that use discrete chip sets. On the AT bus, a signal called MEM16 must be asserted by the bus devices in order to initiate a 16-bit data transfer. This signal must be available almost immediately, or the system may default to 8-bit transfer. Many of the cheaper clone motherboards do not provide valid address signals in time to decode this signal. If the address signals are not presented in time, it is impossible to perform a 16-bit transfer. This causes problems with many 16-bit cards that use memory mapped I/O, such as the WD7000 and DTC3280 SCSI controllers. Older DTK motherboards are notorious in this regard. The solution is to switch to an 8-bit card and suffer a slight loss of performance. If this is not acceptable, the only solution is upgrading to a higher quality motherboard.

ESDI Defect Tables

Many older style controller cards have problems reading the defect tables from some ESDI drives. This is due to the way the defect table is recorded on the drive. The solution is upgrading to a newer style card or rewriting the defect table using a factory analog type drive tester.

VESA VL-Bus Loading Problems

The VESA VL-Bus specification supports two cards at a 33MHz bus speed, and only one card at 40MHz or 50MHz bus speeds. Depending on the quality of their design and construction, some motherboards may exceed these specifications. There's really no way to correct a VESA bus loading problem other than lowering the bus speed or removing one card. A clock doubling CPU (i.e. the Intel 486DX2-66) may be the solution in some cases.

HOT TIP

IDE Drive Master/Slave Compatibility

When mixing different manufacturers of IDE drives on the same cable, compatibility problems may occur. This is caused by timing incompatibilities and because some drives use IDE pins for different purposes (i.e. spindle sync). If you encounter a dual drive IDE situation where only one drive works, try reversing the Master/Slave jumpers on both drives to switch their positions in the system.

Common Installation Problems

The common installation problems below account for 90% of the technical support calls at CSC. Steer clear of trouble by learning about these issues.

Handle Hard Drives Like Eggs!

Hard drives are extremely fragile. Dropping, bumping, or jarring a hard drive can cause permanent damage. Always use a manufacturer approved shipping carton if you need to transport the drive outside of the system. Never transport an optical drive with the media inserted. Rough handling accounts for more drive failures than all other factors combined.

INSTALLATION CAUTION!

Reversed Cables!

Most drive cables are not keyed - they can easily be installed backwards. Reversed cables account for a large number of hard drive electronic failures.

Reversing a SCSI cable will cause the terminator power line to be grounded. This usually blows a fuse or fusable link on either the drive or controller. Without terminator power, SCSI data transfer will be unreliable. Make certain all cables are oriented correctly before applying power. If you reverse a SCSI cable, you may need to replace the fuse, or return the drive for service. Line drivers on either the controller, drive, or both can easily be damaged if cables are reversed. If you are unsure, don't guess - check the documentation or call the manufacturer!

Twisted Cables

Refer to the Drive Cabling section to ensure the proper twisted cable is used when installing multiple Floppy, MFM, RLL, or ESDI drives.

CMOS Setup

Be sure to read the chapter which describes the differences between physical and translated IDE parameters. You must to set CMOS to the translated parameters.

Most ESDI drives use an IBM standard type 1 CMOS setup. This corresponds to a standard 10MB drive. Upon power-up, the BIOS on the ESDI card overrides this drive type. Most SCSI controllers operate with CMOS set to 0 (no drive installed). Double check your controller manual for the correct CMOS setup value. Programs that use drive table overrides for MFM and RLL drives normally use the closest match in the ROM type table with an identical number of heads.

Hardware Conflicts

Hardware conflicts can occur if the controller card conflicts with the interrupt, DMA, I/O address or ROM address of other cards in the system. These conflicts are often difficult to debug. To be sure, check the manuals for ALL of the other boards installed in the system before jumpering the controller card.

Defect Locking

It's important to enter and lock the defect table on all MFM, RLL, and ESDI drives. If these defects are not entered, long term reliability will suffer. IDE and SCSI drives automatically lock out drive defects.

ISA Bus Extended Setup

Be sure to set the following extended setup parameters per your controller card manufacturer's recommendation:

BUS CLOCK SPEED
- Usually 8-12 MHz.

16-BIT BUS WAIT STATES
- Usually 1 or 2 wait states.

AT CLOCK STRETCH
- Usually enabled.

Improper extended setup settings may cause erratic controller operation.

Keep Optical Drives Clean and Cool!

Optical drives must be kept clean, cool and dust free for reliable long term operation. If an optical drive is installed without a proper flow of cool, clean air, long term reliability will suffer. When internal optics become contaminated by dust, error rates rise significantly. When temperatures increase, M/O drives will not operate reliably. Most "clone" cases do not provide a proper environment for optical drives. Most optical drives work best installed in external enclosures with proper fans and filters. Clean fan filters regularly. Use cleaning disks regularly on CD-ROM drives. Purchase a cleaning kit for your erasable media.

SCSI Parity Jumpers

Most SCSI drives are shipped from the factory with parity enabled. PC applications sometimes require that parity be disabled by moving a jumper.

SCSI ID and Termination

95% or the problems we have seen with SCSI installations are due to improper ID settings and termination errors. Please read the section on SCSI cabling instructions and the termination and ID warnings before installing your SCSI peripherals. All SCSI installations require a total of two terminators - no more and no less. This includes the terminators which may be installed on the controller card or host adapter.

Troubleshooting

The following paragraphs list some of the more common problems encountered in drive installation. They are intended for quick troubleshooting reference. If you are receiving an unfamiliar error message, check the Common Error Messages listings later in this chapter.

Bus Mastering Compatibility

Bus Mastering cards usually have jumpers for DMA channels, hardware interrupt levels, and bus on/off time. Check these jumpers first when installing a bus mastering controller. As described in the installation section, each controller must have its own interrupt level and DMA channel. If you intend to use DOS programs like Windows in 386 enhanced mode that use the protected mode of the 386/486 processor with a bus mastering card, you will need a software driver.

Even when they are correctly installed, bus mastering controllers sometimes experience motherboard hardware compatibility problems. If you have trouble getting a bus mastering controller to run with your motherboard, ask the controller manufacturer if your motherboard has been approved for compatibility.

CMOS Drive Type Tables

Matching CMOS tables for IDE Drives

If you are having problems installing a drive which is not listed in your CMOS drive type table, remember that the CMOS type does not need to exactly match the physical parameters of the drive. Modern IDE drives automatically 'translate' to match the physical parameters of the drive to match the logical parameters you select in CMOS. That's why there are two sets of parameters listed in the drive parameters section. Selecting any CMOS drive type which has an identical or lesser formatted capacity than the capacity of the drive will work. IDE translation modes are also used to bypass the DOS 1024 cylinder limitation (see the IDE installation section for more information). If you are installing a high capacity IDE drive in an older system that doesn't have any high capacity drives listed in the CMOS type table, programs like SpeedStor or Disk Manager can be used to override the CMOS table.

ESDI and SCSI Controller Drive Types

All PC SCSI controllers require that CMOS be set to NO DRIVES installed. The only exception to this rule is if an IDE, MFM, or ESDI drive is installed and coexists in the same system as the SCSI controller. If this is the case, set CMOS to the drive type used by the IDE, MFM, or ESDI drive only. Leave additional drive types set to "not installed". SCSI controllers interrogate the SCSI bus and add drive types when the system is first powered up.

Nearly all ESDI controllers require that CMOS be set to 'type 1'. These ESDI cards use an on board BIOS which automatically overrides the CMOS setting on power-up. The few ESDI controllers which don't use a BIOS ROM require that the CMOS type exactly match the physical parameters of the drive. These cards can only be used in systems that have a 'type 47' or user-definable CMOS table or in conjunction with a program like SpeedStor or DiskManager.

Compsurf Failure

Early versions of Novell Netware build the file server operating system during installation by linking a series of object files together to form the Netware 'kernel'. Most installation problems with Netware result from incorrectly installed drivers. The Netware installation process is detailed and complicated. Follow the installation instructions exactly to avoid link problems.

If you are running IDE drives with early versions of Netware, be sure to enable translation to keep the logical number of cylinders below 1024. Early versions of Novell will truncate any additional cylinders.

Watch for potential conflicts between interrupts. Most SCSI cards use IRQ14 or IRQ15, and several network cards use them as well. Under Novell, each card must have its own interrupt level. DOS does not require interrupts, and many SCSI cards do not provide them in the default configurations. If your SCSI controller works under DOS, but not Netware, check the interrupts.

In Netware 386, the drivers are composed of 'NLM's' or Netware Loadable Modules. NLM's are loaded after the file server is up and running. If a driver is not properly configured for Netware 386, the file server will often 'lock up' when the driver is loaded. If this happens, check the software installation and make sure the driver configuration matches your hardware.

DOS Partitioning

The 1024 cylinder barrier is the most common cause of DOS partitioning problems. Most versions of DOS only support 1024 cylinders. To keep the number of cylinders seen by DOS under 1024, do one of the following:

If you are using an IDE drive, enable translation and increase the number of heads of sectors per track to reduce the cylinder count.

If you are using an ESDI drive, enable the "63 sector" or "head mapping" mode to enable controller translation.

If you don't have translation available, the only way to access cylinders above 1024 is by making a boot partition within the first 1024 cylinders, and loading an extended partition driver from within the boot partition.

The 32 Megabyte partition barrier can also be a problem with old versions of DOS. Versions of MS-DOS earlier than 3.3 and Compaq DOS earlier than 3.21 lack the ability to access partitions larger than 32 megabytes. To bypass this, a driver like SpeedStor or Disk Manager is required. The driver file must be installed in CONFIG.SYS before the any extended partitions can be accessed.

DOS 2.0GB Limit

Yes, there is a partition size limit under DOS. It is 2048MB per partition. If this becomes an issue, consider a different operating system like Windows NTtm or OS/2's high performance file system. Although DOS could theorically be made to work on larger drives, it's not a great idea. The efficiency of DOS when storing small files on large drives is poor because the DOS cluster size increases as drive's capacity increases.

Drive Selects

Many manufacturers label the drive select jumpers on drives like this: 0,1,2,3. Others label the same select jumpers 1,2,3,4. The correct jumper depends on the position of the drive in the system, the type of cable you are using, and the way the jumpers are labeled. See the Installation section for more details.

Drive Won't Spin

This is frequently caused by reversed cables in SCSI and IDE installations. Check pin 1 orientation and don't forget to plug a system power cable into the drive! "No-spins" are also often caused by a power problem (see below).

ED Floppy Support

Most existing PC controllers do not yet support the new IBM standard 2.88MB floppy drives. Although many manufacturers advertise the floppy controller section of their boards as "supports 1MHz data rate", the new 2.88 drives use perpendicular recording which requires special write gate timing. Many controllers which support 1MHz data transfer rates only operate at the higher rate with "floppy tape" drives. If you are having problems with an ED drive with a "1MHz" floppy controller, consult the controller manufacturer to make sure the board you have is 2.88 compatible.

ESDI Sector Sparing

Many ESDI controllers offer optional "sector sparing". Sector sparing should be enabled if the drive has any significant number of defects or if the operating system you are using can not tolerate defects. Sector sparing reduces the formatted capacity of the drive slightly but increases the overall reliability significantly. When sector sparing is enabled, the controller can reallocate defects "on the fly". Use sector sparing when ever possible.

IDE Cabling

Since IDE cables carry data at full motherboard bus bandwidth, they must be kept as short as possible. Cables over 18" can cause problems in most installations. The shorter the better.

IDE Master/Slave

Unfortunately, not all IDE drives are created equally. Many IDE drives will not peacefully coexist in the Master/Slave configuration with drives from other manufacturers. See the hardware compatibility section for advice.

Incorrect Drive Parameters

If you are having problems with an IDE, SCSI or ESDI drive installation, make sure that the CMOS settings exactly match your drive's physical or logical parameters. Some ESDI controllers reserve one cylinder of the drive for storing configuration information.

Interrupts and DMA channels

Most controllers running under DOS do not require interrupts. All UNIX and Novell applications require controller interrupts for acceptable performance. If you suspect an interrupt or DMA channel conflict, check the hardware reference manuals for your installed hardware. The most common controller conflicts seem to be with network cards and scanner interface boards.

Long Boot Time

Most SCSI controllers must scan the bus and "interrogate" each SCSI device before booting. This process is long and tedious but occurs only on initial power-up or hardware reset. There is really no way around this with most controllers.

Long Format Time

Depending on the drive and system, a high level format may take up to 15 seconds per cylinder. When the drive steps between cylinders, an audible "click" can usually be heard. If the drive is stepping, be patient and wait for the format to complete. If you are attempting to format an MFM, RLL, or ESDI drive and the drive isn't stepping, check for a reversed 20 pin cable.

Multiple Drive Support Under DOS

Most controllers support only 2 hard drives under DOS. To support additional drives, a software driver is required. If a driver for more drives exists, it is normally only available from the controller manufacturer. An exception to this are CSC's AK-47 and FC-64 boards which support 7 SCSI and 4 floppy drives without any drivers.

No BIOS sign-on banner

This is one of the most common installation problems. Check to see that your controller card BIOS does not overlap the memory areas used by other cards. In particular, watch for VGA and network cards. If you still don't get a banner, check extended setup and make sure that the shadow RAM is disabled in the address range occupied by the controller BIOS.

Partition can't be removed

If a drive is formatted with a 'non-dos' partition, FDISK will not delete it. The only solution is to erase the partition sector with a sector editor or low-level format. Older versions of DOS (i.e. 3.3) will not delete the larger partitions used by newer versions of DOS (i.e. 6.0). Later versions of DOS (i.e. DOS 6.0) will delete partitions created in earlier (i.e. DOS 3.3) versions of DOS. If a low level format is not in order, a program called "Bootwipe" is available from the CSC BBS at (408) 737-1823 to correct this.

Power Supply

Power supply problems frequently crop up in new drive installations. Most hard disk drives require 5 volts +5% and 12 volts +5% at the drive connector. The power supplied to the drive must be clean and well regulated. All modern hard drives include circuitry which monitors the power supply voltages and shuts down the write circuitry if the input power is too far out of range. Many drives won't even spin up if the power supply is too far off. If you suspect a power supply problem, check the voltages at the drive power supply connector while the drive spins up to speed and seeks.

INSTALLATION CAUTION!

SCSI Cabling

SCSI cables MUST be shielded for reliable operation. Many newer SCSI cables have individually twisted pairs for each signal line. If you can afford it, buy the better quality twisted pair variety. Avoid completely unshielded SCSI cables at any cost.

SCSI ID's

Each device installed on the SCSI bus must have a unique and separate ID number. Most SCSI controllers use ID #7, leaving the ID numbers between 0 and 6 available for disk drives. For reasons unknown, some PC based tape drive software requires ID#7. If you have multiple DASD drives installed, most PC controllers will scan and boot from the lowest SCSI ID number. Exceptions to this are the Adaptec 1540 series which only boots from ID#0 and the CSC FlashCache™ 64 which can be programmed to boot from any device.

SCSI Termination

A SCSI bus must be terminated at each physical end of the SCSI chain. Only two terminators per bus can be used. The devices at the physical ends of the cable must have terminators. All other devices on the SCSI chain (including the controller if it is not at the end of the chain) must have their terminators removed. If you are using external and internal SCSI devices on a PC controller, remove the terminators from the controller card.

Shadow RAM

System memory should not be used to shadow controllers which are memory mapped. Controllers which are I/O mapped (i.e. ESDI cards) should be shadowed. System ROM should always be shadowed for performance.

System Hangs On Power Up

The following are common installation errors which cause the system to hang on power up:

Improper BIOS base address (see above)

Interrupt conflicts (see above)

Bus compatibility jumper (try it both ways)

Reversed SCSI Cable (causes termination power short circuit)

INSTALLATION CAUTION!

Thermal Problems

Thermal problems are common in multiple hard drive installations and in situations where a hard or optical drive is not adequately cooled. Drives are mechanical devices and heat is their worst enemy. As temperatures increase in a drive, the motor and bearings are subject to increased wear. Always make sure a hard drive has a continuous flow of cooling air and adequate ventilation around it.

Twisted Data Cables

Twisted floppy and hard drive ribbon cables look suspiciously similar. Floppy cables have seven twisted conductors, and hard drive cables have five. Check the diagram in the previous chapter for a quick identification.

Won't Boot (DOS)

If your system has been formatted and won't boot DOS, check to see that the boot partition has been marked active in FDISK. Also make sure that the system (hidden) files have been correctly transferred and that COMMAND.COM is present and matches the version of the hidden files. If your system was booting correctly but suddenly stopped, scan the boot sector for a virus.

Won't Boot (ESDI)

For new ESDI installations, make sure that translation and sparing modes have been set correctly. Also make sure that the system (hidden) files have been correctly transferred and that COMMAND.COM is present and matches the version of the hidden files. If your system was booting correctly but suddenly stopped, scan the boot sector for a virus. Check FDISK and make sure the boot partition is marked active.

Won't Boot (IDE)

If you can use your IDE drive when booting from floppy but are unable to boot directly from the hard drive, check to see if your IDE drive requires "buffered interrupts". If it does, you may need to change a jumper on the controller card. Also make sure that the system (hidden) files have been correctly transferred and that COMMAND.COM is present and matches the version of the hidden files. If your system was booting correctly but suddenly stopped, scan the boot sector for a virus. Check FDISK and make sure the boot partition is marked active. Verify that the Master/Slave jumpers are correct. If your drive was booting on an older motherboard, but won't boot on a new one, check to see that the CMOS settings are identical.

Won't Boot (SCSI)

Check for unshielded cables and termination (described above). If you are using a hard drive that has a SCSI mode jumper, try it set both ways. Also make sure that the system (hidden) files have been correctly transferred and that COMMAND.COM is present and matches the version of the hidden files. If your system was booting correctly but suddenly stopped, scan the boot sector for a virus. Check FDISK and make sure the boot partition is marked active.

COMMON ERROR MESSAGES

1790/1791 Errors

1790 is the most common error message encountered in drive installations. A 1790 error will result when a controller has been installed, but the attached drive is not formatted. 1791 is the same message but refers to the second hard drive.

Attempting to recover allocation unit XXX

This message appears in high level format when DOS detects a data verification error. If you are using an IDE or SCSI drive, you shouldn't see this message since the drive's embedded controller should mask out most errors before DOS is aware of them. If you see this message in an IDE or SCSI installation, check for a hardware installation problem. If you see this message in an ESDI installation, make sure the controller is able to read the drive's defect map, and be sure you have enabled sector sparing.

C: Drive Failure or Drive C: Error

This is a generic error message produced by the motherboard BIOS on power-up. It is usually caused by a "not-ready" error from the disk subsystem or an unformatted drive. Check cabling and master/slave jumpers on new installations.

Error Reading Fixed Disk

If you have successfully low-level formatted your drive and you encounter this message from FDISK, the system is unable to verify the partition sector. This is usually caused by a hardware problem, typically cabling or termination.

HDD Controller Failure

This message is usually caused by incorrect hardware installation. Check cabling, jumpers and termination. This message will appear if you install a SCSI controller without setting CMOS to "no drive installed". You will also get this message if you have an IDE drive set for slave operation and there is no master drive in the system.

Insert Disk For Drive C:

This message is caused by incorrect software driver installation. This can happen when DRIVER.SYS is used to add extended floppy drives and the command line switches are incorrect. It also appears when extended partition driver software is incorrectly installed.

Invalid Media Type

You have probably seen this message when formatting floppy disks of the wrong density. It is also generated on hard disks when newer versions of DOS utilities are used on older DOS partitions. For example, a DOS 6.0 CHKDSK of a DOS 3.2 disk causes it. Avoid mixing DOS versions.

No Fixed Disk Present

This message is produced by FDISK when it is unable to locate a drive through BIOS. Check hardware installation, particularly cabling, termination, and BIOS base address.

No Partitions Defined

This FDISK message is normal for a disk which has just been formatted. Be sure to set the bootable partition to “active” after creating it with FDISK.

No ROM Basic

The motherboard BIOS displays this message when it is unable to locate a boot device. In IDE or ESDI installations, this message is usually caused by an incorrect CMOS drive type setting. Most SCSI controllers require CMOS be set to “No drive Installed” or type 0. If this error appears in a SCSI isntallation, check cabling, termination, and the partition sector using FDISK. Most ESDI controllers require that CMOS be set to type 1 for each drive installed. If this message occurs in an ESDI installation, CMOS may be accidently set to zero. Also make sure that the system (hidden) files have been correctly transferred and that COMMAND.COM is present and matches the version of the hidden files. If your system was booting correctly but suddenly stopped, scan the boot sector for a virus. Check FDISK and make sure the boot partition is marked active.

Non System Disk or Disk Error

Make sure that the system (hidden) files have been correctly transferred and that COMMAND.COM is present and matches the version of the hidden files. Check termination in SCSI installations.

No SCSI Devices Found

If no SCSI devices appear in the bus scan, check SCSI cabling, termination, and make sure that no two SCSI devices are sharing the same ID number. Make sure that no devices are using ID #7. ID#7 is generally reserved for the SCSI controller card.

Track 0 Bad, Disk Unusable

This fatal data error often indicates a bad drive, although it can also be caused by improper termination.

Unable to Access Fixed Disk

This FDISK message is caused by an error reported by BIOS during an attempt to read the drive. Check termination and cabling. When booting from floppy but are unable to boot directly from the hard drive, check to see if your IDE drive requires “buffered interrupts”. If it does, you may need to change a jumper on the controller card.

Universal IDE Parameters

All newer IDE drives will accept any CMOS parameters which result in a total number of Logical Blocks (LBA's) which are equal to or less than the capacity of the drive. You can calculate any IDE drive's maximum LBA's by taking the total capacity of the drive and dividing it by 512. As long as the product of heads, cylinders, and sectors per track are less than the number LBA's, and within the range of the BIOS, your parameters will work. If you don't know what the manufacturers recommended parameters are, or if you don't have the time or inclination to calculate them, feel free to use the table below.

Note that the location of the DOS partition sector on a drive is determined by the sectors per track used to format the drive. If you are moving a drive from one system to another, you will need to match the number of sectors per track originally used to format the drive in order for DOS to recognize all the partitions on the drive.

Formatted Capacity	No. of Heads	No. of Cylinders	No of Sectors/Track
10	4	306	17
15	4	430	17
20	4	614	17
30	4	862	17
40	6	766	17
42	6	804	17
60	8	862	17
80	10	919	17
84	10	965	17
100	16	718	17
105	16	754	17
120	16	862	17
170	16	329	63
200	16	388	63
210	16	407	63
213	16	413	63
240	16	465	63
252	16	488	63
300	16	581	63
320	16	620	63
330	16	639	63
340	16	659	63
380	16	736	63
400	16	775	63
420	16	814	63
450	16	872	63
528	16	1024	63

Universal IDE Parameters

Macintosh Drive Installation

No hard drive technical manual would be complete without instructions for drive installation on the Apple Macintosh™. Internal and external SCSI drives are relatively easy to connect to the Mac, provided you pay proper attention to cabling, termination, SCSI ID, and driver installation.

As described in earlier chapters, the SCSI bus uses "daisy chain" cabling with dual ended termination. This means that each device must be connected in series using a continuous ribbon cable or a series of "daisy chained" external SCSI cables.

The Macintosh uses a DB-25 connector as its external SCSI port. Most computer stores offer cables which connect the Macintosh to Centronics 50-pin and other industry standard connectors. If you are unable to locate the cable you need locally, CSC can supply you with good quality cables at a reasonable price. Avoid using "T" type cables for SCSI connections. These cables cause noise and ringing which can result in unreliable operation.

Correct termination is critical for any SCSI installation. Every SCSI installation must use a total of two terminating resistors, no more and no less. A Macintosh with one internal hard drive usually has two internal terminators. To add an external SCSI drive or other SCSI device, first remove the terminator from the Macintosh internal hard drive and then add a terminator to the last device installed at the end of the external SCSI cable. If several devices are installed, connect the terminator to the last device of the chain only. Remember not to use more than two terminators total (internal and external).

The Macintosh CPU itself is always SCSI ID number 7 and the internal hard drive should always be set to SCSI ID number 0, for reliable operation. The other external devices can be set to any other ID numbers, 1 though 6, as long as the number is not duplicated on the SCSI chain. Duplicate ID numbers will cause the Macintosh to hang on start-up.

Always power up all external SCSI peripherals before switching the Macintosh on. Allow a few seconds for the attached drives to spin-up before turning on the Macintosh. SCSI devices which are attached but switched off can hang the SCSI bus and prevent drive operation or cause unreliable data transfer.

To maintain compatibility with your installed software, it is important that you install YOUR version of the Macintosh system and finder to any new hard drives, if you intend to boot from that drive. Chances are that the preformatted Macintosh drive you received will have a system and finder installed into the System Folder on the disk. If you have a System Folder installed already, or wish to update the System Folder, you must throw out all of the System Folders, EXCEPT ONE. There must be one and only one System Folder, with a System File and corresponding Finder File, on the entire SCSI chain. The extra System Files will cause problems until they are removed. To remove a non-operating System Folder, place it in the Trash, and empty the Trash. To remove a operating System Folder, place it in the Trash, reboot from a bootable floppy, and then empty the Trash. Using more than one System Folder will cause erratic software crashes and "system bombs".

Most Mac users install the latest version of the System Folder onto the internal hard drive, and place large application and other files onto the external drive(s). To link the applications to the desktop, *aliases* of the various applications are created and then saved in the Apple Menu for easy and rapid access. This frees up the internal drive space to allow more working area.

To format a hard drive, you may use a third party formatting software or the **Apple Hard Drive Tool Kit** software, which is included with the System Installation Disks, but must be installed separately. This software is not installed automatically with the System in normal installation procedures. When reformatting your external hard drive, we recommend an interleave of 1:1 for Macintosh II or faster computers and 2:1 for older 68000 based computers like the Macintosh Plus, Macintosh SE and Macintosh Classic.

The Apple HFS (Hierarchal File System) can easily loose data if files are not properly closed. For this reason, it is important to back up all files as often as possible. Shut off the system power only after using the Finder "Shut-Down" option. If files are accidentally damaged due to a power failure or accidental shut down, the desktop file on your hard drive may need to be rebuilt. To rebuild the desktop, shut off power to the Macintosh. Then restart the system holding down both the Command and Option keys while you turn on the hard drive and then the Macintosh. The message "Are you sure you want the desktop rebuilt?" will appear. This message will be repeated for each device connected to the Macintosh. Rebuilding an undamaged desktop will cause no harm, so click "OK" and the desktop(s) will be rebuilt on all hard drives connected to the Macintosh.

Most software problems with Macintosh drives are caused by driver conflicts or corrupted System and Finder files. Drivers are classified as *Extensions, Control Panels, INITs,* and *Desk Accessories* by the Macintosh.

If your Macintosh hard drive was working correctly but suddenly refuses to boot, start while depressing the Shift key. This turns off all of the *DRIVERS* mentioned above. If the Macintosh successfully starts, you have a driver conflict. To remedy this, you must find the driver(s) which are causing the conflict. Third party software can supply several programs to do this. You can also place all of the drivers into a folder labeled *Disabled Drivers*, and reinstall them one at a time, until the conflicting software is found.

If your multiple hard drive Macintosh system suddenly reports "Disk is unreadable, would you like to initialize?", the problem is most likely a software SCSI driver conflict. This message commonly occurs in systems with two or more hard drives which use different SCSI drivers. Verify that the drivers you are using for all of your hard drives are identical. If the drivers are not identical, the hard drive(s) will need to be reformatted with the same driver. Different versions of the same formatting software can cause this situation, so be sure that you are using the same version to format all of the devices.

Almost all installation problems are caused by cabling, termination, or SCSI ID errors. Be certain of the cables and their orientation. Use only two terminators, one on the CPU and one on the final device on the SCSI chain. Be sure that each device has a unique SCSI ID number. Please note that the physical placement of a device and its SCSI ID are not the same. A device can have the SCSI ID of 1, for example, and be in the final physical place in the SCSI chain.

Hard Drive List

Listed in the following chapter are many common hard drives and their parameters. The capacities listed are in formatted megabytes (1,000,000 bytes), with 512 bytes per sector. Formatted capacities may vary slightly depending on how the drive is formatted (i.e., using sector sparing or 35/36 sectors per track). As you would expect, all older MFM drives have 17 sectors per track, and all RLL drives which use the ST-506 interface have 26 sectors per track. ESDI drives have 35, 36, 48, or 63 sectors per track.

Access times listed are those published by the manufacturer. These advertised access times are often slightly lower than the average tested times. Drive information unavailable at the time of printing is entered as dashes (-).

Landing Zone

The landing zone, or "park cylinder" of a hard drive is a location to which the drive head carriage should be moved before the drive is transported. Older hard drives which use stepper motor actuators had to be manually parked before they were transported. This parking procedure moved the heads away from the data area of the disk and reduced the chance of data loss if the drive was bumped or jarred with the power off.

All newer hard disk drives with voice coil actuators incorporate automatic parking mechanisms. These mechanisms are as simple as a spring and a small latch which move and lock the heads away from the data areas of the disk when power is removed. Because the manual landing zone is no longer used in modern drives, we have omitted it from the tables. If you have an older stepper motor type drive which does require manual parking, step the heads to the maximum cylinder + 1 before removing power from the drive. For example, if you have a ST-225 which has 615 cylinders, step to the 616th cylinder before power down if you intend to transport the drive.

Write Precomp

Write precompensation is a technique which alters the timing of data written to a hard drive on particular cylinders. Since the track length of cylinders which are close to the center of the disk is shorter than the outer cylinders, the timing of data read changes.

To compensate for the difference in read data timing between inner and outer tracks, several drives use "write precompensation" which alters the timing of data written to inner cylinders on the drive. All newer drives automatically generate "write precompensation" using internal logic which senses the position of the head and adjusts the timing of write data accordingly. Older drives depend on the controller card to generate write precompensation. Since write precompensation is either handled internally or not used at all on newer hard drives the starting write precompensation cylinder is not as important as it once was. We have omitted write precomp information in the hard drive list to keep things simple. A valid write precompensation start cylinder for most older drives can be calculated by dividing the maximum cylinder number by two.

CDC, Imprimis or Seagate?

Control Data Corporation (CDC) was one of the first manufacturers of high performance 5.25" hard disk drives. CDC has over the years developed an excellent reputation for reliability. In 1987, Control Data Corporation named its disk drive division Imprimis. Recently, the CDC's Imprimis division was purchased by Seagate.

If you are trying to locate an Imprimis drive, please check both the Seagate and CDC sections.

Miniscribe or Maxtor Colorado

Miniscribes' management caused financial problems which eventually led to Maxtor Corporations acquisition in 1990. Miniscribe is now called Maxtor Colorado. Maxtor's management and expertise in high capacity drives has helped improve the Miniscribe product.

If you are trying to locate an older Maxtor Colorado drive, also check in the Miniscribe section.

Table C - Converting Imprimis to Seagate Numbers					
Imprimis	**Seagate**	**Imprimis**	**Seagate**	**Imprimis**	**Seagate**
94155-85	ST4085	94205-51	ST253	94351-200S	ST1201NS
94155-86	ST4086	94205-77	ST279R	94351-230S	ST1239NS
94155-96	ST4097	94211-106	ST2106N	94354-090	ST1090A
94155-135	ST4135R	94216-106	ST2106E	94354-111	ST1111A
94161-182	ST4182N	94221-125	ST2125N	94354-126	ST1126A
94166-182	ST4182E	94241-502	ST2502N	94354-133	ST1133A
94171-350	ST4350N	94244-274	ST2274A	94354-155	ST1156A
94171-376	ST4376N	94244-383	ST2383A	94354-160	ST1162A
94181-385H	ST4385N	94246-182	ST2182E	94354-186	ST1186A
94181-702	ST4702N	94246-383	ST2383E	94354-200	ST1201A
94186-383	ST4383E	94351-090	ST1090N	94354-239	ST1239A
94186-383H	ST4384E	94351-111	ST1111N	94355-100	ST1100
94186-442	ST4442E	94351-126	ST1126N	94355-150	ST1150R
94191-766	ST4766N	94351-133S	ST1133NS	94356-155	ST1156E
94196-766	ST4766E	94351-155	ST1156N	94356-200	ST1201E
94204-65	ST274A	94351-155S	ST1156NS	94536-111	ST1111E
94204-71	ST280A	94351-160	ST1162N	94601-12G/M	ST41200N
94204-74	ST274A	94351-186S	ST1186NS	94601-767H	ST4767N
94204-81	ST280A	94351-200	ST1201N		

Table C - Converting Imprimis to Seagate Numbers

Hard Drive Parameters

ALPS							
Model Number	Formatted Capacity	No. of Heads	No. of Cylinders	SPT	Avg in ms	Interface	Form Factor
DRND-10A	10	2	615	17	60	MFM	3.50 HH
DRND-20A	20	4	615	17	60	MFM	3.50 HH
DRPO-20D	20	2	615	26	60	RLL	3.50 HH
DR311C	106	2	2109	63	13	IDE	3.5
	Translated Parameters: 13 Heads 954 Cylinders 63 SPT - This is your CMOS setting						
DR311D	106	2	2109	63	13	SCSI	3.5
DR312C	212	4	2109	63	13	IDE	3.5
	Translated Parameters: 13 Heads 965 Cylinders 33 SPT - This is your CMOS setting						
DR312D	212	4	2109	63	13	SCSI	3.5
RPO-20A	20	2	615	26	60	RLL	3.50 HH

AMPEX							
Model Number	Formatted Capacity	No. of Heads	No. of Cylinders	SPT	Avg in ms	Interface	Form Factor
PYXIS-7	5	2	320	17	90	MFM	5.25 FH
PYXIS-13	10	4	320	17	90	MFM	5.25 FH
PYXIS-20	15	6	320	17	90	MFM	5.25 FH
PYXIS-27	20	8	320	17	90	MFM	5.25 FH

AREAL							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
A 120	136	4	1024	60	15	AT-IDE	2.5
	Translated Parameters: 8 Heads 548 Cylinders 61 SPT - This is your CMOS setting						
A 180	81	4	1488	60	17	AT-IDE	2.50
	Translated Parameters: 10 Heads 715 Cylinders 50 SPT - This is your CMOS setting						
MD-2060	62	2	1024	60	19	AT-IDE	2.50
	Translated Parameters: 2 Heads 1024 Cylinders 60 SPT - This is your CMOS setting						
MD-2080	80	2	1323	60	19	AT-IDE	2.50
	Translated Parameters: 9 Heads 1021 Cylinders 17 SPT - This is your CMOS setting						
2085	85	2	1410	59	19	IDE	2.5
	Translated Parameters: 10 Heads 976 Cylinders 17 SPT - This is your CMOS setting						
2100	100	2	1632	63	19	IDE	2.5
	Translated Parameters: 12 Heads 957 Cylinders 17 SPT - This is your CMOS setting						

AURA							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
AU63	63	2	1330	43	17	PCMCIA	1.8
AU126	125	4	1330	43	17	PCMCIA	1.8

ATASI							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
AT-676	765	15	1632	54	16	ESDI	5.25 FH
AT-3020	17	3	645	17	38	MFM	5.25 FH
AT-3033	28	5	645	17	33	MFM	5.25 FH
AT-3046	39	7	645	17	33	MFM	5.25 FH
AT-3051	43	7	704	17	33	MFM	5.25 FH
AT-3051+	44	7	733	17	33	MFM	5.25 FH
AT-3053	44	7	733	17	33	MFM	5.25 FH
AT-3075	67	8	1024	17	33	MFM	5.25 FH
AT-3085	71	8	1024	26	28	RLL	5.25 FH
AT-3128	109	8	1024	26	28	RLL	5.25 FH
AT-6120	1051	15	1925	71	14	ESDI	5.25 FH

BASF							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
6185	23	6	440	17	99	MFM	5.25 FH
6186	15	4	440	17	70	MFM	5.25 FH
6187	8	2	440	17	70	MFM	5.25 FH
6188-R1	10	2	612	17	70	MFM	5.25 FH
6188-R3	21	4	612	17	70	MFM	5.25 FH

BRAND TECHNOLOGY							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
BT3400	400	6	1800	72	12	AT or SCSI-2	3.50 HH
	Translated Parameters: 15 Heads 1021 Cylinders 51 SPT - This is your CMOS setting						
BT 3650	650	10	1800	36	12	AT or SCSI-2	3.50 HH
	Translated Parameters: 16 Heads 1017 Cylinders 78 SPT - This is your CMOS setting						
BT 8085	71	8	1024	17	25	MFM	5.25 FH
BT 8128	109	8	1024	26	25	RLL	5.25 FH
BT 8170	142	8	1024	36	36	ESDI	5.25 FH
BT 9170A	150	7	1165	36	16	AT-IDE	3.50 HH
	Translated Parameters: 9 Heads 968 Cylinders 33 SPT - This is your CMOS setting						
BT 9170E	150	7	1166	36	16	ESDI	3.50 HH
BT 9170S	150	7	1166	36	16	SCSI	3.50 HH
BT 9220A	200	9	1209	36	16	AT-IDE	3.50 HH
	Translated Parameters: 12 Heads 968 Cylinders 33 SPT - This is your CMOS setting						
BT 9220E	200	9	1210	36	16	ESDI	3.50 HH
BT 9220S	200	9	1210	36	16	SCSI	3.50 HH

BULL							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
D-530	26	3	987	17	65	MFM	5.25 FH
D-550	43	5	987	17	65	MFM	5.25 FH
D-570	60	7	987	17	65	MFM	5.25 FH
D-585	71	7	1166	17	65	MFM/RLL	5.25 FH

C. ITOH (also see Ye-Data)							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
YD-3042	44	4	788	26	26	RLL	5.25 FH
YD-3082	87	8	788	26	26	RLL	5.25 FH
YD-3530	32	5	731	17	26	MFM	5.25 FH
YD-3540	45	7	731	17	26	MFM	5.25 FH

CARDIFF							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
F-3053	44	5	1024	17	20	MFM	3.50 HH
F-3080E	68	5	1024	26	20	ESDI	3.50 HH
F-3080S	68	5	1024	26	20	SCSI	3.50 HH
F-3127E	109	5	1024	35	20	ESDI	3.50 HH
F-3127S	109	5	1024	35	20	SCSI	3.5O HH

CDC (also see Seagate)							
Model Number	Formatted Capacity	No. of Heads	No. of Cylinders	SPT	Avg in ms	Interface	Form Factor
94155-19	18	3	697	17	28	MFM	5.25 FH
94155-21	21	3	697	17	28	MFM	5.25 FH
94155-25 Wren I	24	4	697	17	28	MFM	5.25 FH
94155-28	24	4	697	17	28	MFM	5.25 FH
94155-36 Wren I	36	5	697	17	28	MFM	5.25 FH
94155-38	31	5	733	17	28	MFM	5.25 FH
94155-48 Wren II	40	5	925	17	28	MFM	5.25 FH
94155-51 Wren II	43	5	989	17	28	MFM	5.25 FH
94155-57 Wren II	48	6	925	17	28	MFM	5.25 FH
94155-67 Wren II	56	7	925	17	28	MFM	5.25 FH
94155-77 Wren II	64	8	925	17	28	MFM	5.25 FH
94155-85 Wren II	71	8	1024	17	28	MFM	5.25 FH
94155-86 Wren II	72	9	925	17	28	MFM	5.25 FH
94155-96 Wren II	80	9	1024	17	28	MFM	5.25 FH

CDC (also se Seagate) ~ Continued							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
94155-120 Wren II	102	8	960	26	28	RLL	5.25 FH
94155-135 Wren II	115	9	960	26	28	RLL	5.25 FH
94156-48 Wren II	40	5	925	17	28	ESDI	5.25 FH
94156-67 Wren II	56	7	925	17	28	ESDI	5.25 FH
94156-86 Wren II	72	9	925	17	28	ESDI	5.25 FH
94161-86 Wren III	86	9	969	26	17	SCSI	5.25 FH
94161-101 Wren III	86	5	969	26	16	SCSI	5.25 FH
94161-121 Wren III	120	7	969	26	16	SCSI	5.25 FH
94161-141 Wren III	140	7	969	26	16	SCSI	5.25 FH
94161-155	150	9	969	36	16	SCSI	5.25 FH
94161-182 Wren III	155	9	969	36	16	SCSI	5.25 FH
94166-101 Wren III	84	5	969	34	18	ESDI	5.25 FH
94166-141 Wren III	118	7	969	34	18	ESDI	5.25 FH
94166-182 Wren III	152	9	969	34	16	ESDI	5.25 FH
94171-300	288	9	1365	36	18	SCSI	5.25 FH
94171-344	335	9	1549	36	18	SCSI	5.25 FH

CDC (also see Seagate) ~ CONTINUED							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
94171-350 Wren IV	300	9	1412	46	17	SCSI	5.25 FH
94171-375 Wren V	375	9	1549	35	16	SCSI	5.25 FH
94171-376 Wren IV	330	9	1546	45	18	SCSI	5.25 FH
94181-385D	337	15	791	36	11	SCSI	5.25 FH
94181-385H Runner	330	15	791	55	11	SCSI	5.25 FH
94181-574 Wren V	574	15	1549	36	16	SCSI	5.25 FH
94181-702 Wren V	601	15	1546	54	16	SCSI	5.25 FH
94181-702M Wren V	613	15	1549	54	16	SCSI	5.25 FH
94186-265 Wren V	221	9	1412	34	18	ESDI	5.25 FH
94186-324 Wren V	270	11	1412	34	18	ESDI	5.25 FH
94186-383 Wren V	319	13	1412	34	18	ESDI	5.25 FH
94186-383H Wren V	319	15	1224	34	15	ESDI	5.25 FH
94186-383S Wren V	338	13	1412	36	19	ESDI	5.25 FH
94186-442 Wren V	368	15	1412	34	16	ESDI	5.25 FH
94186-442H Wren V	368	15	1412	34	16	ESDI	5.25 FH
94191-766 Wren VI	676	15	1632	54	16	SCSI	5.25 FH

CDC (also see Seagate) ~ CONTINUED							
Model Number	Formatted Capacity	No. of Heads	No. of Cylinders	SPT	Avg in ms	Interface	Form Factor
94191-766M Wren VI	676	15	1632	54	16	SCSI	5.25 FH
94196-383 Wren VI	338	13	1412	34	16	ESDI	5.25 FH
94196-766 Wren VI	664	15	1632	54	16	ESDI	5.25 FH
94204-65	65	5	948	26	29	AT-IDE	5.25 HH
94204-71	71	5	1032	26	29	AT-IDE	5.25 HH
	Translated Parameters: 5 Heads 989 Cylinders 27 SPT - This is your CMOS setting						
94204-74 Wren II	65	5	948	26	29	AT-IDE	5.25 HH
	Translated Parameters: 8 Heads 933 Cylinders 17 SPT - This is your CMOS setting						
94204-81 Wren II	71	5	1032	26	28	AT-IDE	5.25 HH
	Translated Parameters: 8 Heads 1024 Cylinders 27 SPT - This is your CMOS setting						
94205-30 Wren II	25	3	989	26	28	RLL	5.25HH
94205-41 Wren II	38	3	989	26	28	RLL	5.25 HH
94205-51 Wren II	43	5	989	26	28	RLL	5.25 HH
94205-77	65	5	989	26	28	RLL	5.25 HH
94205-75 Wren II	60	5	989	26	30	AT-IDE	5.25 HH
	Translated Parameters: 5 Heads 989 Cylinders 26 SPT - This is your CMOS setting						
94211-91 Wren II	91	5	969	36	16	SCSI	5.25 FH
94211-106 Wren III	91	5	1022	26	18	SCSI	5.25 FH
94211-209 Wren V	142	5	1547	36	18	SCSI	5.25 FH
94216-106 Wren III	89	5	1024	34	18	ESDI	5.25 HH

CDC (also see Seagate) ~ Continued							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
94221-125 Wren V	107	3	1544	36	18	SCSI	5.25 HH
94221-190 Wren V	190	5	1547	36	18	SCSI	5.25 HH
94221-209 Wren V	183	5	1544	36	18	SCSI	5.25 HH
94241-383 Wren VI	338	7	1261	36	14	SCSI	5.25 HH
94241-502 Wren VI	435	7	1755	69	16	SCSI	5.25 HH
94244-219	191	4	1747	54	16	AT-IDE	5.25 HH
	Translated Parameters: 16 Heads 536 Cylinders 44 SPT - This is your CMOS setting.						
94244-274 Wren VI	191	4	1747	54	16	AT-IDE	5.25 HH
	Translated Parameters: 14 Heads 983 Cylinders 33 SPT - This is your CMOS setting.						
94244-383 Wren VI	338	7	1747	54	16	AT-IDE	5.25 HH
	Translated Parameters: 11 Heads 952 Cylinders 63 SPT - This is your CMOS setting.						
94246-182 Wren VI	160	4	1453	54	15	ESDI	5.25 HH
94246-383 Wren VI	338	7	1747	54	15	ESDI	5.25 HH
94295-51	43	5	989	17	28	MFM	5.25 FH
94311-136S Swift SL	120	5	1068	36	15	SCSI-2	3.50 3H
94314-136 Swift SL	120	5	1068	36	15	AT-IDE	3.50 3H
	Translated Parameters: 11 Heads 917 Cylinders 17 SPT - This is your CMOS setting.						
94316-111 Swift	98	5	1072	36	23	ESDI	3.50 HH

CDC (alsp see Seagate) ~ Continued							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
94316-136 Swift SL	120	5	1268	36	15	ESDI	3.50 3H
94316-155 Swift	138	7	1072	36	15	ESDI	3.50 HH
94316-200 Swift	177	9	1072	36	15	ESDI	3.50 HH
94335-55	46	5	1268	17	25	MFM	3.50 HH
94335-100	83	9	1268	17	25	MFM	3.50 HH
94351-90	79	5	1068	29	15	SCSI	3.50 HH
94351-111 Swift	98	5	1068	36	15	SCSI	3.50 HH
94351-126 Swift	111	7	1068	29	15	SCSI	3.50 HH
94351-128	111	7	1068	36	15	SCSI	3.50 HH
94351-133 Swift	116	7	1268	36	15	SCSI	3.50 HH
94351-133S Swift	116	5	1268	36	15	SCSI-2	3.50 HH
94351-134	117	7	1068	36	15	SCSI	3.50 HH
94351-155 Swift	138	7	1068	36	15	SCSI	3.50 HH
94351-155S Swift	138	7	1068	36	15	SCSI-2	3.50 HH
94351-160 Swift	142	9	1068	29	15	SCSI	3.50 HH
94351-172	150	9	1068	36	15	SCSI	3.50 HH
94351-186S Swift	163	7	1268	36	15	SCSI-2	3.50 HH

CDC (also see Seagate) ~ Continued							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
94351-200 Swift	177	9	1068	36	15	SCSI	3.50 HH
94351-200S Swift	177	9	1068	36	15	SCSI-2	3.50 HH
94351-230 Swift	210	9	1272	36	15	SCSI	3.50 HH
94351-230S Swift	210	9	1268	36	15	SCSI-2	3.50 HH
94354-90 Swift	79	5	1072	29	15	AT-IDE	3.50 HH
	Translated Parameters: 10 Heads 536 Cylinders 29 SPT - This is your CMOS setting						
94354-111 Swift	98	5	1072	36	15	AT-IDE	3.50 HH
	Translated Parameters: 10 Heads 1024 Cylinders 17 SPT - This is your CMOS setting						
94354-126 Swift	111	7	1072	29	15	AT-IDE	3.50 HH
	Translated Parameters: 13 Heads 984 Cylinders 17 SPT - This is your CMOS setting						
94354-133 Swift	117	5	1272	36	15	AT-IDE	3.50 HH
	Translated Parameters: 14 Heads 961 Cylinders 17 SPT - This is your CMOS setting						
94354-155 Swift	138	7	1072	36	15	AT-IDE	3.50 HH
	Translated Parameters: 16 Heads 993 Cylinders 17 SPT - This is your CMOS setting						
94354-160 Swift	143	9	1072	29	15	AT-IDE	3.50 HH
	Translated Parameters: 9 Heads 942 Cylinders 33 SPT - This is your CMOS setting						
94354-186 Swift	164	7	1272	36	15	AT-IDE	3.50 HH
	Translated Parameters: 10 Heads 971 Cylinders 33 SPT - This is your CMOS setting						
94354-200 Swift	177	9	1072	36	15	AT-IDE	3.50 HH
	Translated Parameters: 11 Heads 956 Cylinders 33 SPT - This is your CMOS setting						

CDC (also see Seagate) ~ Continued							
Model Number	Formatted Capacity	No. of Heads	No. of Cylinders	SPT	Avg in ms	Interface	Form Factor
94354-230 Swift	211	9	1272	36	15	AT-IDE	3.50 HH
	Translated Parameters: 12 Heads 989 Cylinders 35 SPT - This is your CMOS setting						
94355-55 Swift	46	5	1072	17	16	MFM	3.50 HH
94355-100 Swift	83	9	1072	17	15	MFM	3.50 HH
94355-150 Swift	128	9	1072	26	15	RLL	3.50 HH
94356-111 Swift	98	5	1072	36	15	ESDI	3.50 HH
94356-155 Swift	138	7	1072	36	15	ESDI	3.50 HH
94356-200 Swift	171	9	1072	36	15	ESDI	3.50 HH
94601-12G/M	1037	15	1931	VAR	15	SCSI	5.25 FH
94601-767H	665	15	1356	64	12	SCSI-2	5.25 FH
94601-767M	676	15	1508	54	12	SCSI	5.25 FH
97155-36	30	5	733	17	28	MFM	8.00
9720-1123 SABRE	964	19	1610	VAR	15	SMD	8.00
9720-1230 SABRE	1236	15	1635	VAR	15	SMD SCSI	8.00
9720-2270 SABRE	1948	19	2551	VAR	12	SMD	8.00
9720-2500 SABRE	2145	19	2220	VAR	12	SMD SCSI	8.00
9720-368 SABRE	368	10	1635	VAR	18	SMD SCSI	8.00

CDC (also see Seagate) ~ Continued							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
9720-500 SABRE	500	10	1217	VAR	18	SMD SCSI	8.00
9720-736 SABRE	741	15	1217	VAR	15	SMC SCSI	8.00
9720-850 SABRE	851	15	1635	VAR	15	SMD SCSI	8.00
97229-1150	990	19	1784	VAR	15	IPI-2	8.00
97500-12G	1050	17	1884	VAR	15	IPI-2	5.25 FH
97500-15G Elite	1285	17	1991	VAR	16	SCSI-2	5.25 FH
BJ7D5A 77731608	29	5	670	17	28	MFM	5.25 FH
BJ7D5A 77731613	33	5	733	17	28	MFM	5.25 FH
BJ7D5A 77731614	23	4	670	17	28	MFM	5.25 FH

CENTURY DATA							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
CAST 10203E	55	3	1050	35	28	ESDI	5.25 FH
CAST 10203S	55	3	1050	35	28	SCSI	5.25 FH
CAST 10304E	75	4	1050	35	28	ESDI	5.25 FH
CAST 10304S	75	4	1050	35	28	SCSI	5.25 FH

CENTURY DATA (Continued)							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
CAST 10305E	94	5	1050	35	28	ESDI	5.25 FH
CAST 10305S	94	5	1050	35	28	SCSI	5.25 FH
CAST 14404E	114	4	1590	35	25	ESDI	5.25 FH
CAST 14404S	114	4	1590	35	25	SCSI	5.25 FH
CAST 14405E	140	5	1590	35	25	ESDI	5.25 FH
CAST 14405S	140	5	1590	35	25	SCSI	5.25 FH
CAST 14406E	170	6	1590	35	25	ESDI	5.25 FH
CAST 14406S	170	6	1590	35	25	SCSI	5.25 FH
CAST 24509E	258	9	1599	35	18	ESDI	5.25 FH
CAST 24509S	258	9	1599	35	18	SCSI	5.25 FH
CAST 24611E	315	11	1599	35	18	ESDI	5.25 FH
CAST 24611S	315	11	1599	35	18	SCSI	5.25 FH
CAST 24713E	372	13	1599	35	18	ESDI	5.25 FH
CAST 24713S	372	13	1599	35	18	SCSI	5.25 FH

CMI							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
CM 3206	10	4	306	17	99	MFM	5.25 FH
CM 3426	20	4	615	17	85	MFM	5.25 FH
CM 5018H	15	2	860	17	85	MFM	5.25 FH
CM 5205	4	2	256	17	105	MFM	5.25 FH
CM 5206	5	2	306	17	99	MFM	5.25 FH
CM 5410	8	4	256	17	105	MFM	5.25 FH
CM 5412	10	4	306	17	99	MFM	5.25 FH
CM 5616	13	6	256	17	105	MFM	5.25 FH
CM 5619	15	6	306	17	105	MFM	5.25 FH
CM 5826	21	8	306	17	99	MFM	5.25 FH
CM 6213	11	2	640	17	105	MFM	5.25 FH
CM 6426	21	4	615	17	40	MFM	5.25 FH
CM 6426S	22	4	640	17	40	MFM	5.25 FH
CM 6640	33	6	640	17	40	MFM	5.25 FH
CM 7660	50	6	960	17	40	MFM	5.25 FH
CM 7880	67	8	960	17	40	MFM	5.25 FH

CMS ENHANCEMENTS							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
F115ESDI-T	114	7	915	35	30	ESDI	5.25 FH
F150AT-CA	150	9	969	34	17	IDE	5.25 FH
	Translated Parameters: 9 Heads 986 Cylinders 33 SPT - This is your CMOS setting						
F150AT-WCA	150	7	1224	36	17	IDE	5.25 FH
	Translated Parameters: 9 Heads 986 Cylinders 33 SPT - This is your CMOS setting						
F150EQ-WCA	150	7	1224	36	17	ESDI	5.25 FH
F320AT-CA	320	15	1224	36	15	ESDI	5.25 FH
F70ESDI-T	73	2	1224	36	30	ESDI	5.25 FH
H330E1	330	7	1780	54	14	ESDI	5.25 FH
H340E1	340	7	1780	54	14	ESDI	5.25 FH
PS Express 150	150	7	1224	36	17	ESDI	5.25 FH
PS Express 320	320	15	1224	36	15	ESDI	5.25 FH

COGITO							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
CG-906	5	2	306	17	85	MFM	5.25 FH
CG-912	11	4	306	17	65	MFM	5.25 FH
CG-925	21	4	612	17	65	MFM	5.25 FH
PT-912	11	2	612	17	40	MFM	5.25 FH
PT-925	21	4	612	17	40	MFM	5.25 FH

CONNER							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
CP-340	42	4	788	26	29	SCSI	3.50 HH
CP-342	40	4	805	26	29	AT-IDE	3.5O HH
	Translated Parameters: 4 Heads 805 Cylinders 26 SPT - This is your CMOS setting						
CP-344	43	4	788	26	29	AT-IDE	3.50 HH
	Translated Parameters: 4 Heads 788 Cylinders 26 SPT - This is your CMOS setting						
CP-2020	21	2	642	32	23	SCSI	3.50 HH
CP-2024 KATO	21	2	653	32	40	AT/XT IDE	2.50 HH
	Translated Parameters: 2 Heads 653 Cylinders 32 SPT - This is your CMOS setting						
CP-2034 PANCHO	32	2	823	38	19	AT-IDE	2.50 HH
	Translated Parameters: 2 Heads 823 Cylinders 38 SPT - This is your CMOS setting						
CP-2064 PANCHO	64	4	823	38	19	AT-IDE	2.50 HH
	Translated Parameters: 4 Heads 823 Cylinders 38 SPT - This is your CMOS setting						
CP-2084 PANCHO	85	8	548	38	19	AT-IDE	2.50 HH
	Translated Parameters: 8 Heads 548 Cylinders 38 SPT - This is your CMOS setting						
CP-2304	215	8	1348	39	19	AT-IDE	3.50 HH
	Translated Parameters: 12 Heads 989 Cylinders 35 SPT - This is your CMOS setting						
CP-3000	43	5	976	17	27	AT-IDE	3.50 HH
	Translated Parameters: 5 Heads 988 Cylinders 17 SPT - This is your CMOS setting						
CP-3020	21	2	622	33	27	SCSI	3.50 HH
CP-3022	21	2	622	33	27	AT-IDE	3.50 HH
	Translated Parameters: 2 Heads 622 Cylinders 33 SPT - This is your CMOS setting						

CONNER							
Model Number	Formatted Capacity	No. of Heads	No. of Cylinders	SPT	Avg in ms	Interface	Form Factor
CP-3024	22	2	636	33	27	AT-IDE	3.50 HH
	Translated Parameters: 2 Heads 636 Cylinders 33 SPT - This is your CMOS setting						
CP-3040	42	2	1026	40	25	SCSI	3.50 HH
CP-3044	43	2	1047	40	25	AT-IDE	3.50 HH
	Translated Parameters: 5 Heads 988 Cylinders 17 SPT - This is your CMOS setting						
CP-3100	105	8	776	33	25	SCSI	3.50 HH
CP-3102	104	8	776	33	25	AT-IDE	3.50 HH
	Translated Parameters: 8 Heads 776 Cylinders 33 SPT - This is your CMOS setting						
CP-3104	105	8	776	33	25	AT-IDE	3.50 HH
	Translated Parameters: 8 Heads 776 Cylinders 33 SPT - This is your CMOS setting						
CP-3111	112	8	832	33	25	AT-IDE	3.50 HH
	Translated Parameters: 8 Heads 832 Cylinders 33 SPT - This is your CMOS setting						
CP-3114	112	8	832	33	25	AT-IDE	3.50 HH
	Translated Parameters: 8 Heads 832 Cylinders 33 SPT - This is your CMOS setting						
CP-3180	84	6	832	33	25	SCSI	3.50 HH
CP-3184	84	6	832	33	25	AT-IDE	3.50 HH
	Translated Parameters: 6 Heads 832 Cylinders 33 SPT - This is your CMOS setting						
CP-3200/F	213	8	1366	38	19/16	SCSI	3.50 HH
CP-3204/F	213	16	683	38	19/16	AT-IDE	3.50 HH
	Translated Parameters: 6 Heads 683 Cylinders 33 SPT - This is your CMOS setting						
CP-3209F	213	4	1366	38	16	MCA	3.50 HH
	Translated Parameters: 6 Heads 683 Cylinders 38 SPT - This is your CMOS setti						
CP-3304	340	8	1806	46	16	AT-IDE	3.50 HH
	Translated Parameters: 16 Heads 659 Cylinders 63 SPT - This is your CMOS setting						

CONNER (Continued)

Model Number	Formatted Capacity	No. of Heads	No. of Cylinders	SPT	Avg in ms	Interface	Form Factor
CP-3360	360	8	1806	49	12	SCSI-2	3.50 HH
CP-3364	360	8	1806	6349	12	PC/AT	3.50 HH
	Translated Parameters: 11 Heads 702 Cylinders 63 SPT - This is your CMOS setting						
CP-3500	510	12	1695	49	12	SCSI	3.50 HH
CP-3504	509	12	1695	49	12	AT-IDE	3.50 HH
	Translated Parameters: 16 Heads 987 Cylinders 63 SPT - This is your CMOS setting						
CP-3540	540	12	1806	49	12	SCSI-2	3.50 HH
CP-3544	540	12	1806	49	12	PC/AT	3.50 HH
	Translated Parameters: 16 Heads 987 Cylinders 38 SPT - This is your CMOS setting						
CP-4024 STUBBY	22	2	627	34	29	AT/XT-IDE	3.50 HH
CP-4044 STUBBY	43	2	1104	38	29	AT/XT-IDE	3.50 HH
	Translated Parameters: 7 Heads 699 Cylinders 17 SPT - This is your CMOS setting						
CP-30060	60	2	1524	39	19	SCSI	3.50 HH
CP-30064	61	2	1522	39	-	AT-IDE	3.50 HH
	Translated Parameters: 4 Heads 762 Cylinders 39 SPT - This is your CMOS setting						
CP-3544	540	12	1806	49	12	PC/AT	3.50 HH
	Translated Parameters: 16 Heads 987 Cylinders 38 SPT - This is your CMOS setting						
CP-3554	544	16	1054	63	12	AT-IDE	3.50 HH
CP-4024 STUBBY	22	2	627	34	29	AT/XT-IDE	3.50 HH
	Translated Parameters: 2 Heads 627 Cylinders 34 SPT - This is your CMOS setting						
CP-4044 STUBBY	43	2	1104	38	50	AT/XT-IDE	3.50 HH
	Translated Parameters: 7 Heads 699 Cylinders 17 SPT - This is your CMOS setting						

CONNER (Continued)							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
CP-30060	60	2	1524	39	19	SCSI	3.50 HH
CP-30064	61	2	1522	39	14	AT-IDE	3.50 HH
	Translated Parameters: 4 Heads 762 Cylinders 39 SPT - This is our CMOS setting						
CP-30080E	85	2	1806	47	17	PC/AT,SCSI	3.50 HH
CP-30080	84	4	1053	39	17	SCSI	3.50 HH
	Translated Parameters: 8 Heads 529 Cylinders 39 SPT - This is our CMOS setting						
CP-30084	84	4	1058	39	19	AT-IDE	3.50 HH
	Translated Parameters: 8 Heads 529 Cylinders 39 SPT - This is our CMOS setting						
CP-30084E	85	4	903	46	19	AT-IDE	3.50 HH
	Translated Parameters: 8 Heads 529 Cylinders 39 SPT - This is our CMOS setting						
CP-30100 HOPI	120	4	1522	39	19	SCSI	3.50 HH
CP-30104 H Allegheny	120	4	1522	39	19	AT-IDE	3.50 HH
	Translated Parameters: 8 Heads 762 Cylinders 39 SPT - This is our CMOS setting						
CP-30104 HOPI	120	4	1522	39	19	AT-IDE	3.50 HH
	Translated Parameters: 8 Heads 762 Cylinders 39 SPT - This is our CMOS setting						
CP-30109 HOPI	120	4	1522	39	19	MCA	3.50 HH
CP-30170E	170	4	1806	46	17	AT - IDE	3.50 HH
	Translated Parameters: 11 Heads 941 Cylinders 33 SPT - This is our CMOS setting						
CP-30200	212	4	2119	49	12	SCSI-2	3.50 HH
CP-30204	213	4	2119	49	12	AT-IDE	3.50 HH
	Translated Parameters: 16 Heads 683 Cylinders 38 SPT - This is our CMOS setting						

CONNER (Continued)

Model Number	Formatted Capacity	No. of Heads	No. of Cylinders	SPT	Avg in ms	Interface	Form Factor
CP-30254	251	4	1984	62	12	PC/AT	3.50 HH
	Translated Parameters: 4 Heads 990 Cylinders 33 SPT - This is our CMOS setting						
CP-30340	343	4	-	-	13	SCSI-2	3.50 HH
CP-30344	343	4	1121	60	13	PC/AT	3.50 HH
	Translated Parameters: 11 Heads 966 Cylinders 63 SPT - This is our CMOS setting						
CP-30540	545	6	1984	62	10	Fast SCSI-2	3.50 HH
CP-31370	1,371.80	14	2694	63	10	Fast SCSI-2	3.50 HH

CORE INTERNATIONAL

Model Number	Formatted Capacity	No. of Heads	No. of Cylinders	SPT	Avg in ms	Interface	Form Factor
AT 30	31	5	733	17	26	MFM	5.25 FH
AT 30R	48	5	733	26	26	RLL	5.25 FH
AT 32	31	5	733	17	21	MFM	5.25 HH
AT 32R	48	5	733	26	21	RLL	5.25 HH
AT 40	40	5	924	17	26	MFM	5.25 FH
AT 40R	61	5	924	26	26	RLL	5.25 FH
AT 63	42	5	988	17	26	MFM	5.25 FH
AT 63R	65	5	988	26	26	RLL	5.25 FH
AT 72	72	9	924	17	26	MFM	5.25 FH
AT 72R	107	9	924	26	26	RLL	5.25 FH
AT 150	150	8	1024	36	18	ESDI	5.25 FH
HC 40	40	4	564	35	10	RLL	5.25 FH
HC 90	91	5	969	35	16	RLL	5.25 HH

CORE INTERNATIONAL (Continued)							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
HC 100F	101	-	-	-	9	ESDI	5.25 FH
HC 150	156	9	969	35	16	RLL	5.25 FH
HC 175	177	9	1072	35	16	ESDI	5.25 FH
HC 260	260	12	1212	35	25	RLL	5.25 FH
HC 310	311	12	1582	35	16	RLL	5.25 FH
HC 315	340	8	1447	57	16	ESDI	5.25 FH
HC 380	383	15	1412	35	16	ESDI	5.25 FH
HC 650	658	15	1661	53	16	ESDI	5.25 FH
HC 650S	663	14	1661	56	18	SCSI	5.25 FH
HC 655	680	16	1447	57	16	ESDI	5.25 FH
HC 1000S	1200	16	1918	64	18	SCSI	5.25 FH
OPTIMA 30	31	5	733	17	21	MFM	5.25 HH
OPTIMA 30R	48	5	733	26	21	RLL	5.25 HH
OPTIMA 40	41	5	963	17	26	MFM	5.25 HH
OPTIMA 40R	64	5	963	26	26	RLL	5.25 HH
OPTIMA 70	71	9	918	17	26	MFM	5.25 FH
OPTIMA 70R	109	9	918	26	26	RLL	5.25 FH

CORPORATE SYSTEMS CENTER							
Model Number	Formatted Capacity	No. of Heads	No. of Cylinders	SPT	Avg in ms	Interface	Form Factor
GD 2024	21	2	653	32	23	XT/AT IDE	2.5 HH
	Translated Parameters: 4 Heads 615 Cylinders 17 SPT - This is your CMOS setting						
GD 2044	40	4	552	38	19	AT-IDE	2.5 HH
	Translated Parameters: 5 Heads 980 Cylinders 17 SPT - This is your CMOS setting						
GD 2061	60	4	823	38	19	AT-IDE	2.5 HH
	Translated Parameters: 4 Heads 823 Cylinders 38 SPT - This is your CMOS setting						
GD 2064	60	4	823	38	19	AT - IDE	2.5HH
	Translated Parameters: 4 Heads 823 Cylinders 38 SPT - This is your CMOS setting						
GD 2081	85	4	1097	38	19	AT-IDE	2.5HH
	Translated Parameters: 10 Heads 976 Cylinders 17 SPT - This is your CMOS setting						
GD 2084	85	4	1097	38	19	AT-IDE	2.5HH
	Translated Parameters: 10 Heads 976 Cylinders 17 SPT - This is your CMOS setting						
GD 2088	121	4	1097	38	19	AT-IDE	2.5HH
	Translated Parameters: 10 Heads 976 Cylinders 17 SPT - This is your CMOS setting						
GD 2121	120	4	1123	53	17	AT-IDE	2.5HH
	Translated Parameters: 14 Heads 992 Cylinders 17SPT - This is your CMOS setting						
GD 2124	120	4	1123	53	19	AT-IDE	2.5HH
	Translated Parameters: 14 Heads 992 Cylinders 17 SPT - This is your CMOS setting						
GD 2254	252	6	1339	47	12	AT-IDE	2.5HH
	Translated Parameters: 16 Heads 489 Cylinders 63 SPT - This is your CMOS setting						
GD 30001A	42	2	1045	40	19	AT-IDE	3.5HH
	Translated Parameters: 5 Heads 980 Cylinders 17 SPT - This is your CMOS setting						

CORPORATE SYSTEMS CENTER (Continued)							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
GD 30080E	80	4	1053	39	15	SCSI	3.5 HH
GD 30084E	85	4	1053	39	19	AT-IDE	3.5 HH
	Translated Parameters: 8 Heads 526 Cylinders 39 SPT - This is your CMOS setting						
GD 30085E	80	2	1806	46	19	AT-IDE	3.5 HH
	Translated Parameters: 4 Heads 903 Cylinders 46 SPT - This is your CMOS setting						
GD 30087	80	2	1806	46	19	AT - IDE	3.5HH
	Translated Parameters: 4 Heads 903 Cylinders 46 SPT - This is your CMOS setting						
GD 30100	121	4	1522	39	19	SCSI-II	3.5HH
GD 30100D	121	4	1524	39	19	AT-IDE	3.5HH
	Translated Parameters: 8 Heads 762 Cylinders 39 SPT - This is your CMOS setting						
GD 30174E	170	4	1806	46	15	AT-IDE	3.5HH
	Translated Parameters: 8 Heads 903 Cylinders 46 SPT - This is your CMOS setting						
GD 30175E	170	2	2116	63	19	AT-IDE	3.5HH
	Translated Parameters: 8 Heads 904 Cylinders 46 SPT - This is your CMOS setting						
GD 30200	212	4	2119	49	12	SCSI-II	3.5HH
GD 30204	212	4	2119	49	12	AT-IDE	3.5HH
	Translated Parameters: 12 Heads 989 Cylinders 35 SPT - This is your CMOS setting						
GD 30214	213	4	2119	49	14	AT-IDE	3.5HH
	Translated Parameters: 16 Heads 685 Cylinders 38 SPT - This is your CMOS setting						
GD 30254	251	4	1895	62	15	AT-IDE	3.5HH
	Translated Parameters: 10 Heads 895 Cylinders 55 SPT - This is your CMOS setting						
GD 30270	270	16	524	63	10	SCSI-II	3.5HH

CORPORATE SYSTEMS CENTER (Continued)							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
GD 30344	330	4	2116	63	12	AT-IDE	3.5 HH
	Translated Parameters: 16 Heads 904 Cylinders 46 SPT - This is your CMOS setting						
GD 3040A	42	2	1026	40	25	SCSI-34	3.5 HH
GD 3044	42	2	1047	40	25	AT - IDE	3.5HH
	Translated Parameters: 5 Heads 988 Cylinders 17 SPT - This is your CMOS setting						
GD 3045	42	2	1047	40	25	AT-IDE	3.5HH
	Translated Parameters: 5 Heads 977 Cylinders 17 SPT - This is your CMOS setting						
GD 30540	545	6	2243	60	10	SCSI-II	3.5HH
GD 30544	540	6	2249	59	12	AT-IDE	3.5HH
	Translated Parameters: 16 Heads 1023 Cylinders 63 SPT - This is your CMOS setting						
GD 30548	540	6	2242	47	10	SCSI-II	3.5HH
GD 31050	1037	8	2756	47	10	SCSI-II	3.5HH
GD 3114	112	8	832	33	15	AT-IDE	3.5HH
	Translated Parameters: 8 Heads 832 Cylinders 33 SPT - This is your CMOS setting						
GD 31370	1300	14	2387	37	10	SCSI-II	3.5HH
GD 3200D	212	8	1366	38	15	SCSI	3.5HH
GD 3200F	212	8	1366	38	15	SCSI	3.5HH
GD 3300	340	8	1807	46	12	SCSI-II	3.5HH
GD 3301	85	8	1806	46	12	AT-IDE	3.5HH
	Translated Parameters: 16 Heads 659 Cylinders 63 SPT - This is your CMOS setting						
GD 3500	510	12	1695	49	12	SCSI-II	3.5HH
GD 3504	510	12	1806	46	12	AT-IDE	3.5HH
	Translated Parameters: 16 Heads 987 Cylinders 63 SPT - This is your CMOS setting						

CORPORATE SYSTEMS CENTER (Continued)							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
GD 3544	524	6	1053	63	12	AT-IDE	3.5 HH
	Translated Parameters: 16 Heads 1023 Cylinders 63 SPT - This is your CMOS setting						
GD 5500	510	16	1441	62	6	SCSI-II	3.5 HH
PI - 16E	1340	19	1772	77	15	ESDI	5.2 FH
McHuge	334	20	1020	36	18	SCSI	External
McHuge II	641	15	1224	48	16	SCSI	External

DATA TECH MEMORIES							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
DTM-553	44	5	1024	17	65	MFM	5.25 FH
DTM-853	44	8	640	17	65	MFM	5.25 FH
DTM-885	71	8	1024	17	36	MFM	5.25 FH

DISCTEC							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
RHD-20	21	2	615	34	23	AT-IDE	3.50 HH
RHD-60	63	2	1024	60	22	AT-IDE	3.50 HH

DISCTRON (also see Otari)

Model Number	Formatted Capacity	No. of Heads	No. of Cylinders	SPT	Avg in ms	Interface	Form Factor
D-503	3	2	153	17	85	MFM	5.25 FH
D-504	4	2	215	17	85	MFM	5.25 FH
D-506	5	4	153	17	85	MFM	5.25 FH
D-507	5	2	306	17	85	MFM	5.25 FH
D-509	8	4	215	17	85	MFM	5.25 FH
D-512	11	8	153	17	85	MFM	5.25 FH
D-513	11	6	215	17	85	MFM	5.25 FH
D-514	11	4	306	17	85	MFM	5.25 FH
D-518	15	8	215	17	85	MFM	5.25 FH
D-519	16	6	306	17	85	MFM	5.25 FH
D-526	21	8	306	17	85	MFM	5.25 FH

DMA

Model Number	Formatted Capacity	No. of Heads	No. of Cylinders	SPT	Avg in ms	Interface	Form Factor
306	11	2	612	17	85	MFM	5.25 FH

DTC

Model Number	Formatted Capacity	No. of Heads	No. of Cylinders	SPT	Avg in ms	Interface	Form Factor
HF12	10	2	301	78	65	SCSI	5.25 HH
HF24	20	2	506	78	60	SCSI	5.25 HH

ECOL.2							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
EC-50	50	1	1720	60	40	IDE	3.50 HH
	Translated Parameters: 2 Heads 860 Cylinders 60 SPT - This is your CMOS setting						
EC-100	100	2	1720	60	40	IDE	3.50 HH
	Translated Parameters: 2 Heads 1005 Cylinders 17 SPT - This is your CMOS setting						
EC3-100	100	1	2300	85	20	IDE	3.50 HH
	Translated Parameters: 2 Heads 957 Cylinders 17 SPT - This is your CMOS setting						
EC3-200	200	2	2300	85	20	IDE	3.50 HH
	Translated Parameters: 2 Heads 986 Cylinders 33 SPT - This is your CMOS setting						

ELCOH							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
DISCACHE 10	10	4	320	17	65	MFM	5.25 FH
DISCACHE 20	20	8	320	17	65	MFM	5.25 FH

EMULEX							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
EMS/760	663	-	-	-	18	ESDI	5.25
ER2E/760	663	-	-	-	17	ESDI	5.25
ES36/760-1	663	-	-	-	17	ESDI	5.25

EPSON							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
HD 850	11	4	306	17	99	MFM	5.25 HH
HD 860	21	4	612	17	99	MFM	5.25 HH

ESPERT							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
EP-340A	42	4	1040	27	25	AT-IDE	3.50 HH
	Translated Parameters: 5 Heads 919 Cylinders 17 SPT - This is your CMOS setting						

FUJI							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
FK301-13	10	4	306	17	65	MFM	3.50 HH
FK302-13	10	2	612	17	65	MFM	3.50 HH
FK302-26	21	4	612	17	65	MFM	3.50 HH
FK302-39	32	6	612	17	65	MFM	3.50 HH
FK303-52	40	8	615	17	65	MFM	3.50 HH
FK305-26	21	4	615	17	65	MFM	3.50 HH
FK305-39	32	6	615	17	65	MFM	3.50 HH
FK305-39R	32	4	615	26	65	RLL	3.50 HH

FUJI (Continued)

Model Number	Formatted Capacity	No. of Heads	No. of Cylinders	SPT	Avg in ms	Interface	Form Factor
FK305-58R	49	6	615	26	65	RLL	3.50 HH
FK308S-39R	31	4	615	26	65	SCSI	3.50 HH
FK308S-58R	45	6	615	26	65	SCSI	3.50 HH
FK309-26	20	4	615	17	65	MFM	3.50 HH
FK309-39	32	6	615	17	65	MFM	3.50 HH
FK309-39R	30	4	615	26	65	RLL	3.50 HH
FK309S-50R	41	4	615	26	47	SCSI	3.50 HH

FUJITSU

Model Number	Formatted Capacity	No. of Heads	No. of Cylinders	SPT	Avg in ms	Interface	Form Factor
M 2225D/D2	21	4	615	32	40/35	MFM	3.50 HH
M 2225DR	32	4	615	26	35	RLL	3.50 HH
M 2226D/D2	30	6	615	32	40/35	MFM	3.50 HH
M 2225DR	49	6	615	26	35	RLL	3.50 HH
M 2227D/D2	40	8	615	32	40/35	MFM	3.50 HH
M 2227DR	65	8	615	26	35	RLL	3.50 HH
M 2230AS	5	2	320	17	65	MFM	5.25 FH
M 2230AT	5	2	320	17	65	MFM	5.25 FH
M 2231	5	2	306	17	80	MFM	5.25 FH
M 2233AS	11	4	320	17	80	MFM	5.25 FH
M 2233AT	11	4	320	17	95	MFM	5.25 HH
M 2234AS	16	6	320	17	80	MFM	5.25 FH
M 2235AS	22	8	320	17	80	MFM	5.25 FH
M 2241AS/AS2	25	4	754	32	33/30	MFM	5.25 FH

FUJITSU (Continued)							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
M 2242AS/AS2	43	7	754	17	33/30	MFM	5.25 FH
M 2243AS/AS2	68	11	754	17	33/30	MFM	5.25 FH
M 2243R	110	7	1186	26	25	RLL	5.25 HH
M 2243T	68	7	1186	17	25	MFM	5.25 HH
M 2245SA	120	7	823	35	25	SCSI	5.25 HH
M 2246E	172	10	823	35	25	ESDI	5.25 FH
M 2246SA	148	10	823	35	25	SCSI	5.25 FH
M 2247E	143	7	1243	64	18	ESDI	5.25 FH
M 2247S	138	7	1243	65	18	SCSI	5.25 FH
M 2247SA	149	7	1243	36	18	SCSI	5.25 FH
M 2247SB	160	7	1243	19	18	SCSI	5.25 FH
M 2248E	224	11	1243	64	18	ESDI	5.25 FH
M 2248S	221	11	1243	65	18	SCSI	5.25 FH
M 2248SA	238	11	1243	36	18	SCSI	5.25 FH
M 2248SB	252	11	1243	19	18	SCSI	5.25 FH
M 2249E	305	15	1243	64	18	ESDI	5.25 FH
M 2249S	303	15	1243	65	18	SCSI	5.25 FH
M 2249SA	324	15	1243	36	18	SCSI	5.25 FH
M 2249SB	343	15	1243	19	18	SCSI	5.25 FH
M 2261	357	8	1658	-	16	ESDI/SCSI	5.25 FH
M 2261E	326	8	1658	53	16	ESDI	5.25 FH
M 2262E	448	11	1658	48	16	ESDI	5.25 FH
M 2263	671	15	1658	-	16	ESDI/SCSI	5.25 FH

FUJITSU (Continued)							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
M 2614T	180	8	1334	33	20	AT-IDE	3.50 HH
M 2622SA	330	8	1435	56	12	SCSI	3.50 HH
M 2622T	330	8	1435	56	12	AT-IDE	3.50 HH
M 2623SA	425	10	1435	56	12	SCSI	3.50 HH
M 2623T	425	10	1435	56	12	AT-IDE	3.50 HH
M 2624SA	520	12	1435	56	12	SCSI	3.50 HH
M 2624T	520	12	1435	56	12	AT-IDE	3.50 HH
M 2635FA	425	9	1435	64	12	SCSI-1/2	3.50 HH
M 2651S	1313	16	1944	64	11	SCSI-2	5.25 FH
M 2652S	1752	20	1944	84	11	SCSI-2	5.25 FH
M 2652P	1586	20	1893	84	11	IPI-2	5.25 FH
M 2653	1400	15	2078	88	12	SCSI	5.25 FH
M 2654	2100	21	2179	88	12	SCSI	5.25 FH
M 2671P	2640	15	2671	88	12	IPI-2	5 x 8.5 x 15"

HEWLETT-PACKARD							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
HP-97500	20	-	-	-	-	SCSI	3.50 HH
HP-97530E	136	4	-	-	18	ESDI	5.25 FH
HP-97530S	204	6	-	-	18	SCSI	5.25 FH
HP-97532E	103	-	-	-	17	ESDI	5.25 FH

HEWLETT-PACKARD (Continued)							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
HP-97500	20	4	615	17	28	SCSI	3.50 HH
HP-97530E	136	4	1229	36	18	ESDI	5.25 FH
HP-97530S	204	6	1643	64	18	SCSI	5.25 FH
HP-97532E	103	4	1643	64	17	ESDI	5.25 FH
HP-97533E	155	6	1643	64	17	ESDI	5.25 FH
HP-97536E	311	12	1643	64	17	ESDI	5.25 FH
HP-97544E	340	8	1457	57	17	ESDI	5.25 FH
HP-97544S/D	331	8	1447	56	17	SCSI	5.25 FH
HP-97544T/P	331	8	1447	56	17	SCSI-2	5.25 FH
HP-97548E	680	16	1457	57	17	ESDI	5.25 FH
HP-97548S/F	663	16	1447	56	17	SCSI	5.25 FH
HP-97548T/P	663	16	1447	56	17	SCSI-2	5.25 FH
HP-97549T/P	1000	16	1911	64	18	SCSI-2	5.25 FH
HP-97556E	681	11	1680	72	14	ESDI	5.25 FH
HP-97556	677	11	1670	72	13.5	SCSI-2	5.25 FH
HP-97556T/P	673	11	1670	72	14	SCSI-2	5.25 FH
HP-97558E	1084	15	1962	72	14	ESDI	5.25 FH
HP-97558	1069	15	1935	72	13.5	SCSI-2	5.25 FH
HP-97558T/P	1075	15	1952	72	14	SCSI-2	5.25 FH
HP-97560	1355	19	1935	72	13.5	SCSI-2	5.25 FH
HP-97560E	1374	19	1962	72	14	ESDI	5.25 FH
HP-97560T/P	1363	19	1952	72	14	SCSI-2	5.25 FH
HP-C2233	234	5	1546	72	12.6	IDE,SCSI-2	3.50 HH

HEWLETT-PACKARD (Continued)							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
HP-C2233S	238	5	1511	49	13	SCSI-2	3.50 HH
HP-C2234	328	7	1546	61	12.6	AT - IDE	3.50 HH
	Translated Parameters: 10 Heads 1016 Cylinders 63 SPT - This is your CMOS setting						
HP-C2234S	334	7	1511	61	13	SCSI-2	3.50 HH
HP-C2235	422	9	1546	61	12.6	IDE,SCSI-2	3.50 HH
	Translated Parameters: 13 Heads 1006 Cylinders 63 SPT - This is your CMOS setting						
HP-C2235S	429	9	1511	73	13	SCSI-2	3.50 HH
HP-C3007	1370	13	2255	73	11.5	SCSI-2	5.25 FH
HP-C3009	1792	17	2255	73	11.5	SCSI-2	5.25 FH
HP-C3010	2003	19	2255	73	11.5	SCSI-2	5.25 FH
HP-C3010	1027	19	1100	73	9	SCSI-2	5.25 FH
HP-D1660A	333	8	1457	57	16	ESDI	5.25 FH
HP-D1661A	667	16	1457	57	16	ESDI	5.25 FH

HITACHI							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
DK 301-1	10	4	306	17	85	MFM	3.50 HH
DK 301-2	15	6	306	17	85	MFM	3.50 HH
DK 312C-20	209	10	1076	38	16	SCSI	3.50 HH
DK 312C-25	251	12	1076	38	16	SCSI	3.50 HH
DK 314C-41	419	14	1076	38	17	SCSI	3.50 HH

HITACHI (Continued)							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
DK 315C-11	1100	15	1457	63	11.8	Fast SCSI-2	3.50 HH
DK-315C-14	1400	15	1457	63	11.8	Fast SCSI-2	3.50 HH
DK 502-2	21	4	615	17	85	MFM	5.25 HH
DK 511-3	30	5	699	17	30	MFM	5.25 FH
DK 511-5	42	7	699	17	30	MFM	5.25 FH
DK 511-8	67	10	823	17	23	MFM	5.25 FH
DK 512-8	67	5	823	34	23	ESDI	5.25 FH
DK 512C-8	67	5	823	34	23	SCSI	5.25 FH
DK 512-12	94	7	823	34	23	ESDI	5.25 FH
DK 512C-12	94	7	823	34	23	SCSI	5.25 FH
DK 512-17	134	10	823	34	23	ESDI	5.25 FH
DK 512C-17	134	10	819	34	23	SCSI	5.25 FH
DK 514-38	330	14	903	51	16	ESDI	5.25 FH
DK 514C-38	321	14	903	51	16	SCSI	5.25 FH
DK 514S-38	330	14	903	51	14	SMD	5.25 FH
DK 515-12	1229	15	1224	69	14	ESDI	5.25 FH
DK 515-78	673	14	1361	69	16	ESDI, SCSI, E-SMD	5.25 FH
DK 515C-78	670.5	14	1261	69	16	ESDI, SCSI, E-SMD	5.25 FH
DK 516-12	1230	15	1778	77	16	ESDI	5.25 FH
DK 516-15	1320	15	2235	77	14	ESDI	5.25 FH
DK 516C-16	1500	15	2172	81	14	SCSI-2	5.25 FH
DK 517C	2900	21	2381	81	12.8	Fast SCSI-2	5.25 FH

HITACHI (Continued)							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
DK 517C-26	2000	14	2381	81	12	SCSI-2	5.25 FH
DK 517C-37	2900	21	2381	81	12	SCSI-2	5.25 FH
DK 521-5	42	6	823	17	25	MFM	5.25 HH
DK 522-10	103	6	823	36	25	ESDI	5.25 HH
DK 522C-10	88	6	819	35	25	SCSI	5.25 HH

IBM							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
20MB(2)	21	4	615	17	40	MFM	5.25 FH
20MB(13)	21	8	306	17	40	MFM	5.25 FH
30MB(22)	31	5	733	17	40	MFM	5.25 FH
0661-371	320	14	949	48	12	SCSI-2	3.50 HH
0661-467	400	14	1199	48	11	SCSI-2	3.50 HH
0663-H11/L11	868	13	2051	66	10	SCSI	3.50 HH
0663-H12/L12	1004	15	2051	66	10	SCSI	3.50 HH
0671E	319	15	1224	34	20	ESDI	5.25 HH
0671S	319	15	1224	34	20	SCSI	5.25 HH
0681	476	11	1458	58	13	SCSI-2	5.25 HH
WDS-L40	41	2	1038	39	17	SCSI-2	3.50 HH
WDA-L42	42	2	1067	39	17	AT-IDE	3.50 HH
WDS-L42	42	2	1066	39	17	SCSI	3.50 HH
WD-240	43	2	1120	38	19	PS/2	2.50

IBM (Continued)							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
WDA-240	43	2	1122	38	19	AT-IDE	2.50
	Translated Parameters: 14 Heads 10214 Cylinders 33 SPT - This is your CMOS setting						
WDS-240	43	2	1120	38	19	SCSI	2.50
WD-380	80	4	1021	39	16	PS/2	3.50 HH
WDA-380	80	4	1021	39	16	AT-IDE	3.50 HH
	Translated Parameters: 9 Heads 1021 Cylinders 17 SPT - This is your CMOS setting						
WDS-380	80	4	1021	39	16	SCSI-2	3.50 HH
WD-387	61	4	928	32	23	PS/2	3.50 HH
WD-3100	105	2	1990	44	12	SCSI-2	3.50 HH
WD-3158	120	8	920	32	23	PS/2	3.50 HH
WD-3160	160	8	1021	39	16	PS/2	3.50 HH
WDA-3160	160	8	1021	39	16	AT-IDE	3.50 HH
	Translated Parameters: 8 Heads 1021 Cylinders 39 SPT - This is your CMOS setting						
WDS-3160	160	8	1021	39	16	SCSI-2	3.50 HH
WDS-2200	210	4	1990	44	12	SCSI	3.50 HH

IOMEGA							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
MultiDisk 150	150	2	1380	36	18	SCSI-2	Removable 5.25

IMI							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
5006	5	2	306	17	85	MFM	5.25 FH
5007	5	2	312	17	85	MFM	5.25 FH
5012	10	4	306	17	85	MFM	5.25 FH
5018	15	6	306	17	85	MFM	5.25 FH
5021H	15	4	306	17	85	MFM	5.25 FH
7720	21	4	310	17	85	MFM	8.00
7740	43	8	315	17	85	MFM	8.00

JCT							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
100	5	2	226	17	110	MFM	5.25 HH
105	7	4	306	17	110	MFM	5.25 HH
110	14	8	306	17	130	MFM	5.25 HH
120	20	4	615	17	100	MFM	5.25 HH
1000	5	2	226	17	110	Commodore	5.25 HH
1005	7	4	306	17	110	Commodore	5.25 HH
1010	14	8	306	-	130	Commodore	5.25 HH

KALOK							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
KL 320 Octagon I	21	4	615	17	48	MFM	3.50 HH
KL 330 Octagon I	32	4	615	26	40	RLL	3.50 HH
KL 341 Octagon I	40	4	644	26	25	SCSI	3.50 HH
KL 343 Octagon I	42	4	676	31	25	AT-IDE	3.50 HH
KL 3100 Octagon II	105	6	820	35	19	AT-IDE	3.50 HH
KL 3120 Octagon II	120	6	820	40	19	AT-IDE	3.50 HH
P5-125	125	2	2048	80	17	AT-IDE	3.50 .5"
P5-250	251	4	2048	80	17	AT-IDE	3.50 .5"

KYOCERA							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
KC 20A/B	21	4	615	17	65/62	MFM	3.50 HH
KC 30A/B	32	4	615	26	65/62	RLL	3.50 HH
KC 40GA	41	2	1075	26	28	AT-IDE	3.50 HH
KC 80C	87	8	787	28	28	SCSI	3.50 HH

LANSTOR							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
LAN-64	71	8	1024	17	-	MFM	5.25 FH
LAN-115	119	15	918	17	-	MFM	5.25 FH
LAN-140	142	8	1024	34	-	ESDI	5.25 FH
LAN-180	180	8	1024	26	-	RLL	5.25 FH

LAPINE							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
3522	10	4	306	17	65	MFM	3.50 HH
LT 10	10	2	615	17	65	MFM	3.50 HH
LT 20	20	4	615	17	65	MFM	3.50 HH
LT 200	20	4	614	17	65	MFM	3.50 HH
LT 300	32	4	614	26	65	RLL	3.50 HH
LT 2000	20	4	614	17	65	MFM	3.50 HH
TITAN 20	21	4	615	17	65	MFM	3.50 HH
TITAN 30	33	4	615	26	65	RLL	3.50 HH
TITAN 3532	32	4	615	26	65	RLL	3.50 HH

MAXTOR							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
2585	85	4	1092	36	15	AT	2.50 HH
	Translated Parameters: 10 Heads 976 Cylinders 17 SPT - This is your CMOS setting						
25128A	128.2	4	1092	48	15	AT	2.50 HH
	Translated Parameters: 15 Heads 980 Cylinders 17 SPT - This is your CMOS setting						
25252A,S	251	6	1320	63	12	AT, SCSI	17mm high
	Translated Parameters: 15 Heads 990 Cylinders 33 SPT - This is your CMOS setting						
7080A, S	80	4	1170	36	17	AT, SCSI	1" high
	Translated Parameters: 9 Heads 1021 Cylinders 17 SPT - This is your CMOS setting						
7120A, S	120	4	1516	42	15	AT, SCSI	1" high
	Translated Parameters: 14 Heads 984 Cylinders 17 SPT - This is your CMOS setting						
7213A, S	213	4	1690	48	15	AT, SCSI	1" high
	Translated Parameters: 13 Heads 969 Cylinders 33 SPT - This is your CMOS setting						
7245A, S	244	4	1881	48	15	AT, SCSI	1" high
	Translated Parameters: 15 Heads 962 Cylinders 33 SPT - This is your CMOS setting						
LXT-50S	48	4	733	32	27	SCSI	3.50 HH
LXT-100S	96	8	733	32	27	SCSI	3.50 HH
LXT-200A	207	7	1320	45	15	AT-IDE	3.50 HH
	Translated Parameters: 12 Heads 1020 Cylinders 33 SPT - This is your CMOS setting						
LXT-200S	191	7	1320	33	15	SCSI	3.50 HH
LXT-213A	213	7	1320	55	15	AT-IDE	3.50 HH
	Translated Parameters: 13 Heads 969 Cylinders 33 SPT - This is your CMOS setting						
LXT-213S	200	7	1320	55	15	SCSI	3.50 HH

MAXTOR							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
LXT-340A	320	7	1560	47	13	AT-IDE	3.50 HH
	Translated Parameters: 10 Heads 992 Cylinders 63 SPT - This is your CMOS setting						
LXT-340S	320	7	1560	47	15	SCSI	3.50 HH
LXT-437A	437	9	1560	63	13	AT-IDE	3.50 HH
	Translated Parameters: 14 Heads 967 Cylinders 63 SPT - This is your CMOS setting						
LXT-437S	437	9	1560	63	13	SCSI	3.50 HH
LXT-535A	535	11	1560	63	12	AT-IDE	3.50 HH
LXT-535S	535	11	1560	63	12	SCSI	3.50 HH
P0-12S Panther	1224	15	1224	63	13	SCSI-2	5.25 FH
P1-08E Panther	696	9	1778	72	12	ESDI	5.25 FH
P1-08S Panther	696	9	1778	72	12	SCSI	5.25 FH
P1-12E Panther	1051	15	1778	72	13	ESDI	5.25 FH
P1-12S Panther	1005	19	1216	72	10	SCSI	5.25 FH
P1-13E Panther	1160	15	1778	72	13	ESDI	5.25 FH
P1-16E Panther	1331	19	1778	72	13	ESDI	5.25 FH
P1-17E Panther	1470	19	1778	72	13	ESDI	5.25 FH
P1-17S Panther	1759	19	1778	85	13	SCSI-2	5.25 FH
MXT 540SL/AL	540	7	2367	41	7.5/8.5	IDE	3.5" 1" high
	Translated Parameters: 16 Heads 1024 Cylinders 63 SPT - This is your CMOS setting						

MAXTOR (Continued)							
Model Number	Formatted Capacity	No. of Heads	No. of Cylinders	SPT	Avg in ms	Interface	Form Factor
MXT 1240S	1.24GB	15	2367	41	8.5/9	SCSI-2	3.5"
RXT-800HS (WORM)	786	1	2410	88	108	SCSI	5.25 FH
TAHITI (M/O)	650	1	2870	104	35	SCSI	5.25 FH
XT 1050	38	5	902	17	30	MFM	5.25 FH
XT 1065	52	7	918	17	30	MFM	5.25 FH
XT 1085	69	8	1024	17	27	MFM	5.25 FH
XT 1105	82	11	918	17	30	MFM	5.25 FH
XT 1120R	104	8	1024	26	27	RLL	5.25 FH
XT 1140	116	15	918	17	26	MFM	5.25 FH
XT 1140E	140	15	1141	17	28	ESDI	5.25 FH
XT 1240R	196	15	1024	26	27	RLL	5.25 FH
XT 2085	72	7	1224	17	30	MFM	5.25 FH
XT 2140	113	11	1224	17	30	MFM	5.25 FH
XT 2190	159	15	1224	17	28	MFM	5.25 FH
XT 3170	129	9	1224	26	30	SCSI	5.25 FH
XT 3280	216	15	1224	26	30	SCSI	5.25 FH
XT 3380	277	15	1224	26	27	SCSI	5.25 FH
XT 4170E	157	7	1224	35	14	ESDI	5.25 FH
XT 4170S	157	7	1224	36	14	SCSI	5.25 FH
XT 4175E	149	7	1224	34	27	ESDI	5.25 FH
XT 4179E	158	7	1224	36	14	ESDI	5.25 FH
XT 4230E	203	9	1224	35	15	ESDI	5.25 FH

MAXTOR (Continued)							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
XT 4280E	234	11	1224	34	27	ESDI	5.25 FH
XT 4280S	241	11	1224	36	27	SCSI	5.25 FH
XT 4380E	338	15	1224	35	16	ESDI	5.25 FH
XT 4380S	337	15	1224	36	16	SCSI	5.25 FH
XT 8380E	360	8	1632	54	14	ESDI	5.25 FH
XT 8380EH	361	8	1632	54	13.5	ESDI	5.25 FH
XT 8380S	360	8	1632	54	14	SCSI	5.25 FH
XT 8380SH	361	8	1632	54	13.5	SCSI	5.25 FH
XT 8610E	541	12	1632	54	16	ESDI	5.25 FH
XT 8702S	616	15	1490	54	16	SCSI	5.25 FH
XT 8760E	676	15	1632	54	16	ESDI	5.25 FH
XT 8760EH	677	15	1632	54	13.5	ESDI	5.25 FH
XT 8760S	675	15	1632	54	16	SCSI	5.25 FH
XT 8760SH	670	15	1632	54	14.5	SCSI	5.25 FH
XT 8800E	694	15	1274	71	16	ESDI	5.25 FH
XT 81000E	889	15	1632	54	16	ESDI	5.25 FH

MAXTOR COLORADO (also see Miniscribe)							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
7040A Cheyene	42	2	1170	36	17	AT-IDE	3.50 HH
	Translated Parameters: 5 Heads 977 Cylinders 17 SPT - This is your CMOS setting						
7040S Cheyene	40	2	1155	36	17	SCSI	3.50 HH
7060A Cheyene	65	2	1516	42	15	AT-IDE	3.50 1"
	Translated Parameters: 7 Heads 984 Cylinders 17 SPT - This is your CMOS setting						
7060S Cheyene	65	2	1516	42	15	SCSI	3.50 1"
7080A Cheyene	81	4	1170	36	17	AT-IDE	3.50 1"
	Translated Parameters: 9 Heads 1021 Cylinders 17 SPT - This is your CMOS setting						
7080S Cheyene	65	4	1155	36	15	AT-IDE	3.50 1"
7120A Cheyene	65	4	1516	42	15	AT-IDE	3.50 1"
	Translated Parameters: 14 Heads 984 Cylinders 17 SPT - This is your CMOS setting						
7120S Cheyene	130	4	1516	42	15	SCSI	3.50 1"
8051A	43	4	745	28	28	AT-IDE	3.50 HH
	Translated Parameters: 5 Heads 977 Cylinders 17 SPT - This is your CMOS setting						

MEGADRIVE

Model Number	Formatted Capacity	No. of Heads	No. of Cylinders	SPT	Avg in ms	Interface	Form Factor
P-42	42	3	834	33	19	SCSI	3.50 HH
P-84	84	6	834	33	19	SCSI	3.50 HH
P-105	105	6	1019	33	19	SCSI	3.50 HH
P-120	120	5	1123	33	14	SCSI	3.50 HH
P-170	170	7	1123	33	14	SCSI	3.50 HH
P-210	210	7	1156	33	14	SCSI	3.50 HH
P-425	425	9	1512	63	12	SCSI	3.50 HH

MEMOREX

Model Number	Formatted Capacity	No. of Heads	No. of Cylinders	SPT	Avg in ms	Interface	Form Factor
310	2	2	118	17	90	MFM	5.25 FH
321	5	2	320	17	90	MFM	5.25 FH
322	10	4	320	17	90	MFM	5.25 FH
323	15	6	320	17	90	MFM	5.25 FH
324	20	8	320	17	90	MFM	5.25 FH
450	10	2	612	17	90	MFM	5.25 FH
512	25	3	961	17	90	MFM	5.25 FH
513	41	5	961	17	90	MFM	5.25 FH
514	58	7	961	17	90	MFM	5.25 FH

MICROPOLIS							
Model Number	Formatted Capacity	No. of Heads	No. of Cylinders	SPT	Avg in ms	Interface	Form Factor
1202	45	7	977	17	-	MFM	8.00
1223	45	7	977	17	-	MFM	8.00
1302	20	3	830	17	30	MFM	5.25 FH
1303	34	5	830	17	30	MFM	5.25 FH
1304	41	6	830	17	30	MFM	5.25 FH
1323	35	4	1024	17	28	MFM	5.25 FH
1323A	44	5	1024	17	28	MFM	5.25 FH
1324	53	6	1024	17	28	MFM	5.25 FH
1324A	62	7	1024	17	28	MFM	5.25 FH
1325	71	8	1024	17	28	MFM	5.25 FH
1333	35	4	1024	17	28	MFM	5.25 FH
1333A	44	5	1024	17	28	MFM	5.25 FH
1334	53	6	1024	17	28	MFM	5.25 FH
1334A	62	7	1024	17	28	MFM	5.25 FH
1335	71	8	1024	17	28	MFM	5.25 FH
1352	30	2	1024	36	23	ESDI	5.25 FH
1352A	41	3	1024	36	23	ESDI	5.25 FH
1353	75	4	1024	36	23	ESDI	5.25 FH
1353A	94	5	1024	36	23	ESDI	5.25 FH
1354	113	6	1024	36	23	ESDI	5.25 FH
1354A	132	7	1024	36	23	ESDI	5.25 FH
1355	151	8	1024	36	23	ESDI	5.25 FH
1373	73	4	1024	36	23	SCSI	5.25 FH

MICROPOLIS (Continued)							
Model Number	Formatted Capacity	No. of Heads	No. of Cylinders	SPT	Avg in ms	Interface	Form Factor
1373A	91	5	1024	36	23	SCSI	5.25 FH
1374	109	6	1024	36	23	SCSI	5.25 FH
1374A	127	7	1024	36	23	SCSI	5.25 FH
1375	146	8	1024	36	23	SCSI	5.25 FH
1488-15	675	15	1628	54	16	SCSI	5.25 FH
1516-10S	678	10	1840	72	13	ESDI	5.25 FH
1517-13	922	13	1925	72	14	ESDI	5.25 FH
1518	1419	15	2100	72	14.5	ESDI	5.25 FH
1518-14	993	14	1925	72	14	ESDI	5.25 FH
1518-15	1064	15	1925	72	14	ESDI	5.25 FH
1528	1341	15	2094	72	14.5	SCSI-2	5.25 FH
1528-15	1354	15	2106	84	14	SCSI-2	5.25 FH
1538-15	872	15	1925	71	15	ESDI	5.25 FH
1548	1748	15	2096	72	14	Fast SCSI-2	5.25 FH
1551	149	7	1224	34	18	ESDI	5.25 FH
1554-7	158	7	1224	36	18	ESDI	5.25 FH
1554-11	234	11	1224	34	18	ESDI	5.25 FH
1555-8	180	8	1224	36	18	ESDI	5.25 FH
1555-9	203	9	1224	36	18	ESDI	5.25 FH
1555-12	255	12	1224	34	18	ESDI	5.25 FH
1556-10	226	10	1224	36	18	ESDI	5.25 FH
1556-11	248	11	1224	36	18	ESDI	5.25 FH
1556-13	276	13	1224	34	18	ESDI	5.25 FH

MICROPOLIS (Continued)							
Model Number	Formatted Capacity	No. of Heads	No. of Cylinders	SPT	Avg in ms	Interface	Form Factor
1557-12	270	12	1224	36	18	ESDI	5.25 FH
1557-13	293	13	1224	36	18	ESDI	5.25 FH
1557-14	315	14	1224	36	18	ESDI	5.25 FH
1557-15	338	15	1224	36	18	ESDI	5.25 FH
1558-14	315	14	1224	36	18	ESDI	5.25 FH
1558-15	338	15	1224	36	18	ESDI	5.25 FH
1566-11	496	11	1632	54	16	ESDI	5.25 FH
1567-12	541	12	1632	54	16	ESDI	5.25 FH
1567-13	586	13	1632	54	16	ESDI	5.25 FH
1568-14	631	14	1632	54	16	ESDI	5.25 FH
1568-15	676	15	1632	54	16	ESDI	5.25 FH
1576-11	243	11	1224	36	18	SCSI	5.25 FH
1577-12	266	12	1224	36	18	SCSI	5.25 FH
1577-13	287	13	1224	36	18	SCSI	5.25 FH
1578-14	310	14	1224	36	18	SCSI	5.25 FH
1578-15	332	15	1224	36	18	SCSI	5.25 FH
1586-11	490	11	1632	54	16	SCSI	5.25 FH
1587-12	535	12	1632	54	16	SCSI	5.25 FH
1587-13	579	13	1632	54	16	SCSI	5.25 FH
1588	667	15	1626	54	16	SCSI	5.25 FH
1588-14	624	14	1632	54	16	SCSI	5.25 FH
1588-15	668	15	1632	54	16	SCSI	5.25 FH
1596-10S	668	10	1834	72	35	SCSI	5.25 FH

MICROPOLIS (Continued)							
Model Number	Formatted Capacity	No. of Heads	No. of Cylinders	SPT	Avg in ms	Interface	Form Factor
1597-13	909	13	1919	72	14	SCSI	5.25 FH
1598	1034	15	1922	72	14.5	SCSI-2	5.25 FH
1598-14	979	14	1919	72	14	SCSI	5.25 FH
1598-15	1098	15	1928	71	14.5	SCSI-2	5.25 FH
1624	667	7	2099	72	15	Fast SCSI-2	5.25 HH
1653-4	92	4	1249	36	16	ESDI	5.25 HH
1653-5	115	5	1249	36	16	ESDI	5.25 HH
1654-6	138	6	1249	36	16	ESDI	5.25 HH
1654-7	161	7	1249	36	16	ESDI	5.25 HH
1663-4	197	4	1780	36	14	ESDI	5.25 HH
1663-5	246	5	1780	36	14	ESDI	5.25 HH
1664-6	295	6	1780	54	14	ESDI	5.25 HH
1664-7	345	7	1780	54	14	ESDI	5.25 HH
1673-4	90	4	1249	36	16	SCSI	5.25 HH
1673-5	112	5	1249	36	16	SCSI-MAC	5.25 HH
1674-6	135	6	1249	36	16	SCSI	5.25 HH
1674-7	158	7	1249	36	16	SCSI-MAC	5.25 HH
1683-4	193	4	1776	54	14	SCSI-MAC	5.25 HH
1683-5	242	5	1776	54	14	SCSI	5.25 HH
1684-6	291	6	1776	54	14	SCSI	5.25 HH
1684-7	340	7	1776	54	14	SCSI-MAC	5.25 HH
1743-5	112	5	1140	28	15	AT-IDE	3.50 HH
1744-6	135	6	1140	28	15	AT-IDE	3.50 HH

MICROPOLIS (Continued)							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
1744-7	157	7	1140	28	15	AT-IDE	3.50 HH
	Translated Parameters: 10 Heads 929 Cylinders 33 SPT - This is your CMOS setting						
1745-8	180	8	1140	28	15	AT-IDE	3.50 HH
	Translated Parameters: 11 Heads 968 Cylinders 33 SPT - This is your CMOS setting						
1745-9	202	9	1140	28	15	AT-IDE	3.50 HH
	Translated Parameters: 12 Heads 986 Cylinders 33 SPT - This is your CMOS setting						
1773-5	112	5	1140	28	15	SCSI	3.50 HH
1774-6	135	6	1140	28	15	SCSI	3.50 HH
1774-7	157	7	1140	28	15	SCSI	3.50 HH
1775-8	180	8	1140	28	15	SCSI	3.50 HH
1775-9	202	9	1140	28	15	SCSI	3.50 HH

MICROSCIENCE							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
4050	45	5	1024	17	18	MFM	3.50 HH
4060	68	5	1024	26	18	RLL	3.50 HH
4070	62	7	1024	17	18	MFM	3.50 HH
4090	95	7	1024	26	18	RLL	3.50 HH
5040	46	3	855	35	18	ESDI	3.50 HH
5070	77	5	855	35	18	ESDI	3.50 HH
5070-20	86	5	960	35	18	ESDI	3.50 HH
5100	107	7	855	35	18	ESDI	3.50 HH
5100-20	120	7	960	35	18	ESDI	3.50 HH
5160	159	7	1271	35	18	ESDI	3.50 HH
6100	110	7	855	36	18	SCSI	3.50 HH

MICROSCIENCE (Continued)							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
7040	47	3	855	36	18	AT-IDE	3.50 HH
	Translated Parameters: 6 Heads 890 Cylinders 17 SPT - This is your CMOS setting						
7070-20	86	5	960	35	18	AT-IDE	3.50 HH
	Translated Parameters: 9 Heads 919 Cylinders 17 SPT - This is your CMOS setting						
7100	107	7	855	35	18	AT-IDE	3.50 HH
	Translated Parameters: 12 Heads 1024 Cylinders 17 SPT - This is your CMOS setting						
7100-20	120	7	960	35	18	AT-IDE	3.50 HH
	Translated Parameters: 14 Heads 984 Cylinders 17 SPT - This is your CMOS setting						
7100-21	121	5	1077	44	18	AT-IDE	3.50 HH
	Translated Parameters: 14 Heads 984 Cylinders 17 SPT - This is your CMOS setting						
7200	201	7	1277	44	18	AT-IDE	3.50 HH
	Translated Parameters: 12 Heads 964 Cylinders 33 SPT - This is your CMOS setting						
7400	420	8	1904	39	15	AT-IDE	3.50 HH
	Translated Parameters: 13 Heads 1001 Cylinders 63 SPT - This is your CMOS setting						
8040	43	2	1047	40	25	AT-IDE	3.50 HH
	Translated Parameters: 5 Heads 977 Cylinders 17 SPT - This is your CMOS setting						
8040/MLC	42	2	1024	40	25	AT-IDE	3.50 HH
	Translated Parameters: 5 Heads 977 Cylinders 17 SPT - This is your CMOS setting						
8080	85	2	1768	47	17	AT-IDE	3.50 1"
	Translated Parameters: 10 Heads 976 Cylinders 17 SPT - This is your CMOS setting						
8200	210	4	1904	39	16	AT-IDE	3.50 1"
	Translated Parameters: 12 Heads 986 Cylinders 33 SPT - This is your CMOS setting						
FH 2414	367	8	1658	54	14	ESDI	5.25 FH

MICROSCIENCE (Continued)							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
FH 2777	688	15	1658	54	14	ESDI	5.25 FH
FH 3414	367	8	1658	54	14	SCSI	5.25 FH
FH 3777	688	15	1658	54	14	SCSI	5.25 FH
FH 21200	1062	15	1921	72	13	ESDI	5.25 FH
FH 21600	1418	15	2147	86	14	ESDI	5.25 FH
FH 31200	1062	15	1921	72	13	SCSI	5.25 FH
FH 31600	1418	15	2147	86	14	SCSI	5.25 FH
HH 312	10	4	306	17	65	MFM	5.25 HH
HH 315	10	4	306	17	65	MFM	5.25 HH
HH 325	21	4	612	17	80	MFM	5.25 HH
HH 330	33	4	612	26	105	RLL	5.25 HH
HH 612	11	4	306	17	85	MFM	5.25 HH
HH 625	21	4	612	17	65	MFM	5.25 HH
HH 712	11	2	612	17	105	MFM	5.25 HH
HH 712A	11	2	612	17	75	MFM	5.25 HH
HH 725	21	4	612	17	105	MFM	5.25 HH
HH 738	33	4	612	26	105	RLL	5.25 HH
HH 825	21	4	615	17	65	MFM	5.25 HH
HH 830	33	4	615	26	65	RLL	5.25 HH
HH 1050	45	5	1024	17	28	MFM	5.25 HH
HH 1060	66	5	1024	25	28	RLL	5.25 HH
HH 1075	62	7	1024	17	28	MFM	5.25 HH

MICROSCIENCE (Continued)							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
HH 1080	68	7	1024	26	28	RLL	5.25 HH
HH 1090	80	7	1314	17	28	MFM	5.25 HH
HH 1095	95	7	1024	26	28	RLL	5.25 HH
HH 1120	122	7	1314	26	28	RLL	5.25 HH
HH 2012	10	4	306	17	80	MFM	5.25 HH
HH 2120	128	7	1024	35	28	ESDI	5.25 HH
HH 2160	160	7	1276	35	28	ESDI	5.25 HH
HH 3120	121	5	1314	36	28	SCSI	5.25 HH
HH 3160	169	7	1314	36	28	SCSI	5.25 HH

MINISCRIBE (also see Maxtor Colorado)							
Model Number	Formatted Capacity	No. of Heads	No. of Cylinders	SPT	Avg in ms	Interface	Form Factor
1006	5	2	306	17	179	MFM	5.25 FH
1012	10	4	306	17	179	MFM	5.25 FH
2006	5	2	306	17	93	MFM	5.25 FH
2012	11	4	306	17	85	MFM	5.25 HH
3006	5	2	306	17	-	MFM	5.25 HH
3012	10	2	612	17	155	MFM	5.25 HH
3053	44	5	1024	17	25	MFM	5.25 HH
3085	71	7	1170	17	28	MFM	5.25 FH
3085E	72	3	1270	36	17	ESDI	5.25 HH
3085S	72	3	1255	36	17	SCSI	5.25 HH
3130E	112	5	1250	36	17	ESDI	5.25 HH
3130S	115	5	1255	36	17	SCSI	5.25 HH
3180E	157	7	1250	36	17	ESDI	5.25 HH
3180S	153	7	1255	36	17	SCSI	5.25 HH
3180SM	160	7	1250	36	17	SCSI-MAC	5.25 HH
3212/3212 PLUS	11	2	612	17	85/53	MFM	5.25 HH
3412	21	4	615	17	60	MFM	5.25 HH
3425/3425 PLUS	21	4	615	17	85/53	MFM	5.25 HH
3438/3438 PLUS	32	4	615	26	85/53	RLL	5.25 HH
3650/3650F	42	6	809	17	61/46	MFM	5.25 HH
3675	63	6	809	26	61	RLL	5.25 HH

MINISCRIBE (also see Maxtor Colorado) ~ Continued							
Model Number	Formatted Capacity	No. of Heads	No. of Cylinders	SPT	Avg in ms	Interface	Form Factor
4010	8	2	480	17	133	MFM	5.25 FH
4020	17	4	480	17	133	MFM	5.25 FH
5330	25	6	480	17	80	MFM	5.25 FH
5338	32	6	612	17	65	MFM	5.25 FH
5440	32	8	480	17	65	MFM	5.25 FH
5451	43	8	612	17	65	MFM	5.25 FH
6032	26	3	1024	17	28	MFM	5.25 FH
6053/6053 II	44	5	1024	17	28	MFM	5.25 FH
6074	62	7	1024	17	28	MFM	5.25 FH
6085	71	8	1024	17	28	MFM	5.25 FH
6128	110	8	1024	26	28	RLL	5.25 FH
6170E	130	8	1024	36	28	ESDI	5.25 FH
6212	10	2	612	17	90	MFM	5.25 FH
7040A	40	4	980	36	19	AT-IDE	3.50 HH
7040S	40	2	1156	36	19	SCSI	3.50 HH
7080A	80	4	980	36	19	AT-IDE	3.50 HH
7080S	81	4	1155	36	19	SCSI	3.50 HH
7426	21	4	612	17	65	MFM	3.50 HH
8048	40	4	1024	36	65	SCSI	3.50 HH
8051A	43	4	745	28	28	AT-IDE	3.50 HH
8051AT	42	4	745	28	28	AT-IDE	3.50 HH
8051S	45	4	793	28	28	SCSI	3.50 HH
8212	11	2	612	17	68	MFM	3.50 HH

MINISCRIBE (also see Maxtor Colorado) ~ Continued							
Model Number	Formatted Capacity	No. of Heads	No. of Cylinders	SPT	Avg in ms	Interface	Form Factor
8225	20	2	771	26	68	RLL	3.50 HH
8225AT	21	2	745	28	28	AT-IDE	3.50 HH
8225C	21	2	798	26	68	RLL	3.50 HH
8225S	21	2	804	26	68	SCSI	3.50 HH
8225XT	21	2	805	26	68	XT-IDE	3.50 HH
8412	10	4	306	17	50	MFM	3.50 HH
8425/8425F	21	4	615	17	68/40	MFM	3.50 HH
8425S	21	4	612	17	68	SCSI	3.50 HH
8425XT	21	4	615	17	68	XT-IDE	3.50 HH
8434F	32	4	615	26	40	RLL	3.50 HH
8438/8438F	32	4	615	26	68/40	RLL	3.50 HH
8438XT	31	4	615	26	68	XT-IDE	3.50 HH
8450	40	4	771	26	45	RLL	3.50 HH
8450AT	42	4	745	28	40	AT-IDE	3.50 HH
8450C	42	4	748	26	45	RLL	3.50 HH
8450XT	42	4	805	26	45	XT-IDE	3.50 HH
9000E	338	15	1224	36	16	ESDI	5.25 FH
9000S	347	15	1220	36	16	SCSI	5.25 FH
9230E	203	9	1224	36	36	ESDI	5.25 FH
9230S	203	9	1224	36	36	SCSI	5.25 FH
9380E	338	15	1224	36	16	ESDI	5.25 FH
9380S	347	15	1224	36	16	SCSI	5.25 FH
9380SM	319	15	1218	36	16	SCSI-MAC	5.25 FH

MINISCRIBE (also see Maxtor Colorado) ~ Continued							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
9424E	360	8	1661	54	17	ESDI	5.25 FH
9424S	355	8	1661	54	17	SCSI	5.25 FH
9780E	676	15	1661	54	17	ESDI	5.25 FH
9780S	668	15	1661	54	17	SCSI	5.25 FH

MITSUBISHI							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
M2860-1	21	4	620	17	120	MFM	8.00
M2860-2	50	6	681	17	120	MFM	8.00
M2860-3	85	8	681	17	120	MFM	8.00
MR 521	10	2	612	17	85	MFM	5.25 HH
MR 522	20	4	612	17	85	MFM	5.25 HH
MR 533	25	3	971	17	85	MFM	5.25 HH
MR 535	42	5	977	17	28	MFM	5.25 HH
MR 535R	65	5	977	26	28	RLL	5.25 HH
MR 535S	50	5	977	26	28	SCSI	5.25 HH
MR 537S	76	5	977	26	28	SCSI	5.25 HH
MR 5310E	101	5	977	26	28	ESDI	5.25 HH

MMI							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
M 106	5	2	306	17	75	MFM	3.50 HH
M 112	10	4	306	17	75	MFM	3.50 HH
M 125	20	8	306	17	75	MFM	3.50 HH
M 212	10	4	306	17	75	MFM	5.25 HH
M 225	20	8	306	17	75	MFM	5.25 HH
M 306	5	2	306	17	75	MFM	3.50 HH
M 312	10	4	306	17	75	MFM	5.25 HH
M 325	20	8	306	17	75	MFM	5.25 HH
M 5012	10	4	306	17	75	MFM	3.50 HH

NCR							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
6091-5101	323	9	1350	26	27	SCSI	5.25
6091-5301	675	15	1350	26	25	SCSI	5.25

NEC							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
2247	87	6	841	VAR	80	SMD	8.00
D 3126	20	4	615	17	85	MFM	3.50 HH
D 3142	42	8	642	17	28	MFM	3.50 HH
D 3146H	40	8	615	17	35	MFM	3.50 HH
D 3661	118	7	915	36	40	ESDI	3.50 HH
D 3735	56	2	1084	41	20	AT-IDE	3.50 1"
D 3755	105	4	1250	41	20	AT-IDE	3.50 1"
D 3756	105	4	1251	41	19	PC/AT	3.50 "
D 3761	114	7	915	35	20	AT-IDE	3.50 HH
D 3765	176	4	1486	58	16.5	PC/AT	3.50 "
D 3772	331	7	1468	63	14	PC/AT	3.50 "
D 3781	425	9	1464	63	15	PC/AT	3.50 "
D 3835	45	2	1084	41	20	SCSI	3,50 1"
D 3855	105	4	1250	41	20	SCSI	3.50 1"
D 3856	105	4	1251	41	19	SCSI	3.50 "
D 3861	114	7	915	35	20	SCSI	3.50 HH
D 3865	176	4	1486	58	16.5	SCSI	3.50 "
D 3872	331	7	1468	63	14	SCSI	3.50 "
D 3881	425	9	1464	63	15	SCSI-2	3.50 "
D 5114	5	2	306	17	-	MFM	5.25
D 5124	10	4	309	17	85	MFM	5.25 HH

NEC (Continued)							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
D5126, D5216H	20	4	612	17	85/40	MFM	5.25 HH
D 5127H	32	4	615	26	85	RLL	5.25 HH
D5146, D5146H	40	8	615	17	85/40	MFM	5.25 HH
D 5147H	65	8	615	26	85	RLL	5.25 HH
D 5392	22	8	615	26	14	IPI-2	5.25 FH
D 5452	71	10	823	17	65	MFM	5.25 HH
D 5652	143	10	823	17	23	ESDI	5.25 HH
D 5655	153	7	1224	35	18	ESDI	5.25 HH
D 5662	319	15	1224	34	16	ESDI	5.25 FH
D 5682	664	15	1633	53	16	ESDI	5.25 FH
D 5862	385	8	1633	65	18	SCSI	5.25 FH
D 5882	665	15	1633	53	16	SCSI	5.25 FH
D 5892	1404	19	1678	86	14	SCSI	5,25 FH
SD040S	40	-	-	-	<0.35	SCSI Solid State	5.25"
SD1205	120	-	-	-	<0.35	SCSI Solid State	5.25"

NEI							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
RD 3127	10	2	612	17	150	MFM	5.25
RD 3255	21	4	612	17	150	MFM	5.25
RD 4127	10	4	306	17	150	MFM	5.25
RD 4255	21	8	306	17	150	MFM	5.25

NEWBURY DATA							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
NDR 320	21	4	615	17	150	MFM	5.25
NDR 340	42	8	615	17	40	MFM	3.50 HH
NDR 360	65	8	615	26	150	RLL	-
NDR 1065	55	7	918	17	25	MFM	5.25 FH
NDR 1085	71	8	1025	17	26	MFM	5.25 FH
NDR 1105	87	11	918	17	25	MFM	5.25 FH
NDR 1140	119	15	918	17	25	MFM	5.25 FH
NDR 2085	74	7	1224	17	28	MFM	5.25 FH
NDR 2140	117	11	1224	17	28	MFM	5.25 FH
NDR 2190	191	15	918	17	28	MFM	5.25 FH
NDR3170S	146	9	1224	26	28	SCSI	5.25 FH
NDR3280S	244	15	1224	26	28	SCSI	5.25 FH
NDR 4170	149	7	1224	34	28	ESDI	5.25 FH
NDR 4175	179	7	1224	36	28	ESDI	5.25 FH
NDR 4380	384	15	1224	36	28	ESDI	5.25 FH
NDR4380S	319	15	1224	34	28	SCSI	5.25 FH
PENNY340	42	8	615	17	28	MFM	5.25

NPL							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
4064	5	2	306	17	-	MFM	5.25 FH
4127	10	4	306	17	-	MFM	5.25 FH
4191S	15	6	306	17	-	MFM	5.25 FH
4255	20	4	615	17	-	MFM	5.25 FH
NP 02-26S	22	4	640	17	-	MFM	5.25
NP 03-13	10	4	306	17	-	MFM	5.25
NP 03-6	5	2	306	17	-	MFM	5.25

OKIDATA							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
OD 526	31	4	612	26	65	RLL	3.50 HH
OD 540	47	6	612	26	65	RLL	3.50 HH

OLIVETTI							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
HD662/11	10	2	612	17	65	MFM	5.25 HH
HD662/12	20	4	612	17	65	MFM	5.25 HH
XM 5210	10	4	612	17	65	MFM	5.25 HH
XM 5220/2	20	4	612	17	85	MFM	5.25 HH

ORCA TECHNOLOGY

Model Number	Formatted Capacity	No. of Heads	No. of Cylinders	SPT	Avg in ms	Interface	Form Factor
OT5H 53M	45	5	1024	17	28	MFM	5.25 HH
OT5H 80R	65	5	1024	26	28	RLL	5.25 HH
OT5H 138E	115	4	1600	35	25	ESDI	5.25 HH
OT5H 138S	115	4	1600	35	25	SCSI	5.25 HH
OT5H 172E	140	5	1600	35	25	ESDI	5.25 HH
OT5H 172S	140	5	1600	35	25	SCSI	5.25 HH
OT5H 207E	170	6	1600	35	25	ESDI	5.25 HH
OT5H 207S	170	6	1600	35	25	SCSI	5.25 HH
OT5H 760S	702	15	1024	28	14	SCSI	5.25 FH

OTARI (also see Disctron)

Model Number	Formatted Capacity	No. of Heads	No. of Cylinders	SPT	Avg in ms	Interface	Form Factor
C 214	10	4	306	17	79	MFM	5.25 FH
C 507	5	2	306	17	79	MFM	5.25 FH
C 514	10	4	306	17	79	MFM	5.25 FH
C 519	15	6	306	17	79	MFM	5.25 FH
C 526	21	8	306	17	65	MFM	5.25 FH

PACIFIC MAGTRON

Model Number	Formatted Capacity	No. of Heads	No. of Cylinders	SPT	Avg in ms	Interface	Form Factor
MT-4115E	115	4	1600	35	16	ESDI	5.25 HH
MT-4115S	115	4	1600	35	16	SCSI	5.25 HH
MT-4140E	140	5	1600	35	16	ESDI	5.25 HH
MT-4140S	140	5	1600	35	16	SCSI	5.25 HH

PACIFIC MAGTRON (Continued)							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
MT-4170E	170	6	1600	35	16	ESDI	5.25 HH
MT-4170S	170	6	1600	35	16	SCSI	5.25 HH
MT-5400E	361	8	1632	54	14	ESDI	5.25 HH
MT-5400S	359	8	1623	54	14	SCSI	5.25 HH
MT-5760E	677	15	1632	54	14	ESDI	5.25 HH
MT-5760S	673	15	1623	54	14	SCSI	5.25 HH

PANASONIC							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
JU-116	20	4	615	17	85	MFM	3.50 HH
JU-128	42	7	733	17	35	MFM	3.50 HH

PRAIRIETEK							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
Prairie 120	21	2	615	34	23	AT-IDE	2.50
Prairie 140	40	2	615	34	23	AT-IDE	2.50
	Translated Parameters: 8 Heads 615 Cylinders 17 SPT - This is your CMOS setting						
Prairie 220A	20	2	612	34	28	AT-IDE	2.50
	Translated Parameters: 4 Heads 615 Cylinders 17 SPT - This is your CMOS setting						
Prairie 220B	20	4	612	34	28	SCSI	2.50
Prairie 240	43	4	615	34	28	AT-IDE	2.50
	Translated Parameters: 8 Heads 615 Cylinders 17 SPT - This is your CMOS setting						

PRAIRIETEK (Continued)							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
Prairie 242A	41	4	615	34	28	XT/AT-IDE	2.50
	Translated Parameters: 8 Heads 615 Cylinders 17 SPT - This is your CMOS setting						
Prairie 242S	41	4	1820	34	28	AT-IDE	2.50
	Translated Parameters: 5 Heads 942 Cylinders 17 SPT - This is your CMOS setting						
Prairie 282A	82	4	1031	34	28	AT-IDE	2.50
	Translated Parameters: 9 Heads 1021 Cylinders 17 SPT - This is your CMOS setting						
Prairie 282S	82	4	1031	34	28	SCSI	2.50

PRIAM (also see Vertex)							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
502	46	7	755	17	65	MFM	5.25 FH
504	46	7	755	17	65	MFM	5.25 FH
514	117	11	1224	17	22	MFM	5.25 FH
519	160	15	1224	17	22	MFM	5.25 FH
617	153	7	1225	36	20	ESDI	5.25 FH
623	196	15	752	34	65	ESDI	5.25 FH
628	241	11	1225	36	20	ESDI	5.25 FH
630	319	15	1224	34	15	ESDI	5.25 FH
638	329	15	1225	36	20	ESDI	5.25 FH
717	153	7	1225	36	20	SCSI	5.25 FH
728	241	11	1225	36	20	SCSI	5.25 FH
738	329	15	1225	36	20	SCSI	5.25 FH
3504	44	5	771	17	65	MFM	3.50 HH
ID20	26	3	987	17	23	MFM	5.25 FH

PRIAM (also see Vertex) ~ Continued							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
ID45H	44	5	1024	17	23	MFM	5.25 FH
ID330	338	15	1225	36	18	ESDI	5.25 FH
ID/ED40	43	5	987	17	23	MFM	5.25 FH
ID/ED45	44	5	1166	17	23	MFM	5.25 FH
ID/ED60	59	7	1018	17	30	MFM	5.25 FH
ID/ED62	62	7	1166	17	23	MFM	5.25 FH
ID/ED75	73	5	1166	25	23	RLL	5.25 FH
ID/ED100	103	7	1166	25	15	RLL	5.25 FH
ID/ED120	121	7	1024	33	28	ESDI	5.25 FH
ID/ED130	132	15	1224	17	13	MFM	5.25 FH
ID/ED150	159	7	1276	35	28	ESDI	5.25 HH
ID/ED160	158	7	1225	36	18	ESDI	5.25 FH
ID160E-PS2	152	7	1195	36	18	PS2	5.25 FH
ID200L-1	200	15	1195	25	15	AT-IDE	5.25 FH
	Translated Parameters: 15 Heads 1024 Cylinders 28 SPT - This is your CMOS setting						
ID/ED230	233	15	1224	25	11	RLL	5.25 FH
ID/ED250	248	11	1225	36	18	ESDI	5.25 FH
ID330E	336	15	1218	36	18	ESDI	5.25 FH
ID330-PS2	330	15	1195	36	18	PS2	5.25 FH
ID330S	338	15	1218	36	18	SCSI	5.25 FH
ID340H-U	340	7	1776	54	14	ESDI	5.25 FH
ID660-U	660	15	1628	54	16	ESDI	5.25 FH
ID700E	701	15	1774	54	16	ESDI	5.25 FH

PRIAM (also see Vertex) ~ Continued							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
ID700S	668	15	1774	54	16	SCSI	5.25 FH
V 130R	39	3	987	26	28	RLL	5.25 FH
V 150	42	5	987	17	28	MFM	5.25 FH
V 160	50	5	1166	17	28	MFM	5.25 FH
V 170	60	7	987	17	28	MFM	5.25 FH
V 170R	91	7	987	26	28	RLL	5.25 FH
V 185	71	7	1166	17	28	MFM	5.25 FH
V 519	159	15	1224	17	28	MFM	5.25 FH
V 519-	62	7	1024	17	28	MFM	5.25 FH

PROCOM							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
Propaq 185-15	189	5	1224	36	15	AT-IDE	3.50 HH
	Translated Parameters: 11 Heads 1016 Cylinders 33 SPT - This is your CMOS setting						
HiPer 380	388	8	1224	63	17	ESDI	5.25
Si 200/PS3	209	4	1224	63	18	SCSI	3.50 HH
Si 585/S5	601	8	1224	54	17	SCSI	5.25
Si 1000/S5	1037	8	1731	77	15	SCSI	5.25

PTI							
Model Number	Formatted Capacity	No. of Heads	No. of Cylinders	SPT	Avg in ms	Interface	Form Factor
PT-225	21	4	615	17	35	MFM	3.50 HH
PT-234	28	4	820	17	35	MFM	3.50 HH
PT-238A	32	4	615	26	35	AT-IDE	3.50 HH
	Translated Parameters: 4 Heads 615 Cylinders 26 SPT - This is your CMOS setting						
PT-238R	32	4	615	26	35	RLL	3.50 HH
PT-238S	32	4	615	26	35	SCSI	3.50 HH
PT-251A	43	4	820	26	35	AT-IDE	3.50 HH
	Translated Parameters: 4 Heads 820 Cylinders 26 SPT - This is your CMOS setting						
PT-251R	43	4	820	26	35	RLL	3.50 HH
PT-251S	43	4	820	26	35	SCSI	3.50 HH
PT-325R	21	4	615	26	65	RLL	3.50 HH
PT-338	32	6	615	17	35	MFM	3.50 HH
PT-338R	32	4	615	26	65	RLL	3.50 HH
PT-351	42	6	820	17	35	MFM	3.50 HH
PT-351R	60	6	820	26	35	RLL	3.50 HH
PT-357A	49	6	615	26	35	AT-IDE	3.50 HH
	Translated Parameters: 6 Heads 820 Cylinders 26 SPT - This is your CMOS setting						
PT-357R	49	6	615	26	35	RLL	3.50 HH
PT-357S	49	6	615	26	35	SCSI	3.50 HH
PT-376A	65	6	820	26	35	AT-IDE	3.50 HH
PT-376R	65	6	820	26	35	RLL	3.50 HH
PT-376S	65	6	820	26	35	SCSI	3.50 HH
PT-468	57	8	820	17	35	MFM	3.50 HH
PT-4102A	87	8	820	26	35	AT-IDE	3.50 HH
	Translated Parameters: 8 Heads 820 Cylinders 26 SPT - This is your CMOS setting						
PT-4102R	87	8	820	26	28	RLL	3.50 HH

QUANTUM							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
2010	10	-	-	17	-	MFM	8.00
2020	20	-	-	17	-	MFM	8.00
2030	30	-	-	17	-	MFM	8.00
2040	40	-	-	17	-	MFM	8.00
2080	80	-	-	17	-	MFM	8.00
GoDrive 40	43	2	957	48	16	AT-IDE or SCSI-2	2.50
	Translated Parameters: 5 Heads 977 Cylinders 17 SPT - This is your CMOS setting						
GoDrive 80	86	4	957	48	16	AT-IDE or SCSI-2	2.50
	Translated Parameters: 10 Heads 977 Cylinders 17 SPT - This is your CMOS setting						
GoDrive 120	127	4	1097	19	<17	SCSI-2, IDE-AT	2.50
	Translated Parameters: 15 Heads 965 Cylinders 17 SPT - This is your CMOS setting						
GRS 160	169	4	966	38	<17	SCSI-2, IDE-AT	2.50
	Translated Parameters: 4 Heads 839 Cylinders 19 SPT - This is your CMOS setting						
Hardcard EZ42	42	5	977	17	19	PC ISA-Slot	Slot
Hardcard EZ85	85	10	977	17	19	PC ISA-Slot	Slot
Hardcard EZ127	127	16	919	17	19	PC ISA-Slot	Slot

QUANTUM (Continued)							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
Hardcard EZ240	245	15	966	33	16	PC ISA-Slot	Slot
Passport XL42	42	5	965	17	19	SCSI-2	Removable
Passport XL85	85	10	976	17	17	SCSI-2	Removable
Passport XL127	127	15	973	17	17	SCSI-2	Removable
Passport XL170	170	10	1005	33	17	SCSI-2	Removable
Passport XL240	245	14	1014	33	16	SCSI-2	Removable
Passport XL525	525	16	1015	63	10	SCSI-2	Removable
Plus Hardcard XL 50	52	6	957	17	9	ISA-Slot	Slot
Plus Hardcard XL 105	105	12	1005	17	9	ISA-Slot	Slot
Plus Hardcard XL 231	231	14	976	33	9	ISA-Slot	Slot
Plus Hardcard XL 311	311	10	955	63	9	ISA-Slot	Slot
Plus Hardcard XL 360	360	11	958	63	9	ISA-Slot	Slot
ProDrive 40AT	42	3	834	52	19	AT-IDE	3.50 HH
	Translated Parameters: 5 Heads 900 Cylinders 17 SPT - This is your CMOS setting						
ProDrive 40S	42	3	834	52	19	SCSI	3.50 HH

QUANTUM (Continued)							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
ProDrive 80AT	84	6	834	63	19	AT-IDE	3.50 HH
	Translated Parameters: 10 Heads 960 Cylinders 17 SPT - This is your CMOS setting						
ProDrive 80S	84	6	834	63	19	SCSI	3.50 HH
ProDrive 105S	105	6	1019	63	19	SCSI	3.50 HH
ProDrive 120AT	120	5	1123	63	19	AT-IDE	3.50 HH
	Translated Parameters: 14 Heads 984 Cylinders 17 SPT - This is your CMOS setting						
ProDrive 120S	120	5	1123	63	15	SCSI	3.50 HH
ProDrive 170AT	168	4	1536	65	19	AT-IDE	3.50 HH
ProDrive 170S	168	4	1536	65	15	SCSI	3.50 HH
ProDrive 210AT	210	7	1156	63	15	AT-IDE	3.50 HH
	Translated Parameters: 13 Heads 950 Cylinders 33 SPT - This is your CMOS setting						
ProDrive 210S	210	7	1156	63	15	SCSI	3.50 HH
ProDrive 330AT	330	7	1536	63	14	AT-IDE	3.50 HH
	Translated Parameters: 10 Heads 1023 Cylinders 63 SPT - This is your CMOS setting						
ProDrive 330S	330	7	1536	63	14	SCSI	3.50 HH
ProDrive 425AT	425	7	1800	63	14	AT-IDE	3.50 HH
	Translated Parameters: 13 Heads 1013 Cylinders 63 SPT - This is your CMOS setting						
ProDrive 425S	425	7	1800	63	14	SCSI	3.50 HH

QUANTUM (Continued)							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
ProDrive 700S	700	8	1921	63	12	SCSI-2	3.50 HH
ProDrive 1050	1050	12	2224	63	12	SCSI-2	3.50 HH
ProDrive 1225	1225	14	2224	63	12	SCSI-2	3.50 HH
ProDrive ELS 42	42	1	977	63	19	SCSI-2	3.50 HH
ProDrive ELS 85	85	2	977	63	17	SCSI-2	3.50 HH
ProDrive ELS 127	127	3	919	63	17	SCSI-2	3.50 HH
ProDrive ELS 170	170	4	1011	63	17	SCSI-2	3.50 HH
ProDrive LPS 80	85	4	611	63	15	SCSI	3.50 HH
ProDrive LPS 105	105	4	1219	63	17	SCSI	3.50 HH
ProDrive LPS 105AT	105	4	1219	63	17	AT-IDE	3.50 HH
	Translated Parameters: 12 Heads 1000 Cylinders 17 SPT - This is your CMOS setting						
ProDrive LPS 105S	105	4	1219	63	17	SCSI	3.50 HH
ProDrive LPS 120	122	2	-	44	16	AT-IDE SCSI	3.50 HH
	Translated Parameters: 14 Heads 980 Cylinders 17 SPT - This is your CMOS setting						
ProDrive LPS 240	245	4	1530	44	16	AT-IDE SCSI	3.50 HH
	Translated Parameters: 14 Heads 1014 Cylinders 33 SPT - This is your CMOS setting						

QUANTUM (Continued)

Model Number	Formatted Capacity	No. of Heads	No. of Cylinders	SPT	Avg in ms	Interface	Form Factor
ProDrive LPS 525S/AT	525	6	1800	81	10	SCSI-2, IDE-AT	3.50 HH
	Translated Parameters: 16 Heads 1017 Cylinders 63 SPT - This is your CMOS setting						
Q-160	200	12	971	36	16	SCSI	5.25 HH
Q-250	53	4	823	36	28	SCSI	5.25 HH
Q-280	80	6	823	36	28	SCSI	5.25 HH
Q-510	8	2	512	17	85	MFM	5.25 HH
Q-520	18	4	512	17	85	MFM	5.25 HH
Q-530	27	6	512	17	47	MFM	5.25 FH
Q-540	36	8	512	17	40	MFM	5.25 FH

RICOH

Model Number	Formatted Capacity	No. of Heads	No. of Cylinders	SPT	Avg in ms	Interface	Form Factor
RH-5130	10	2	612	17	85	MFM	-
RH-5260	10	2	615	17	85	MFM	-
RH-5261	10	2	612	-	85	SCSI	-
RH-5500	50	2	1285	76	25	SCSI	5.25 HH
RH-9150AR	49	2	1285	76	25	SCSI	5.25 HH

RMS

Model Number	Formatted Capacity	No. of Heads	No. of Cylinders	SPT	Avg in ms	Interface	Form Factor
RMS 506	5	4	153	17	130	MFM	5.25
RMS 509	7.5	6	153	17	130	MFM	5.25
RMS 512	10	8	153	17	130	MFM	5.25

RODIME SYSTEMS

Model Number	Formatted Capacity	No. of Heads	No. of Cylinders	SPT	Avg in ms	Interface	Form Factor
Cobra 40AT	44	8	640	17	20	AT-IDE	3.50 HH
	Translated Parameters: 8 Heads 640 Cylinders 17 SPT - This is your CMOS setting						
Cobra 80AT	80	4	1030	28	20	AT-IDE	3.50 HH
	Translated Parameters: 4 Heads 1024 Cylinders 17 SPT - This is your CMOS setting						
Cobra 110AT	105	7	1053	28	20	ESDI	3.50 HH
	Translated Parameters: 13 Heads 972 Cylinders 17 SPT - This is your CMOS setting						
Cobra 110E	105	7	1053	28	18	SCS-2I	3.50 HH
Cobra 210AT	210	7	1156	62	20	AT-IDE	3.50 HH
	Translated Parameters: 13 Heads 956 Cylinders 33 SPT - This is your CMOS setting						
Cobra 210E	210	7	1156	62	18	SCSI-2	3.50 HH
Cobra 650E	650	15	1224	63	17	SCSI-2	5.25

RODIME, INC.

Model Number	Formatted Capacity	No. of Heads	No. of Cylinders	SPT	Avg in ms	Interface	Form Factor
RO 101	3	2	192	17	85	MFM	5.25 FH
RO 102	6	4	192	17	85	MFM	5.25 FH
RO 103	9	6	192	17	85	MFM	5.25 FH
RO 104	12	8	192	17	85	MFM	5.25 FH
RO 201	5	2	321	17	90	MFM	5.25 FH
RO 201E	11	2	640	17	55	MFM	5.25 FH
RO 202	11	4	321	17	90	MFM	5.25 FH

RODIME, INC. (Continued)							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
RO 202E	22	4	640	17	55	MFM	5.25 FH
RO 203	16	6	321	17	90	MFM	5.25 FH
RO 203E	33	6	640	17	55	MFM	5.25 FH
RO 204	22	8	320	17	90	MFM	5.25 FH
RO 204E	44	8	640	17	55	MFM	5.25 FH
RO 251	5	2	306	17	85	MFM	5.25 HH
RO 252	11	4	306	17	85	MFM	5.25 HH
RO 351	5	2	306	17	85	MFM	3.50 HH
RO 352	11	4	306	17	85	MFM	3.50 HH
RO 652A	20	4	306	33	85	SCSI	3.50 HH
RO 652B	20	4	306	33	85	SCSI	3.50 HH
RO 752A	20	4	306	33	85	SCSI	3.50 HH
RO 3045	37	5	872	17	28	MFM	3.50 HH
RO 3055	45	6	872	17	28	MFM	3.50 HH
RO 3055T	45	3	1053	28	24	SCSI	3.50 HH
RO 3057S	45	5	680	26	28	SCSI	3.50 HH
RO 3058A	45	3	868	34	18	AT-IDE	3.50 HH
	Translated Parameters: 3 Heads 868 Cylindrers 34 SPT - This is your CMOS setting						
RO 3058T	45	3	868	34	18	SCSI	3.50 HH
RO 3060R	49	5	750	26	28	RLL	3.50 HH
RO 3065	53	7	872	17	28	MFM	3.50 HH
RO 3075R	59	6	750	26	28	RLL	3.50 HH
RO 3085R	69	7	750	26	28	RLL	3.50 HH
RO 3085S	70	7	750	26	28	SCSI	3.50 HH

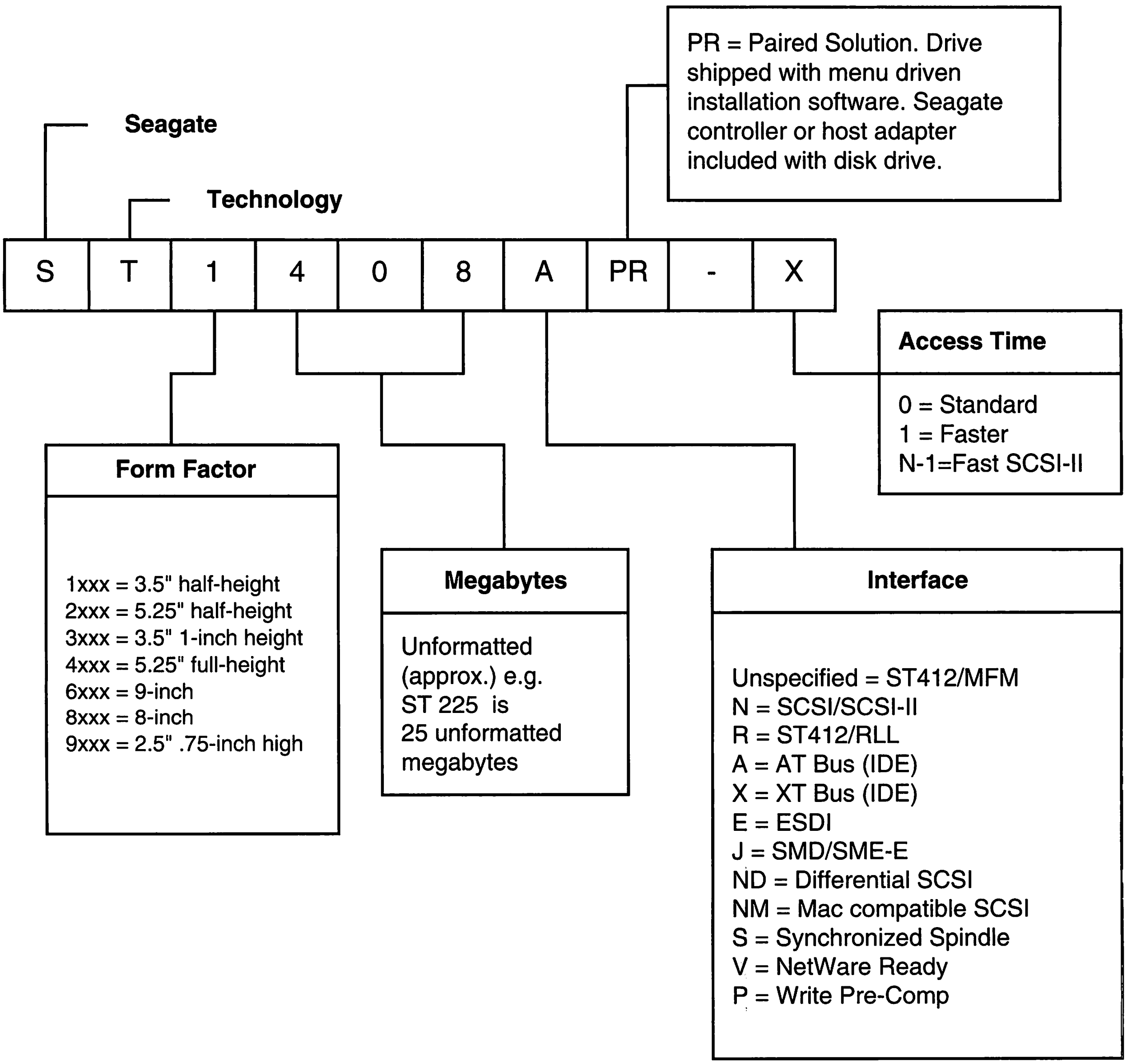
RODIME, INC. (Continued)							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
RO 3088A	75	5	868	34	18	AT-IDE	3.50 HH
	Translated Parameters: 5 Heads 868 Cylinders 34 SPT - This is your CMOS setting						
RO 3088T	76	5	868	34	18	SCSI	3.50 HH
RO 3090T	75	5	1053	28	24	SCSI	3.50 HH
RO 3095A	80	5	923	34	19	AT-IDE	3.50 HH
	Translated Parameters: 5 Heads 923 Cylinders 34 SPT - This is your CMOS setting						
RO 3099AP	80	4	1030	28	18	AT-IDE	3.50 HH
	Translated Parameters: 4 Heads 1024 Cylinders 29 SPT - This is your CMOS setting						
RO 3121A	122	4	1207	53	14	AT-IDE	3.50 HH
	Translated Parameters: 14 Heads 1001 Cylinders 17 SPT - This is your CMOS setting						
RO 3128A	105	7	868	34	18	AT-IDE	3.50 HH
	Translated Parameters: 14 Heads 868 Cylinders 17 SPT - This is your CMOS setting						
RO 3128T	105	7	868	34	18	SCSI	3.50 HH
RO 3129TS	105	5	1091	41	18	SCSI	3.50 HH
RO 3130T	105	7	1053	28	24	SCSI	5.25 HH
RO 3135A	112	7	923	34	19	AT-IDE	3.50 HH
	Translated Parameters: 14 Heads 923 Cylinders 17 SPT - This is your CMOS setting						
RO 3139A	112	7	923	28	18	AT-IDE	3.50 HH
	Translated Parameters: 14 Heads 923 Cylinders 17 SPT - This is your CMOS setting						
RO 3139TP	112	5	1148	42	18	SCSI	3.50 HH
RO 3199AP	112	5	1168	28	18	AT-IDE	3.50 HH
	Translated Parameters: 13 Heads 989 Cylinders 17 SPT - This is your CMOS setting						
RO 3199TS	163	7	1216	41	18	SCSI	3.50 HH

RODIME, INC. (Continued)							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
RO 3209A	163	15	759	28	18	AT-IDE	3.50 HH
	Translated Parameters: 10 Heads 964 Cylinders 33 SPT - This is your CMOS setting						
RO 3259A	213	15	990	28	18	AT-IDE	3.50 HH
	Translated Parameters: 13 Heads 990 Cylinders 33 SPT - This is your CMOS setting						
RO 3259AP	213	9	1235	28	18	AT-IDE	3.50 HH
	Translated Parameters: 13 Heads 969 Cylinders 33 SPT - This is your CMOS setting						
RO 3259T	210	9	1216	41	18	SCSI	3.50 HH
RO 3259TP	210	9	1189	42	18	SCSI	3.50 HH
RO 3259TS	210	9	1216	41	18	SCSI	3.50 HH
RO 5065	53	5	1224	17	28	MFM	5.25 HH
RO 5075E	65	3	1224	35	22	ESDI	5.25 HH
RO 5075S	61	3	1219	33	28	SCSI	5.25 HH
RO 5078S	61	5	1219	33	18	SCSI	5.25 HH
RO 5090	74	7	1224	17	28	MFM	5.25 HH
RO 5125E	109	5	1224	35	22	ESDI	5.25 HH
RO 5125S	103	5	1219	33	24	SCSI	5.25 HH
RO 5128S	103	7	1219	33	18	SCSI	5.25 HH
RO 5130R	114	7	1224	26	28	RLL	5.25 HH
RO 5178S	144	7	1219	33	19	SCSI	5.25 HH
RO 5180E	153	7	1224	35	22	ESDI	5.25 HH
RO 5180S	144	7	1219	33	24	SCSI	5.25 HH

SAMSUNG							
Model Number	Formatted Capacity	No. of Heads	No. of Cylinders	SPT	Avg in ms	Interface	Form Factor
SHD-3101A	105	4	1282	40	19	AT-IDE	3.50 HH
SHD-3201S	211	7	1376	43	16	SCSI	3.50 HH

SEAGATE

The table below shows how to identify Seagate Drive model numbers.



SEAGATE							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
ST 124	21	4	615	17	40	MFM	3.50 HH
ST 125 ST125-1	21	4	615	17	40/28	MFM	3.50 HH
ST 125A ST 125A-1	21	4	404	26	40/28	AT-IDE	3.50 HH
	Translated Parameters: 4 Heads 404 Cylinders 26 SPT - This is your CMOS setting						
ST 125N ST 125N-1	21	4	407	26	40/28	SCSI	3.50 HH
ST 138 ST 138-1	32	6	615	17	40/28	MFM	3.50 HH
ST 138A ST 138A-1	32	4	604	26	40/28	AT-IDE	3.50 HH
	Translated Parameters: 4 Heads 604 Cylinders 26 SPT - This is your CMOS setting						
ST 138N ST 138N-1	32	4	615	26	40/28	SCSI	3.50 HH
ST 138R ST 138R-1	33	4	615	26	40/28	RLL	3.50 HH
ST 151	43	5	977	17	24	MFM	3.50 HH
ST 157A ST 157A-1	45	6	560	26	40/28	AT-IDE	3.50 HH
	Translated Parameters: 6 Heads 560 Cylinders 26 SPT - This is your CMOS setting						
ST 157N ST 157N-1	49	6	615	26	40/28	SCSI	3.50 HH
ST 157R ST 157R-1	49	6	615	26	40/28	RLL	3.50 HH
ST 177N	61	5	921	26	24	SCSI	3.50 HH
ST 206	5	2	306	17	-	MFM	5.25 HH
ST 212	10	4	306	17	65	MFM	5.25 HH
ST 213	10	2	615	17	65	MFM	5.25 HH
ST 225	21	4	615	17	65	MFM	5.25 HH
ST 225N	21	4	615	17	65	SCSI	5.25 HH

SEAGATE (Continued)							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
ST 225R	21	2	667	31	70	RLL	5.25 HH
ST 238R	32	4	615	26	65	RLL	5.25 HH
ST 250R	42	4	667	31	70	RLL	5.25 HH
ST 251 ST 251-1	43	6	820	17	40/28	MFM	5.25 HH
ST 251N	43	4	820	26	40	SCSI	5.25 HH
ST 251N-1	43	4	630	34	28	SCSI	5.25 HH
ST 252	43	6	820	17	40	MFM	5.25 HH
ST 253	43	5	989	17	28	MFM	5.25 HH
ST 274A	65	5	948	26	29	AT-IDE	5.25 HH
	Translated Parameters: 5 Heads 948 Cylinders 26 SPT - This is your CMOS setting						
ST 277N	65	6	820	26	40	SCSI	5.25 HH
ST 277N-1	65	6	628	34	28	SCSI	5.25 HH
ST 277R ST 277R-1	66	6	820	26	40/28	RLL	5.25 HH
ST 278R ST 278R-1	66	6	820	26	40/28	RLL	5.25 HH
ST 279R	65	5	989	26	28	RLL	5.25 HH
ST 280A	71	5	1032	27	29	AT-IDE	5.25 HH
	Translated Parameters: 5 Heads 1024 Cylinders 27 SPT - This is your CMOS setting						
ST 296N	80	6	820	34	28	SCSI	5.25 HH
ST 325A/X	21	4	615	17	28	AT/XT-IDE	3.50 1"
	Translated Parameters: 4 Heads 615 Cylinders 17 SPT - This is your CMOS setting						
ST 351A/X	42.8	6	820	17	28	AT/XT	3.50 low profile
	Translated Parameters: 6 Heads 820 Cylinders 17 SPT - This is your CMOS setting						

SEAGATE (Continued)							
Model Number	Formatted Capacity	No. of Heads	No. of Cylinders	SPT	Avg in ms	Interface	Form Factor
ST 406	5	2	306	17	85	MFM	5.25 FH
ST 412	10	4	306	17	85	MFM	5.25 FH
ST 419	15	6	306	17	85	MFM	5.25 FH
ST 506	5	4	153	17	85	MFM	5.25 FH
ST 1057A	53	6	1024	17	18	AT-IDE	3.50 HH
	Translated Parameters: 6 Heads 1024 Cylinders 17 SPT - This is your CMOS setting						
ST 1090A	79	5	1072	29	15	AT-IDE	3.50 HH
	Translated Parameters: 5 Heads 1024 Cylinders 33 SPT - This is your CMOS setting						
ST 1090N	79	5	1068	29	15	SCSI	3.50 HH
ST 1096N	80	7	906	26	20	SCSI	3.50 HH
ST 1100	83	9	1072	17	15	MFM	3.50 HH
ST 1102A	89	10	1024	17	18	AT-IDE	3.50 HH
	Translated Parameters: 10 Heads 1024 Cylinders 17 SPT - This is your CMOS setting						
ST 1106R	91	7	977	26	24	RLL	3.50 HH
ST 1111A	98	5	1072	36	15	AT-IDE	3.50 HH
	Translated Parameters: 5Heads 1024 Cylinders 37 SPT - This is your CMOS setting						
ST 1111E	98	5	1072	36	15	ESDI	3.50 HH
ST 1111N	98	5	1068	36	15	SCSI	3.50 HH
ST 1126A	111	7	1072	29	15	AT-IDE	3.50 HH
	Translated Parameters: 13 Heads 980 Cylinders 17 SPT - This is your CMOS setting						
ST 1126N	111	7	1068	29	15	SCSI	3.50 HH
ST 1133A	117	5	1272	36	15	AT-IDE	3.50 HH
	Translated Parameters: 14 Heads 960 Cylinders 17 SPT - This is your CMOS setting						

Seagate (Continued)							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
ST 1133NS	116	5	1268	36	15	SCSI-2	3.50 HH
ST 1144A	130	15	1385	36	18	AT-IDE	3.50 HH
	Translated Parameters: 15 Heads 1001 Cylinders 17 SPT - This is your CMOS setting						
ST 1150R	128	9	1072	26	15	RLL	3.50 HH
ST 1156A	138	7	1072	36	15	AT-IDE	3.50 HH
	Translated Parameters: 16 Heads 990 Cylinders 17 SPT - This is your CMOS setting						
ST 1156E	138	7	1072	36	15	ESDI	3.50 HH
ST 1156N/NS	138	7	1068	36	15	SCSI/SCSI-2	3.50 HH
ST 1162A	143	9	1072	29	15	AT-IDE	3.50 HH
	Translated Parameters: 9 Heads 1024Cylinders 30 SPT - This is your CMOS setting						
ST 1162N	142	9	1068	29	15	SCSI	3.50 HH
ST 1186A	164	7	1272	36	15	AT-IDE	3.50 HH
	Translated Parameters: 10 Heads 970Cylinders 33 SPT - This is your CMOS setting						
ST 1186NS	163	7	1268	36	15	SCSI-2	3.50 HH
ST 1201A	177	9	1072	36	15	AT-IDE	3.50 HH
	Translated Parameters: 9 Heads 804 Cylinders 48 SPT - This is your CMOS setting						
ST 1201E	177	9	1072	36	15	ESDI	3.50 HH
ST 1201N ST 1201NS	177	9	1068	36	15	SCSI SCSI-2	3.50 HH
ST 1239A	211	9	1272	36	15	AT-IDE	3.50 HH
	Translated Parameters: 12 Heads 954 Cylinders 36 SPT - This is your CMOS setting						
ST 1239NS	210	9	1268	36	15	SCSI-2	3.50 HH

Seagate (Continued)							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
ST 1400A	331	7	1475	62	14	AT	3.50 HH
	Translated Parameters: 15 Heads 736 Cylinders 62 SPT - This is your CMOS setting						
ST 1400N	331	7	1476	62	14	SCSI-2	3.50 HH
ST 1401A	340	9	1121	62	12	AT	3.50 HH
	Translated Parameters: 15 Heads 736 Cylinders 62 SPT - This is your CMOS setting						
ST 1401N	338	9	1121	62	12	SCSI-2	3.50 HH
ST 1480A	426	9	1474	-	14	AT	3.50 HH
	Translated Parameters: 15 Heads 895 Cylinders 62 SPT - This is your CMOS setting						
ST 1480N ST 1480ND	426	9	1476	62	14	SCSI-2	3.50 HH
ST 1480N ST 1480NV	426	9	1476	62	14	SCSI-2	3.50 HH
ST 1481N	426	9	1476	62	14	Fast SCSI-2	3.50 HH
ST 1581N	525	9	1476	77	14	Fast SCSI-2	3.50 HH
ST 1980N ST 1980ND	860	13	1730	77	9.9 11.4	Fast SCSI-2	3.50 HH
ST 2106E	92	5	1024	36	18	ESDI	5.25 HH
ST 2106N ST 2106NM	91	5	1022	36	18	SCSI	5.25 HH

SEAGATE (Continued)							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
ST 2125 N,NM,NV	107	3	1544	45	18	SCSI	5.25 HH
ST 2182E	160	4	1453	54	16	ESDI	5.25 HH
ST 2209 N,NM,NV	179	5	1544	45	18	SCSI	5.25 HH
ST 2274A	241	5	1747	54	16	AT-IDE	5.25 HH
	Translated Parameters: 16 Heads 465 Cylinders 63 SPT - This is your CMOS setting						
ST 2383A	338	7	1747	54	16	AT-IDE	5.25 HH
	Translated Parameters: 16 Heads 737 Cylinders 56 SPT - This is your CMOS setting						
ST 2383E	338	7	1747	54	16	ESDI	5.25 HH
ST 2383 N,NM,ND	332	7	1261	74	14	SCSI SCSI-2	5.25 HH
ST 2502 N,NM, ND, NV	435	7	1755	69	16	SCSI SCSI-2	5.25 HH
ST 3051A	43.1	7	706	17	16	AT-IDE	3.5 low profile
	Translated Parameters: 6 Heads 820 Cylinders 17 SPT - This is your CMOS setting						
ST 3096A	89.1	16	590	17	14	AT-IDE	3.5 low profile
	Translated Parameters: 10 Heads 1024 Cylinders 17 SPT - This is your CMOS setting						
ST 3120A	106.9	16	754	17	15	AT-IDE	3.5 low profile
	Translated Parameters: 12 Heads 1024 Cylinders 17 SPT - This is your CMOS setting						
ST 3144A	130.7	16	953	17	16	AT-IDE	3.5 low profile
	Translated Parameters: 15 Heads 1001 Cylinders 17 SPT - This is your CMOS setting						

SEAGATE (Continued)							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
ST 3243A	214	16	413	63	16	AT-IDE	3.5 low profile
	Translated Parameters: 12 Heads 1024Cylinders 36 SPT - This is your CMOS setting						
ST 3283A	245.3	16	470	63	12	AT-IDE	3.5 low profile
	Translated Parameters: 16 Heads 470 Cylinders 63 SPT - This is your CMOS setting						
ST 3283N	248.6	NA	NA	-	12	Fast SCSI-2	3.5 low profile
ST 3385A	340	14	767	63	12	AT-IDE	3.5 lkow profile
	Translated Parameters: 16 Heads 659 Cylinders 63 SPT - This is your CMOS setting						
ST 3500A	426	8	1820	36	10	AT-IDE	3.50 1"
	Translated Parameters: 16 Heads 825 Cylinders 63 SPT - This is your CMOS setting						
ST 3500 N,ND	426	16	825	63	10	SCSI-2	3.50 1"
ST 3550A	452.4	7	1810	63	12	AT-IDE	3.5 low profile
	Translated Parameters: 16 Heads 876 Cylinders 63 SPT - This is your CMOS setting						
ST 3550N	456.5	7	1810	63	12	Fast SCSI-2	3.5 low profile
ST 3600A	540	7	1874	-	10.5 12	AT-IDE	3.5 low profile
	Translated Parameters: 16 Heads 1024 Cylinders 63 SPT - This is your CMOS setting						
ST 3600 N,ND	525	7	1872	-	10.2 12	Fast SCSI-2	3.5 low profile
ST 3601 N,ND	535	7	1872	-	10.2 12	Fast SCSI-2	3.5 low prof.

SEAGATE (Continued)							
Model Number	Formatted Capacity	No. of Heads	No. of Cylinders	SPT	Avg in ms	Interface	Form Factor
ST 4026	21	4	615	17	40	MFM	5.25 FH
ST 4038	31	5	733	17	40	MFM	5.25 FH
ST 4051	42	5	977	17	40	MFM	5.25 FH
ST 4053	45	5	1024	17	28	MFM	5.25 FH
ST 4085	71	8	1024	17	28	MFM	5.25 FH
ST 4086	72	9	925	17	28	MFM	5.25 FH
ST 4096	80.2	9	1024	17	28	RLL	5.25 FH
ST 4097	80	9	1024	17	28	MFM	5.25 FH
ST 4135R	115	9	960	26	28	RLL	5.25 FH
ST 4144R	122.7	9	1024	26	28	ST412	5.25 FH
ST 4182E	160	9	969	36	16	ESDI	5.25 FH
ST 4182 N,NM	155	9	969	35	16	SCSI	5.25 FH
ST 4350 N,NM	300	9	1412	46	17	SCSI	5.25 FH
ST 4376 N,NM,NV	330	9	1546	45	18	SCSI	5.25 FH
ST 4383E	338	13	1412	36	18	ESDI	5.25 FH
ST 4384E	338	15	1224	36	14.5	ESDI	5.25 FH
ST 4385 N,NM,NV	330	15	1412	55	10.7	SCSI	5.25 FH
ST 4442E	380	15	1412	36	16	ESDI	5.25 FH
ST 4702 N,NM	601	15	1546	50	16.5	SCSI	5.25 FH
ST 4766E	676	15	1632	54	15.5	SCSI	5.25 FH

SEAGATE (Continued)							
Model Number	Formatted Capacity	No. of Heads	No. of Cylinders	SPT	Avg in ms	Interface	Form Factor
ST 9095A	85.3	16	1024	63	16	AT-IDE	2.5"
ST 9096A	85.3	16	1024	63	16	AT	2.5"
ST 9096N	85	-	-	-	16	SCSI-2	2.50 .75"
ST 9100AG	85.3	16	1024	-	16	AT	2.5"
ST 9144	42.6	16	1024	63	16	AT-IDE	2.5"
ST 9144A	127.9	16	1024	63	16	AT-IDE	2.50 .75"
ST 9144N	128	-	-	-	16	SCSI-2	2.50 .75"
ST 9235AG	209.7	13/16	985 1024	-	16	AT	2.5"
ST 9235N	209	NA	NA	-	16	SCSI	2.5"
ST 9295AG	261	16	1024	-	16	AT	2.5"
ST 11200 N, ND	1050	15	1877	-	10.5 12	Fast SCSI-2	3.5 HH
ST 11200 N, ND	1050	15	1877	-	10.5 12	Fast Wide SCSI-2	3.50 HH
ST 11700 N, ND	1430	13	2626	-	9 10.5	Fast SCSI-2	3.50 HH
ST 11701 N, ND	1430	13	2626	63	9 10.5	Fast Wide SCSI-2	3.50 HH
ST 11750 N, ND	1437	12	2756	63	8, 9	Fast SCSI-2	3.50 HH
ST 11751 N, ND	1437	12	2756	63	8, 9	Fast Wide SCSI-2	3.50 HH
ST 12400 N, ND	2100	19	2626	63	9 10.5	Fast SCSI-2	3.50 HH
ST 12401 N, ND	2100	19	2626	63	9 10.5	Fast Wide SCSI-2	3.50 HH

SEAGATE (Continued)							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
ST 12550 N, ND	2100	19	2756	63	8, 9	Fast SCSI-2	3.50 HH
ST 12551 N, ND	2100	19	2756	63	8/9	Fast SCSI-2	3.50 HH
ST 31200 N, ND	1050	9	2626	63	9/10.5	Fast SCSI-2	3.5 low prof.
ST 41097J	1097	17	2101	71	12	SMD-01E	5.25 FH
ST 41200 N, NM, NV	1037	15	1931	71	15	SCSI	5.25 FH
ST 41201 J, K	1200	15	2101	71	11.5	SMD-O/E	5.25 FH
ST 41291K	1200	15	2101	71	11.5	IPI-2 dual port	5.25 FH
ST 41520 N, ND	1370	18	2101	71	11.5	SCSI-2 dual port	5.25 FH
ST 41600 N, ND	1370	18	2101	75	11.5	SCSI-2	5.25 FH
ST 41601 N, ND	1370	18	2101	75	11.5	Fast SCSI-2	5.25 FH
ST 41650 N, ND	1415	15	2107	87	15	SCSI-2	5.25 FH
ST 41651 N, ND	1415	15	2107	77	15	Fast SCSI-2	5.25 FH
ST 41800K	1624	15	2627	81	11	IPI-2 dual port	5.25 FH
ST 42000 N, ND	1792	15	2627	84	11	Fast SCSI-2	5.25 FH
ST 42100N	1900	15	2574	84	12.9	Fast SCSI-2	5.25 FH
ST 42100 NM, ND, NV	1037	15	1931	84	15	SCSI-2	5.25 FH

SEAGATE (Continued)							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
ST 42101 N,ND	1900	15	2574	84	13	SCSI-2, Fast Wide	5.25 FH
ST 42400N	2100	19	2653	84	11	SCSI-2	5.25 FH
ST 43200K	3385*	19	2738	91	10, 11	Fast Wide SCSI-2 dual port	5.25 FH
ST 43400 N, ND	2912	19	2738	88	11	Fast SCSI-2	5.25 FH
ST 43401 N, ND	2912	19	2738	88	10, 11	Fast Wide SCSI-2	5.25 FH
ST 43402 ND	2912	19	2738	88	10, 11	Fast Wide SCSI-2 dual port	5.25 FH
ST 81236 J, K, N	1056	17	1635	64	15	SMD-O/E, IPI-2, SCSI	8.00
ST 81123J	1123*	17	1635	64	15	SMD-O/E dual port	8.00
ST 81154K	1154*	17	1635	64	15	IPI-2 dual port	8.00
ST 82030 J, K	2030*	21	2120	64	11	SMD-O/E, IPI-2 dual port	8.00

SHUGART							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
SA 604	5	4	160	17	140	MFM	5.25 FH
SA 606	7	6	160	17	140	MFM	5.25 FH
SA 607	5	2	306	17	80	MFM	5.25 FH
SA 612	11	4	306	17	100	MFM	5.25 FH
SA 706	6	2	320	17	120	MFM	5.25 FH
SA 712	11	4	320	17	80	MFM	5.25 FH
SA 724	20	8	320	17	80	MFM	5.25 FH
SA 1002	5	8	320	17	120	MFM	8.00

SHUGART (Continued)							
Model Number	Formatted Capacity	No. of Heads	No. of Cylinders	SPT	Avg in ms	Interface	Form Factor
SA 1004	10	-	-	17	-	MFM	8.00
SA 1106	30	-	-	17	-	MFM	8.00
SA 4004	14	-	-	17	-	MFM	14.00
SA 4008	29	-	-	17	-	MFM	14.00
SA 4100	56	-	-	17	-	MFM	14.00

SIEMENS							
Model Number	Formatted Capacity	No. of Heads	No. of Cylinders	SPT	Avg in ms	Interface	Form Factor
1200	174	8	1216	35	25	ESDI	5.25 FH
1300	261	12	1216	35	25	ESDI	5.25 FH
2200	174	8	1216	35	25	SCSI	5.25 FH
2300	261	12	1216	35	25	SCSI	5.25 FH
4410	322	11	1100	52	16	ESDI	5.25 FH
4420	334	11	1100	54	17	SCSI	5.25 FH
5710	655	15	1224	48	16	ESDI	5.25 FH
5720	655	15	1224	48	16	SCSI	5.25 FH
5810	688	15	1658	54	14	ESDI	5.25 FH
5820	688	15	1658	54	14	SCSI	5.25 FH
6200	1062	15	1921	72	14	SCSI	5.25 FH

STORAGE DIMENSIONS							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
AT-40	44	5	1024	17	28	MFM	5.25 HH
AT-70	71	8	1024	17	28	MFM	5.25 HH
AT-100R	109	8	1024	26	28	RLL	5.25 FH
AT-100S	105	3	1224	54	19	SCSI	3.50 HH
AT-120	119	15	918	17	27	MFM	5.25 FH
AT-133	133	15	1024	17	28	MFM	5.25 FH
AT-140	142	8	1024	34	28	ESDI	5.25 FH
AT-155E	157	7	1224	52	14	ESDI	5.25 FH
AT-155S	156	9	1224	36	36	SCSI	5.25 FH
AT-160	159	15	1224	17	28	MFM	5.25 FH
AT-200	204	15	1024	26	28	RLL	5.25 FH
AT-200S	204	7	1021	26	15	SCSI	3.50 HH
AT-320E	329	15	1224	35	16	ESDI	5.25 FH
AT-320S	320	15	1224	36	16	SCSI	5.25 FH
AT-335E	338	15	1224	36	16	ESDI	5.25 FH
AT-650E	651	15	1632	52	16	ESDI	5.25 FH
AT-650S	651	15	1632	54	16	SCSI	5.25 FH
AT-1000S	1000	15	1632	63	15	SCSI	5.25 FH
MAC-195	195	7	-	-	15	SCSI	3.50 HH
PS-155E	156	9	1224	36	14	ESDI	5.25 FH
PS-155S	156	9	1224	36	14	SCSI	5.25 FH
PS-320S	320	15	1224	36	16	SCSI	5.25 FH
PS-335E	338	15	1224	36	16	ESDI	5.25 FH
PS-650S	651	15	1632	54	16	SCSI	5.25 FH

SYQUEST							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
SQ 225F	20	4	615	17	85	MFM	5.25 HH
SQ 306F	5	4	306	17	85	MFM	5.25 HH
SQ 306R	5	2	306	17	85	MFM	5.25 HH
SQ 306RD	5	2	306	17	85	MFM	5.25 HH
SQ 312	10	2	615	17	85	MFM	4.00 HH
SQ 312RD	10	2	615	17	85	MFM	4.00 HH
SQ 315F	21	4	612	17	65	MFM	4.00 HH
SQ 319	10	2	612	17	85	MFM	4.00 HH
SQ 325	21	4	612	17	85	MFM	4.00 HH
SQ 325F	20	4	615	17	65	MFM	4.00 HH
SQ 338F	30	6	615	17	65	MFM	4.00 HH
SQ 340AF	38	6	640	17	65	MFM	4.00 HH
SQ 555	44	2	1021	42	20	SCSI	5.25 HH
	Translated Parameters: 5 Heads 1011 Cylinders 17 SPT - This is your CMOS setting						
SQ 2542A	43	2	1481	41	15	AT-IDE	2.50
	Translated Parameters: 5 Heads 988 Cylinders 17 SPT - This is your CMOS setting						
SQ 5110	89	2	1720	82	20	SCSI	5.25 HH
	Translated Parameters: 13 Heads 972 Cylinders 17 SPT - This is your CMOS setting						

TANDON							
Model Number	Formatted Capacity	No. of Heads	No. of Cylinders	SPT	Avg in ms	Interface	Form Factor
TM 244	41	4	782	26	37	RLL	5.25 HH
TM 246	62	6	782	26	37	RLL	5.25 HH
TM 251	5	2	306	17	85	MFM	5.25 HH
TM 252	10	4	306	17	85	MFM	5.25 HH
TM 261	10	2	615	17	85	MFM	3.50 HH
TM 262	21	4	615	17	65	MFM	3.50 HH
TM 262R	20	2	782	26	85	RLL	3.50 HH
TM 264	41	4	782	26	85	RLL	3.50 HH
TM 344	41	4	782	26	37	RLL	3.50 HH
TM 346	62	6	782	26	37	RLL	3.50 HH
TM 361	10	2	615	17	65	MFM	3.50 HH
TM 362	21	4	615	17	65	MFM	3.50 HH
TM 362R	20	2	782	26	85	RLL	3.50 HH
TM 364	41	4	782	26	85	RLL	3.50 HH
TM 501	5	2	306	17	85	MFM	5.25 FH
TM 502	10	4	306	17	85	MFM	5.25 FH
TM 503	15	6	306	17	85	MFM	5.25 FH

TANDON (Continued)							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
TM 602S	5	4	153	17	85	MFM	5.25 FH
TM 603S	10	6	153	17	85	MFM	5.25 FH
TM 603SE	21	6	230	17	85	MFM	5.25 FH
TM 702	20	4	615	26	40	RLL	5.25 FH
TM 702AT	8	4	615	17	35	MFM	5.25 FH
TM 703	10	5	733	17	40	MFM	5.25 FH
TM 703-C	25	5	733	17	40	MFM	5.25 FH
TM 703AT	31	5	733	17	35	MFM	5.25 FH
TM 705	41	5	962	17	40	MFM	5.25 FH
TM 755	43	5	981	17	33	MFM	5.25 HH
TM 2085	74	9	1004	36	25	SCSI	5.25 FH
TM 2128	115	9	1004	36	25	SCSI	5.25
TM 2170	154	9	1344	36	25	SCSI	5.25
TM 3085	71	8	1024	17	37	MFM	3.50 HH
TM 3085-R	104	8	1024	26	37	RLL	3.50 HH

TANDY							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
25-1045	20	4	615	17	35	XT-IDE	5.25 HH
	Translated Parameters: 4 Heads 615 Cylinders 17 SPT - This is your CMOS setting						
25-1046	43	4	782	27	28	XT-IDE	5.25 HH
25-1047	20	4	615	17	35	XT-IDE	-
	Translated Parameters: 4 Heads 615 Cylinders 17 SPT - This is your CMOS setting						

TEAC							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
SD 150	10	4	306	17	80	MFM	5.25 FH
SD 340-A	43	2	1050	40	23	AT-IDE	3.50 HH
SD 340S	43	2	1050	40	23	SCSI	3.50 HH
SD 380	86	4	1050	40	20	AT-IDE	3.50 HH
SD 380-S	86	4	1050	40	20	SCSI	3.50 HH
SD 510	10	4	306	17	65	MFM	5.25 FH
SD 520	20	4	615	17	65	MFM	5.25 FH
SD 540	40	8	615	17	65	MFM	5.25 FH
SD 3105H	105	4	1381	48	-20	IDE	3.50 HH
	Translated Parametera: 12 Heads 1005 Cylinders 17 SPT - This is your CMOS setting						

TEXAS INSTRUMENTS							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
TI-5	5	4	153	17	65	MFM	5.25 FH

TOKICO							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
DK 503-2	10	4	306	17	105	MFM	5.25 FH

TOSHIBA							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
MK 53FA(M)	43	5	830	17	30	MFM	5.25 FH
MK 53FA(R)	64	5	830	26	30	RLL	5.25 FH
MK 53FB(M)	43	5	830	17	25	MFM	5.25 FH
MK 53FB(R)	64	5	830	26	25	RLL	5.25 FH
MK 54FA(M)	60	7	830	17	30	MFM	5.25 FH
MK 54FA(R)	90	7	830	26	25	RLL	5.25 FH
MK 54FB(M)	60	7	830	17	25	MFM	5.25 FH
MK 54FB(R)	90	7	830	26	25	RLL	5.25 FH
MK 56FA(M)	86	10	830	17	30	MFM	5.25 FH
MK 56FA(R)	129	10	830	26	30	RLL	5.25 FH
MK 56FB(M)	72	10	830	17	25	MFM	5.25 FH
MK 56FB(R)	105	10	830	26	25	RLL	5.25 FH
MK 72	72	10	830	17	25	MFM	3.50 HH
MK 72PCR	105	10	830	26	25	RLL	3.50 HH
MK 130	53	9	733	17	25	MFM	3.50 HH
MK 134FA(M)	44	7	733	17	25	MFM	3.50 HH
MK 134FA(R)	65	7	733	26	23	RLL	3.50 HH
MK 153FA	74	5	830	35	23	ESDI	5.25 FH
MK 153FB	74	5	830	35	23	SCSI	5.25 FH
MK 154FA	104	7	830	35	23	ESDI	5.25 FH
MK 154FB	104	7	830	35	23	SCSI	5.25 FH
MK 156FA	145	10	830	35	23	PC-ESDI	5.25 FH

TOSHIBA (Continued)							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
MK 156FB	145	10	830	35	23	PC-SCSI	5.25 FH
MK 232FB	45	3	845	35	25	SCSI	3.50 HH
MK 233FB	76	5	845	35	25	SCSI	3.50 HH
MK 234FB	101	7	845	35	25	PC-IDE	3.50 HH
	Translated Parameters: 12 Heads 945 Cylinders 17 SPT - This is your CMOS setting						
MK 234FC	101	7	845	35	25	PC-IDE	3.50 HH
	Translated Parameters: 12 Heads 945 Cylinders 17 SPT - This is your CMOS setting						
MK 250FA	382	10	1224	35	18	ESDI	5.25 FH
MK 250FB	382	10	1224	35	18	SCSI	5.25 FH
MK 355FA	459	9	1632	53	16	ESDI	5.25 FH
MK 355FB	459	9	1632	53	16	SCSI	5.25 FH
MK 358FA	676	15	1661	53	16	ESDI	5.25 FH
MK 358FB	676	15	1661	53	16	SCSI	5.25 FH
MK 438FB	877	15	1691	53	12.5	SCSI-2	3.50 HH
MK 438FM	867	15	1691	53	13	SCSI-2	3.50 HH
MK 538FB	1230	15	1980	53	12	SCSI-2	3.5"
MK 556FA	152	10	830	36	23	ESDI	5.25 FH
MK 1034FC	107	4	1339	39	16	AT-IDE	3.50
	Translated Parameters: 8 Heads 664 Cylinders 39 SPT - This is your CMOS setting						
MK 1122FC	43	5	988	17	23	AT-IDE	2.50
MK 2024FC	86	2	988	17	19	PC/AT-IDE	2.50
	Translated Parameters: 16 Heads 615 Cylinders 17 SPT - This is your CMOS setting						
MK 2124FC	130	6	1820	48	17	PC/AT-IDE	2.50
	Translated Parameters: 16 Heads 1155 Cylinders 17SPT - This is your CMOS setting						

TULIN							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
TL 213	10	2	640	17	105	MFM	5.25 HH
TL 226	22	4	640	17	85	MFM	5.25 HH
TL 238	22	4	640	17	85	MFM	5.25 HH
TL 240	33	6	640	17	65	MFM	5.25 HH
TL 258	33	6	640	17	65	MFM	5.25 HH
TL 326	22	4	640	17	65	MFM	5.25 HH
TL 340	33	6	640	17	65	MFM	5.25 HH

VERTEX (also see Priam)							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
V 130	26	3	987	17	40	MFM	5.25 FH
V 150	43	5	987	17	40	MFM	5.25 FH
V 170	60	7	987	17	28	MFM	5.25 FH

WESTERN DIGITAL							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
WD 262	20	4	615	17	80	MFM	3.50 HH
WD 344R	40	4	782	26	40	RLL	3.50 HH
WD 362	20	4	615	17	80	MFM	3.50 HH
WD 382R	20	2	782	26	85	RLL	3.50 HH
WD 383R	30	4	615	26	85	RLL	3.50 HH
WD 384R	40	4	782	26	85	RLL	3.50 HH
WD 544R	40	4	782	26	40	RLL	3.50 HH
WD 582R	20	2	782	26	85	RLL	3.50 HH
WD 583R	30	4	615	26	85	RLL	3.50 HH
WD 584R	40	4	782	26	85	RLL	3.50 HH
WD 93024-A	20	2	782	27	28	AT-IDE	3.50 HH
WD 93024-X	20	2	782	27	39	XT-IDE	3.50 HH
WD 93028 A,AD	20	2	782	27	69	AT-IDE	3.50 HH
WD 93028-X	20	2	782	27	80	XT-IDE	3.50 HH
WD 93034-X	30	3	782	27	39	XT-IDE	3.50 HH

WESTERN DIGITAL (Continued)							
Model Number	Formatted Capacity	No. of Heads	No. of Cylinders	SPT	Avg in ms	Interface	Form Factor
WD 93038-X	30	3	782	27	80	XT-IDE	3.50 HH
WD 93044-A	40	4	782	27	28	AT-IDE	3.50 HH
WD 93044-X	40	4	782	27	39	XT-IDE	3.50 HH
WD 93048-AD	40	4	782	27	69	AT-IDE	3.50 HH
WD 93048-A	40	4	782	27	69	AT-IDE	3.50 HH
WD 93048-X	40	4	782	27	80	XT-IDE	3.50 HH
WD 95024-A	20	2	782	27	28	AT-IDE	5.25 HH
WD 95024-X	20	2	782	27	39	XT-IDE	5.25 HH
WD 95028-A	20	2	782	27	39	AT-IDE	5.25 HH
WD 95028-AD	20	2	782	27	69	AT-IDE	3.50 HH
WD 95028-X	20	2	782	27	80	XT-IDE	5.25 HH
WD 95034-X	30	3	782	27	39	XT-IDE	3.50 HH
WD 95044-A	40	4	782	27	28	AT-IDE	3.50 HH
WD 95044-X	40	4	782	27	39	XT-IDE	3.50 HH
WD 95048-A	40	4	782	27	69	AT-IDE	3.50 HH
WD 95048-AD	40	4	782	27	69	AT-IDE	3.50 HH
WD 95048-X	40	4	782	27	80	AT-IDE	5.25 HH
WD AB130	32	5	733	17	19	AT-IDE	2.50
WD AH260	63	7	1024	17	19	AT-IDE	2.50
WD AC140	42	5	980	17	18	AT-IDE	3.50
WD AC160	62	7	1024	17	17	AT-IDE	3.50 HH

WESTERN DIGITAL (Continued)							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
WD AC280	85	10	980	17	18	AT-IDE	3.50 HH
WD AC2120	125	8	872	35	17	AT-IDE	3.50 HH
WD AP4200	212	12	987	35	15	AT-IDE	3.50 HH
WD M1130-44	41	2	1104	33	19	MCA	3.50 HH
WD M1130-72	68	4	1104	32	19	MCA	3.50 HH
WD SC8320	320	6	2105	35	12	SCSI-2	3.50 HH
WD SC8400	400	8	1900	35	12	SCSI-2	3.50 HH
WD SP4200	209	4	1900	35	14	SCSI-2	3.50 HH
Condor	320	6	2105	35	13	SCSI	3.50 HH
Piranha 105A	105	2	1917	35	15	AT-IDE	3.50 HH
	Translated Parameters: 13 Heads 1000 Cylinders 16 SPT - This is your CMOS setting						
Piranha 105S	105	2	1917	35	15	SCSI	3.50 HH
Piranha 210A	210	4	1917	35	15	AT-IDE	3.50 HH
	Translated Parameters: 13 Heads 950 Cylinders 33 SPT - This is your CMOS setting						
Piranha 210S	210	4	1917	35	15	SCSI	3.50 HH

XEBEX							
Model Number	**Formatted Capacity**	**No. of Heads**	**No. of Cylinders**	**SPT**	**Avg in ms**	**Interface**	**Form Factor**
OWL I	10	4	306	17/32	65	MFM	5.25 HH
OWL II	20	4	612	17/32	65	MFM	5.25 HH
OWL III	40	4	888	27	38	MFM	5.25 HH

YE-DATA (also see C. Itoh)							
Model Number	Formatted Capacity	No. of Heads	No. of Cylinders	SPT	Avg in ms	Interface	Form Factor
YD-3042	44	4	788	42	28	SCSI	3.50 HH
YD-3081B	45	2	1057	42	28	SCSI	3.50 HH
YD-3082	87	8	788	42	28	SCSI	3.50 HH
YD-3082B	90	4	1057	42	28	SCSI	3.50 HH
YD-3083B	136	6	1057	42	28	SCSI	3.50 HH
YD-3084B	181	8	1057	42	28	SCSI	3.50 HH
YD-3161B	45	2	1057	42	19	AT-IDE	3.50 HH
YD-3162B	90	4	1057	42	19	AT-IDE	3.50 HH
YD-3181B	45	2	1057	42	19	SCSI	3.50 HH
YD-3182B	90	4	1057	42	19	SCSI	3.50 HH
YD-3530	32	5	731	17	-	MFM	5.25 HH
YD-3540	45	7	731	17	-	MFM	5.25 HH

ZENTEC							
Model Number	Formatted Capacity	No. of Heads	No. of Cylinders	SPT	Avg in ms	Interface	Form Factor
ZH 3100	86	-	-	-	20	AT-IDE SCSI	3.50 HH
ZH 3140	121	-	-	-	20	AT-IDE SCSI	3.50 HH
ZH 3240	237	-	-	-	12	AT-IDE SCSI	3.50 HH
ZH 3380	332	-	-	-	12	AT-IDE SCSI	3.50 HH
ZH 3490	427	-	-	-	12	AT-IDE SCSI	3.50 HH

Controller Information

Listed on the following pages are descriptions of common controller cards with performance ratings and jumper settings. The jumper settings listed are the default or most common configuration we've seen.

The jumper settings needed to make the card work in your system may be different. Use the settings shown as a reference guide only. Be sure to consult the controller card manual for detailed information.

Adaptec Controllers:

Adaptec 1520
Adaptec 1522

A 16-bit controller that also supports SCSI-2. The 1520 is a hard drive only controller. The 1522 also supports 2 floppy drives.

Default Jumpers:	In: J5-2, J5-5, J5-6, J6-1, J6-2, J6-3, J6-5, J7-1*, J7-2*, J7-4*, J7-6* J8-4, J9-2, J9-6, J9-7, J9-8
Notes:	*Used only on 1522 (floppy jumpers)

Adaptec 1540A
Adaptec 1542A

A 16-bit SCSI controller. The 1540A is a hard drive only controller. The 1542A also supports 2 floppy drives.

Default Jumpers:	In: J1-10, J6-1, J7-1, J14-2, J15-2, J17 1&2*, J18 1&2* J19 1&2*
Notes:	*Used only on 1542 (floppy jumpers)

Adaptec AHA 1542CF

A 16-bit SCSI host adapter. Supports a total of 7 internal and external devices. Also supports floppy drives.

Default Jumpers:	All switches off.

Adaptec 2070A

An 8-bit controller that controls 2 hard drives only..

Default Jumpers:	None Installed
To Format, Use:	G=C800:CCC
Notes:	Jumper E-F for removable cartridge 0. Jumper G-H for removable cartridge drive 1. Jumper K-L for controller internal diagnostics. Boards with P/N 401400 Rev. C or later are required for use in AT class machines.

Adaptec Controllers (continued):

Adaptec 2320A
Adaptec 2322A
Adaptec 2322A-8

A 16-bit ESDI controller that controls 2 hard drives at 10MHz and supports 1:1 interleave. The 2322A also supports two floppy drives. The 2232A-8 supports data rates up to 15MHz.

Default Jumpers:	In: J13 1&2, J18 1&2, J19 1&2*, J20 1&2*, J21 2&3*
To Format, Use:	G=C800:5
Notes:	*2322A only for floppy control.

Adaptec 2370A
Adaptec 2372A

A 16-bit RLL controller that controls 2 hard drives and supports 1:1 interleave. The 2373A also supports 2 floppy drives.

Default Jumpers:	In: J14 1&2, J19 1&2, J20 1&2*, J21 2&3*, J22 2&3*
To Format, Use:	G=C800:5
Notes:	*2372A only for floppy control.

CCAT Controllers

CCAT 200A IDE Card p/n 6620000440

A 16-bit IDE controller that controls 2 IDE drives and 2 floppy drives.

Default Jumpers:	None Installed
To Format, Use:	G=C800:5

Conner Peripherals Controllers

Conner IDE Card p/n 02090-002

A 16-bit IDE paddle board that controlls 2 IDE drive.

Default Jumpers:	E1, E2, and E4 Installed

CSC Controllers

CSC AK-47 VESA SCSI-II

A 16-bit high speed SCSI-II controller. Controls up to 7 total internal or external hard, optical, and tape drives. Also supports up to 4 floppy drives.

Memory Base Address Setting		
SW7	SW8	Address Range
Off	**On**	**D000-D7FF****
On	Off	D800-DFFF
On	On	C800-CFFF
Off	Off	E000-E7FF

I/O Base Address Setting	
SW6	I/O Address Range
On	180H - 19FH
Off	**320H - 33FH****

Floppy Drive Enable/Disable	
SW1	Floppy Control
On	Disable Floppy
Off	**Enable Floppy**

Interrupt Select Options	
I/O Address	Valid IRQ
180-19FH	IRQ14
320-33FH	**IRQ15**

CSC Caching ESDI Card

A 16-bit caching controller which supports up to a total of 7 ESDI hard drive devices, and lup to 4 floppies. Up to 32MB on board cache.

JUMPER FUNCTIONS AND DEFAULTS

Jumper	Function	Default	Jumper
W1	BIOS Address	ON	ON
W2	BIOS Address	ON	ON
W3	Hard Disk Enable	ON	ON
W4	Fixed Disk Address	OFF	OFF
W5	Floppy Enable	ON	ON
W6	Cache Enable	OFF	ON
W7	DACK2 Enable	ON	ON
W9	Floppy Address	3FX	1/2

IRQ SETTINGS ON SIP SWITCH SW1

IRQ LEVEL	1	2	3	4	5	6	7	8
11	On	On	Off	Off	Off	Off	Off	Off
12	Off	Off	On	On	Off	Off	Off	Off
14	Off	Off	Off	Off	On	On	Off	Off
15	Off	Off	Off	Off	Off	Off	On	On

NOTES: To disable the hard drive controller: remove the jumper from W# and turn ALL switches on SW1 to OFF. To disable the floppy controller: remove the jumpers from W5 and W7. To disable the Caching Algorithm: install the jumper at W6.

CSC Controllers (Continued)

CSC FastCache 32

Supports up to 7 SCSI devices and 4 floppy drives. Up to 32MB on board cache. A single 8-bit position dip switch is used for hardware configurations and are shown in the table to the right.

Base Address			Floppy Drive	
SW0	SW1		SW5	
ON ON OFF OFF	ON OFF ON OFF	D000 C800 E000 D800	ON OFF	Enabled Disabled

Bus Speed		Module Type		
SW4		SW2	SW3	
ON OFF	Fast Faster	ON ON OFF	ON OFF ON	256K 1MB 4MB

Switches 6&7 control the floppy disk density and should be left ON for standard floppy drives. Switch 8 in not used.

CSC FastCache 64

Supports up to 7 SCSI devices and 4 floppy drives. Up to 64MB on board cache. A single 8-bit position dip switch is used for hardware configurations and are shown in the table to the right.

Interrupt			Floppy Drive	
SW1	SW2		SW3	
OFF ON OFF	OFF OFF ON	None IRQ14 IRQ15	ON OFF	Enabled Disabled

Bus Speed		Module Type		
SW4		SW5	SW6	
ON OFF	Non-Std Standard	ON OFF ON OFF	ON ON OFF OFF	256K 1MB 4MB 16MB

Base Address		
SW7	SW8	Address
OFF ON OFF ON	ON ON OFF OFF	C800 D000 D800 E000

CSC Controllers (Continued)

CSC IDE FastCache 64

The IDE FastCache 64 controls up to 2 IDE drives and 4 floppy drives and can have up to 64MB of onboard cache memory.

Base Address			SIMM Type		
SW1	SW2	Address	SW3	SW4	Module
ON ON OFF OFF	OFF ON OFF ON	C800* D000 D800 E000	ON ON OFF OFF	ON OFF ON OFF	256KB 1MB 4MB 16MB
Bus Compatibility			**Floppy Drives**		
SW5			**SW6**		
OFF ON	Standard* Non-Standard		ON OFF	Enabled* Disabled	
IDE Address			**Drive Interrupt**		
SW7			**SW8**		
ON OFF	Primary* Secondary		ON OFF	Buffered* Unbuffered	

DTC Controllers

DTC 3250

An 8-bit SCSI controller that also controls 2 floppy drives.

Default Jumpers:	In: W1. ON: SW2-1, SW2-8, SW2-9
To Format, Use:	GSDIAG

DTC 3180
DTC 3280

A 16-bit SCSI controller. 3280 also controls floppy drives.

Default Jumpers:	W1 2&3, W2 1&2* SW1-8* SW1-10*
To Format, Use:	GSDIAG program
Notes:	*3280 only for floppy control.

DTC Controllers (Continued)

DTC 3290

An EISA bus SCSI controller with up to 4MB cache RAM. Controls up to 7 SCSI devices and 2 floppies.

Default Jumpers:	None installed
To Format, Use:	GSDIAG program

DTC 5150

An XT (8-bit) MFM controller for 2 hard drives. 2:1 interleave.

Default Jumpers:	IN: W1 1&2, W2, W3 2&3 ON: SW4-4
To Format, Use:	G=C800:5

DTC 5180C Rev. C
DTC 5180C Rev. G
DTC 5180CR
DTC 5180CRH
DTC 5180I

These are 16-bit MFM hard drive, 2:1 interleave controllers.

Default Jumpers:	C Rev. C: W1 C Rev. G: W2, W3, W6 CR: W4 2&3, W5 2&3 CRH: W5 1&2, W6, W7 I: W4 2&3
To Format, Use:	G=C800:5

DTC 5187
DTC 5187-1
DTC 5187CR
DTC 5187CRH
DTC 5187I

These are 16-bit RLL hard drive, 2:1 interleave controllers.

Default Jumpers:	87 & 87-1: W1, W2, W4, W7 7&8 CR: W1, W4 2&3, W5 1&2, W6, W7, W8 CRH: W1, W4 1&2, W5 2&3 W6, W7, W8 I: W4 2&3, W6, W7, W8
To Format, Use:	G=C800:5

DTC 5280CA-1
DTC 5280CZ-1
DTC 5280CRA
DTC 5280CRZ
DTC 5280I

These are 16-bit MFM hard drive, 2:1 interleave controllers that also control 2 floppy drives.

Default Jumpers:	All Models: W5, W6
To Format, Use:	G=C800:5

DTC Controllers (Continued)

DTC 5387
DTC 5287CR
DTC 5287I

These are 16-bit RLL hard drive, 2:1 interleave controllers that also control 2 floppy drives.

Default Jumpers:	87: W3, W5, W6, W7 CR: W5, W6 2&3, W8, W10 I: W5, W6, W8, W10
To Format, Use:	G=C800:5

DTC 6180A
DTC 6280A

A 16-bit ESDI, 1:1 interleave controller for 2 hard dives at 10MHz. Model 6280 also controls 2 floppy drives.

Default Jumpers:	6180: W3, SW1-4 6280: W2
To Format, Use:	G=C800:5

DTC 6180-15T
DTC 6280-15T

A 16-bit ESDI, 1:1 interleave controller for 2 hard dives at 10MHz. Model 6280-15T also controls 2 floppy drives.

Default Jumpers:	6180-15T: W4 2&3, SW1-1, SW1-4 SW1-7, SW1-8 6280-15T: SW1-2, SW1-6, SW1-9 SW1-10
To Format, Use:	G=C800:5

DTC 6180-15TX
DTC 6280-15TX
DTC 6282-24

These are 16-bit ESDI, 1:1 interleave controllers that control 2 hard drives. Models 6280-15TX and 6282-24 also control 2 floppy drives. These controllers can operate at data rates up to 15MHz.

Default Jumpers:	6180-15TX: W4 1&2, W5 1&2, SW1-1, SW1-4, SW1-7, SW1-8. 6280-15TX: W4 1&2, W5 1&2 SW1-2, SW1-6, SW1-9, SW1-10. 6282-24: W1 5&6, W1 7&8, W1 9&10, W2 21&22, W2 25&26.
To Format, Use:	G=C800

DTC 6290-24
DTC 6290E

EISA, ESDI, 1:1 interleave controllers with up to 4MB cache. Controls up to 4 ESDI drives and 2 floppies.

Default Jumpers:	6290-24: SW1-4, SW1-5 6290E: SW1-4,
To Format, Use:	G=C800:5
Notes:	Supports translation mode for large capacity drives.

DTC Controllers (Continued)

DTC 6195
DTC 6295

EISA, ESDI, 1:1 interleave hard drive controller. Model 6295 also controls 2 floppy drives.

Default Jumpers:	6195: SW1-4 6295: SW1-4, SW1-8
To Format, Use:	G=C800:5
Notes:	Supports translation mode for large capacity drives.

DTC 7180
DTC 7280

An MFM, 1:1 interleave hard drive controler. Model 7280 also supports 2 floppy drives..

Default Jumpers:	7180: W4 2&3, W6 7280: W5, W6
To Format, Use:	G=C800:5

DTC 7187
DTC 7287

An RLL, 1:1 interleave hard drive controller. Model 7287 also supports 2 floppy drives.

Default Jumpers:	7187: W4 2&3, W6, W7, W8 7287: W5, W6, W8
To Format, Use:	G=C800:5

DTK Controllers (Data Enterprises)

PTI-215

A 16-bit IDE controller for 2 hard drives and 2 floppy drives.

Default Jumpers:	W1 1&2, W2 1&2, W3 2&3
To Format, Use:	DOS

Everex Controllers

Everex EV-346

A 16-bit, 1:1 interleave, MFM hard drive and floppy controller

Default Jumpers:	None Installed
To Format, Use:	SpeedStor or Disk Manager

Future Domain Controllers

Future Domain TMC-885

An 8-bit SCSI host adapter, also controls 2 floppy drives.

Default Jumpers:	W1 & W2
To Format, Use:	Future Domain Software

Future Domain TMC-1670SVP

A 16-bit SCSI-2 host adapter, also controls 2 floppy drives.

Default Jumpers:	
To Format, Use:	Future Domain Software

Future Domain TMC-1660 DNK
Future Domain TMC-1680 DNK

A 16-bit SCSI-2 host adapter. The 1680 also controls 2 floppy drives.

Default Jumpers:	
To Format, Use:	Future Domain Software

Longshine Controllers

Longshine LCS-6210D

An 8-bit MFM controller for 2 hard drives.

Default Jumpers:	1-8 heads: JP1 1&2 9-16 heads: JP1 2&3
To Format, Use:	G=C800:5

NCL Controllers

NDC 5125

A 16-bit MFM controller for 2 hard drives and 2 floppy drives.

Default Jumpers:	JP5, lower two pins jumpered.
To Format, Use:	DIAGS, Speedstor, or Disk Manager

Seagate Controllers

Seagate ST-01
Seagate ST-02

An 8-bit SCSI controller for up to 7 devices. ST-02 also supports 2 floppy drives.

Default Jumpers:	JP5 N&O*, JP6 Q&R.
To Format, Use:	G=C800:5
Notes:	* for ST-02 only.

Seagate ST-05X

An 8-bit XT-IDE controller for up to 2 hard drives.

Default Jumpers:	None Installed
To Format, Use:	DOS

Seagate ST-07A
Seagate ST-08A

A16-bit AT-IDE controller for up to 2 hard drives. Model ST-08A also controls up to 2 floppy drives.

Default Jumpers:	JP4 1&2*, JP5 1&2.
To Format, Use:	DOS
Notes:	*for ST-08A only

Seagate ST-11M
Seagate ST-11R

ST-11M is an 8-bit MFM drive controller. ST-11R is an 8-bit RLL hard drive controller.

Default Jumpers:	None Installed
To Format, Use:	G=C800:5

Seagate ST-21M
Seagate ST-21R
Seagate ST-22M
Seagate ST-22R

ST-21M and ST-22M are 16-bit MFM hard drive controllers. ST-21R and ST-22R are 16-bit RLL controllers. ST-22M and ST-22R also control 2 floppy drives.

Default Jumpers:	JP4*
To Format, Use:	G=C800:5
Notes:	* ST-22M & ST-22R only

SMS/OMTI Controllers

SMS/ OMTI 510

An 8-bit SCSI controller for 2 hard drives only.

Default Jumpers:	W1 2&3, W2 2&3, W3 1&2, W4 2&3.
To Format, Use:	G=C800:5 or OMTIDISK
Notes:	HA7 BIOS may cause partitioning problems with DOS 4.0 or later

SMS/OMTI 822

A 16-bit SCSI controller for 2 hard drives and 2 floppy drives.

Default Jumpers:	W5, W7, W17, W21, W24, W28, W32, W33 1&2, W35, W38 2&3.
To Format, Use:	G=D800:6
Notes:	Drivers for Novell and more than 2 SCSI drives are available. May not operate in machines with 8MHz bus speed and no wait states.

SMS/OMTI 5520

An 8-bit MFM controller for 2 hard drives only.

Default Jumpers:	None installed
To Format, Use:	G=C800:6

SMS/OMTI 5527

An 8-bit RLL controller for 2 hard drives only.

Default Jumpers:	None installed
To Format, Use:	G=C800:6

SMS/OMTI 8120

A 16-bit MFM controller for 2 hard drives only.

Default Jumpers:	None installed
To Format, Use:	G=C800:6

SMS/OMTI Controllers (Continued)

SMS/OMTI 8140
SMS/OMTI 8240

A 16-bit MFM controller for 2 hard drives. Supports 1:1 interleave and fast (average 700 Kb/sec transfer). The 8240 also supports 2 floppy drives.

Default Jumpers:	None installed
To Format, Use:	OMTIDISK software.
Notes:	Incompatible with some motherboards due to timing problem, but runs solid as a rock in boards that comply with the original IBM-AT bus timing specifications.

SMS/OMTI 8630

A 16-bit ESDI controller for 2 hard drives and 2 floppy drives. Operates with drive rates up to 10 MHz. Supports 1:1 interleave, and has a 32K look-ahead cache.

Default Jumpers:	W17, W20 2&3, W23, W24, W25.
To Format, Use:	G=CA00:6

SMS/OMTI 8640

A 16-bit ESDI controller for 2 hard drives and 2 floppy drives. Operates with drive rates up to 15 MHz. Supports 1:1 interleave, and has a 32K look-ahead cache.

Default Jumpers:	W17, W20 2&3, W23, W24, W25.
To Format, Use:	G=CA00:6
Notes:	No known compatibility problems; a good universal card.

Storage Dimensions Controllers

Storage Dimensions SDC-801
Storage Dimensions SDC-802

An 8-bit SCSI host adapter. SDC-802 also controls 2 floppy drives.

Default Jumpers:	SDC-801: JP1-3 SDC-802: W3
To Format, Use:	SpeedStor or Disk Manager

Ultrastor Controllers

Ultrastor 12C

A 1:1 interleave caching controller for 2 ESDI drives at up to 24MHz. Also controls up to 3 floppy drives. Up to 16MB of caching memory can be installed.

Default Jumpers:	
To Format, Use:	G=C800:5

Ultrastor 12F
Ultrastor 12F-24

A 1:1 interleave controller for 2 ESDI drives at up to 22MHz. Also controls up to 3 floppy drives. The 12F-24 supports 24MHz drives.

Default Jumpers:	
To Format, Use:	G=C800:5

Ultrastor 15C
Ultrastor 15CM

A caching controller for 2 IDE drives and 3 floppy drives. Up to 8 MB of cache memory can be installed. The 15 CM also provides 2 serial ports, 2 parallel ports, and a game port.

Default Jumpers:	
To Format, Use:	G=C800:5

Ultrastor 22C
Ultrastor 22F

An ESDI bus ESDI controller for 2 hard drives only. Supports 24 MHz drives. The 22C caching controller supports up to 16 MB of cache memory.

Default Jumpers:	
To Format, Use:	G=C800:5

Ultrastor 24C
Ultrastor 24F

An EISA bus SCSI controller for up to 7 devices and 3 floppy drives. The 24C supports up to 16 MB of cache memory.

Default Jumpers:	
To Format, Use:	G=C800:5

Wangtec Controllers

Wangtec EV-831

Controls QIC-36 tape drives.

Default Jumpers:	E 3&4, E 8&9, E 11&12, W1, W2, W5.
Notes:	See manual for switch settings and DMA and Interrupt jumpers. Most reported problems with this card are a result of DMA interrupt conflicts.

Western Digital Controllers

Western Digital WD AT140

A 16-bit adapter board for 2 AT type IDE drives.

Default Jumpers:	W1 3&4
To Format, Use:	DOS

Western Digital WD AT240

A 16-bit adapter board for 2 AT type IDE drives and 2 floppy drives.

Default Jumpers:	W1 3&4, W2 1&2
To Format, Use:	DOS

Western Digital WD AT440

A 16-bit adapter board for 2 AT type IDE drives and 2 floppy drives. This board also has 2 serial ports and 1 parallel port.

Default Jumpers:	W3 3&4, W4 1&2, W7 3&4, W7 5&6, W7 7&8, W8 1&2, W8 5&6, W8 9&10, W9 1&2, W9 3&4
To Format, Use:	DOS

WesternDigital WD XT140

An 8-bit adapter board for 2 XT type IDE drives.

Default Jumpers:	No jumpers on board
To Format, Use:	G=C800:5
Notes:	Does not support daisy-chain cables. A separate cable must be used for each drive.

Western Digital Controllers (Continued)

Western Digital WD XT150R

An 8-bit adapter board for 1 XT type IDE drive.

Default Jumpers:	W1 2&3, W2 1&2, W3 1&2
To Format, Use:	G=C800:5
Notes:	Does not support daisy-chain cables.

Western Digital WD SCS-XTAT

An 8-bit SCSI host adapter for AT and XT type computers.

Default Jumpers:	See manual
To Format, Use:	See manual

Western Digital WD XTGEN
Western Digital WD XTGEN2
Western Digital WD XTGENR

XT-GEN and XT-GEN2 are 8-bit MFM controllers for 2 hard drives only. XT-GENR is an 8-bit RLL controller.

Default Jumpers:	GEN: No jumpers on board GEN2: None GEN2R: None
To Format, Use:	G=C800:5

Western Digital WD 1002A-FOX F001/003

The F001 controls 2 floppy drives only (No BIOS on card). The F003 includes a ROM BIOS.

Default Jumpers:	W4 2&3

Western Digital WD 1002A-FOX F002/004

F002 controls 4 floppy drives only. F004 has a BIOS on card which permits installation of 1.2 and 1.44 MB drives in XT machines that normally only support 360K or 720K drives.

Default Jumpers:	W1 2&3, W2 2&3, W3 1&2 W5 2&3, W6 2&3.
To Format, Use:	DOS
Notes:	Uses WD-37C65 chip, works well in 286/386 machines.

Western Digital Controllers (Continued)

Western Digital WD 1002-27X
Western Digital WD 1002A-27X

An 8-bit RLL controller for 2 hard drives only.

Default Jumpers:	1002-27X: W3, W4 2&3, W6 2&3, W8 2&3 S1-5, S1-6, W9 1002A-27X: W1, W2.
To Format, Use:	G=C800:5

Western Digital WD 1002A-WX1

An 8-bit MFM controller for 2 hard drives only.

Default Jumpers:	W3, W4 2&3, W6 2&3, W8 2&3, S1-8 (AT Mode)
To Format, Use:	G=C800:5

Western Digital WD 1003-WAH

A 16-bit MFM, 3:1 interleave controller that supports 2 hard drives only.

Default Jumpers:	W6 2&3, W4 2&3, W5 1&2
To Format, Use:	DIAGS, SpeedStor, or Disk Manager

Western Digital WD 1003-WA2

Controls 2 hard drives at 3:1 interleave and 2 floppy drives.

Default Jumpers:	E 2&3, E 4&5, E 7&8
To Format, Use:	DIAGS, SpeedStor, or Disk Manager

Western Digital WD 1003V-MM1
Western Digital WD 1003V-MM2

MM1 is a 16-bit MFM controller for 2 hard drives at 2:1 interleave. MM2 also controls 2 floppy drives.

Default Jumpers:	None installed
To Format, Use:	DIAGS, SpeedStor, or Disk Manager

Western Digital WD 1003V-SR1
Western Digital WD 1003V-SR2

SR1 is a 16-bit controller for 2 hard drives at 2:1 interleave. SR2 also controls 2 floppy drives.

Default Jumpers:	None Installed
To Format, Use:	DIAGS, SpeedStor, or Disk Manager

Western Digital Controllers (Continued)

Western Digital WD 1004-27X
Western Digital WD 1004A-27X

An 8-bit controller for 2 hard drives only.

Default Jumpers:	W25
To Format, Use:	G=C800:5

Western Digital WD 1004A-WX1

An 8-bit MFM controller for 2 hard drives only.

Default Jumpers:	See manual
To Format, Use:	G=C800:5

Western Digital WD 10045A-WAH

An ESDI controller for 2 hard drives only.

Default Jumpers:	See manual
To Format, Use:	G=C800:5

Western Digital WD 1006V-MC1
Western Digital WD 1006V-MCR

MC1 is an MFM micro channel controller, and MCR is an RLL micro channel controller.

Default Jumpers:	No jumpers on board
To Format, Use:	System supplied software.

Western Digital WD 1006V-MM1
Western Digital WD 1006V-MM2

MM1 is a 16-bit MFM controller for 2 hard drives at 1:1 inteleave. MM2 also controls 2 floppy drives.

Default Jumpers:	No jumpers installed
To Format, Use:	DIAGS, SpeedStor or Disk Manager

Western Digital WD 1006V-SR1
Western Digital WD 1006V-SR2

SR1 is a 16-bit RLL controller for 2 hard drives at 1:1 inteleave. SR2 also controls 2 floppy drives.

Default Jumpers:	None installed
To Format, Use:	C800:5

Western Digital Controllers (Continued)

Western Digital WD 1007A-WA2

A 16-bit ESDI controller for 2 hard drives and 2 floppy drives. Supports 1:1 interleave, and 10MBits/sec transfer.

Default Jumpers:	See manual
To Format, Use:	C800:5

Western Digital WD 1007A-WAH

A 16-bit ESDI controller for 2 hard drives. 10 Mb/ps at 1:1 interleave.

Default Jumpers:	W1 2&3, W2 2&3, W3
To Format, Use:	C800:5

Western Digital WD 1007V-MC1

A micro channel controller for 2 ESDI drives.

Default Jumpers:	No jumpers on board
To Format, Use:	System supplied software

Western Digital WD 1007V-SE1
Western Digital WD 1007V-SE2

A 16-bit ESDI controller for 2 hard drives at 1:1 interleave with 32K loo-ahead cache. Model SE2 also controls 2 floppy drives.

Default Jumpers:	W7 1&2, W8 2&3
To Format, Use:	G=CC00:5 or C800:5 is W8 is jumpered to 1&2.

Western Digital WD 1009V-SE1
Western Digital WD 1009V-SE2

A high-speed 16-bit ESDI controller with 64K cache, 1:1 interleave, and up to 24Mbit/sec transfer. Available in ISA or EISA bus models. Model SE2 also supports up to 3 floppy drives.

Default Jumpers:	W2 2&3(floppy), W3 1&2, W7 (EISA only)
To Format, Use:	C800:5

Western Digital Controllers (Continued)

Western Digital WD 7000 FASST

A 16-bit SCSI controller that supports up to 7 SCSI devices and 2 floppy drives.

Default Jumpers:	SA3, SA4, SA6, SA7, SA13, SA14, SA15, SA16, W1 1&2, W2 3&4, W2 9&10, W5
To Format, Use:	Supplied Software
Notes:	Negotiates for synchronous SCSI transfer. Drivers available for Novell and Xenix.

Connector Pinouts

The following pages contain pinout information on various interfaces.

IDE Interface Pinout

Table D - IDE Pinouts

Pin Number	Signal	Pin Number	Signal
01	-Host Reset	02	Ground
03	+Host Data 7	04	+Host Data 8
05	+Host Data 6	06	+Host Data 9
07	+Host Data 5	08	+Host Data 10
09	+Host Data 4	10	+Host Data 11
11	+Host Data 3	12	+Host Data 12
13	+Host Data 2	14	+Host Data 13
15	+Host Data 1	16	+Host Data 14
17	+Host Data 0	18	+Host Data 15
19	Ground	20	Key
21	Reserved	22	Ground
23	-Host IOW	24	Ground
25	-Host IOR	26	Ground
27	Reserved	28	+Host ALE
29	Reserved	30	Ground
31	+Host IRQ 14	32	+Host IO16
33	+Host ADDR 1	34	-Host PDIAG
35	+Host ADDR 0	36	+Host ADDR 2
37	-Host CS0	38	-Host CS1
39	-Host SLV/ACT	40	Ground

ESDI Pinouts

Table E - ESDI Control Signals - J1/P1

Control Signal Name	Ground	Signal Pin	Transmission
-Head Select 3	1	2	To Drive
-Head Select 2	3	4	To Drive
-Write Gate	5	6	To Drive
-Config/-Status Data	7	8	To Controller
-Transfer Ack	9	10	To Controller
-Attention	11	12	To Controller
-Head Select 0	13	14	To Drive
-Sector/-Address Mark	15	16	To Controller
Found	17	18	To Drive
-Head Select 1	19	20	To Controller
-Index	21	22	To Controller
-Ready	23	24	To Drive
-Transfer Request	25	26	To Drive
-Drive Select 1	27	28	To Drive
-Drive Select 2	29	30	To Drive
-Drive Select 3	31	32	To Drive
-Read Gate	33	34	To Drive

ESDI Pinouts (Continued)

Table F - ESDI Data Signals - J2/P2

Control Signal Name	Ground	Signal Pin	Transmission
-Drive Selected		1	To Controller
-Sector Address Mark Found		2	To Controller
		3	To Controller
-Seek Complete		4	To Drive
-Address Mark Enable	6	5	To Controller
-Reserved for Step Mode		7	To Drive
+Write Clock		8	To Drive
-Write Clock		9	To Controller
-Cartridge Changed		10	To Controller
+Read Reference Clock	12	11	To Controller
-Read Reference Clock		13	To Drive
+NRZ Write Data	15, 16	14	To Drive
-NRZ Write Data		17	To Controller
+NRZ Read Data	19	18	To Controller
-NRZ Read Data		20	To Controller

Table G - ESDI DC Power - J3/P3

	VOLTAGE	GROUND	TRANSMISSION
+12 Volts DC	1	2	To Drive
+5 Volts DC	4	3	To Drive

IBM I/O Channel Pinout

Table H - I/O Channel Connector Pinouts (Sides C & D)

PIN	SIGNAL NAME	PIN	SIGNAL NAME
C1	SBHE	D1	/MEMCS16
C2	LA23	D2	/IOCS16
C3	LA22	D3	IRQ10
C4	LA21	D4	IRQ11
C5	LA20	D5	IRQ12
C6	LA19	D6	IRQ15
C7	LA18	D7	IRQ14
C8	LA17	D8	/DACK0
C9	/MEMR	D9	DRQ0
C10	/MEMW	D10	/DACK5
C11	SD08	D11	DRQ5
C12	SD09	D12	/DACK6
C13	SD10	D13	DRQ6
C14	SD11	D14	/DACK7
C15	SD12	D15	DRQ7
C16	SD13	D16	+5VCC
C17	SD14	D17	/MASTER
C18	SD15	D18	GND

IBM I/O Channel Pinout (Continued)

Table I - I/O Channel Connector Pinouts (Sides A & B)

PIN	SIGNAL NAME	PIN	SIGNAL NAME
A1	/IOCHCK	B1	GND
A2	SD7	B2	RESETDRV
A3	SD6	B3	+5VCC
A4	SD5	B4	IRQ9
A5	SD4	B5	-5VCC
A6	SD3	B6	DRQ2
A7	SD2	B7	-12VCC
A8	SD1	B8	OWS
A9	SD0	B9	+12VCC
A10	/IOCHRDY	B10	GND
A11	AEN	B11	/SMEMW
A12	SA19	B12	/SMEMR
A13	SA18	B13	/IOW
A14	SA17	B14	//IOR
A15	SA16	B15	/DACK3
A16	SA15	B16	DRQ3
A17	SA14	B17	/DACK1
A18	SA13	B18	DRQ1
A19	SA12	B19	/REFRESH
A20	SA11	B20	CLK
A21	SA10	B21	IRQ7
A22	SA9	B22	IRQ6
A23	SA8	B23	IRQ5
A24	SA7	B24	IRQ4
A25	SA6	B25	IRQ3
A26	SA5	B26	/DACK2
A27	SA4	B27	T/C
A28	SA3	B28	ALE
A29	SA2	B29	+5VCC
A30	SA1	B30	OSC
A31	SA0	B31	GND

ST-506 Pinout

Table K - ST-506 Control Signals - J1/P1

Control Signal Name	Groundl	Signal Pin	Transmission
-Head Select 8	1	2	To Drive
-Head Select 4	3	4	To Drive
-Write Gate	5	6	To Drive
-Seek Complete	7	8	To Controller
-Track 0	9	10	To Controller
-Write Fault	11	12	To Controller
-Head Select 1	13	14	To Drive
Reserved (To J2 pin 7)	15	16	- - - - -
-Head Select 2	17	18	To Drive
-Index	19	20	To Controller
-Ready	21	22	To Controller
-Step	23	24	To Drive
-Drive Select 1	25	26	To Drive
-Drive Select 2	27	28	To Drive
-Drive Select 3	29	30	To Drive
-Drive Select 4	31	32	To Drive
-Direction In	33	34	To Drive

SCSI Pinout

IDC PIN NUMBER	CENTRONICS PIN NUMBER	MAC DB-25 PIN NUMBER	SINGLE-ENDED SIGNAL NAME	DIFFERENTIAL SIGNAL NAME
1	1		Ground	Shield Ground
2	26	8	-Data Bus Bit 0	Ground
3	2		Ground	+DB (0)
4	27	21	-Data Bus Bit 1	-DB (0)
5	3		Ground	+DB (1)
6	28	22	-Data Bus Bit 2	-DB (1)
7	4		Ground	+DB (2)
8	29	10	-Data Bus Bit 3	-DB (2)
9	5		Ground	+DB (3)
10	30	23	-Data Bus Bit 4	-DB (3)
11	6		Ground	+DB (4)
12	31	11	-Data Bus Bit 5	-DB (4)
13	7		Ground	+DB (5)
14	32	12	-Data Bus Bit 6	-DB (5)
15	8		Ground	+DB (6)
16	33	13	-Data Bus Bit 7	-DB (6)
17	9		Ground	+DB (7)
18	34	20	-Data Bus Parity Bit	-DB (7)
19	10		Ground	+DB (P)
20	35	7	Ground	-DB (P)
21	11		Ground	DIFFSENS
22	36	9	Ground	Ground
23	12		Ground	Ground
24	37	24	Ground	Ground
25	13	25	Not Connected	TERMPWR
26	38		Terminator Power Source	TERMPWR
27	14		Ground	Ground
28	39	14	Ground	Ground
29	15		Ground	+ATN
30	40	16	Ground	-ATN
31	16		Ground	Ground
32	41	17	-ATN (Attention)	Ground
33	17		Ground	+BSY
34	42	18	Ground	-BSY
35	18		Ground	+ACK
36	43	6	-BSY (Busy)	-ACK
37	19		Ground	+RST
38	44	5	-ACK (Acknowledge)	-RST
39	20		Ground	+MSG
40	45	4	-RST (Reset Bus)	-MSG
41	21		Ground	+SEL
42	46	2	-MSG (Message)	-SEL
43	22		Ground	+C/D
44	47	19	-SEL (Select)	-C/D
45	23		Ground	+REQ
46	48	15	-C/D (Command/Data)	-REQ
47	24		Ground	+I/O
48	49	1	-REQ (Request)	-I/O
49	25		Ground	Ground
50	50	3	-I/O (Input/Output)	Ground

Table L - ST-506 Data Signals - J2/P2

Control Signal Name	Ground	Signal Pin	Transmission
-Drive Selected	2	1	To Controller
Reserved	4	3	- - - - -
Reserved	6	5	- - - - -
Reserved (To J1 pin 16)	8	7	- - - - -
Reserved		9	- - - - -
Reserved		10	- - - - -
Ground	11,12		- - - - -
+MFM Write Data		13	To Drive
-MFM Write Data		14	To Drive
Ground	15,16		- - - - -
+MFM Read Data		17	To Controller
-MFM Read Data		18	To Controller
Ground	19,20		- - - - -

Table M - ST-506 DC Power - J3/P3

	VOLTAGE	GROUND	TRANSMISSION
+12 Volts DC	1	2	To Drive
+5 Volts DC	4	3	To Drive

SA-400 Pinout

Table N - SA-400 Interface Signals and Pin Designations

Signal Name	Direction	Signal Pin Number	Return Pin Number
HD (High Density) / LSP (Speed)	Out/In	2	1
In Use/Head Load	Input	4	3
-Drive Select 3	Input	6	5
-Index Pulse	Output	8	7
-Drive Select 0	Input	10	9
-Drive Select 1	Input	12	11
-Drive Select 2	Input	14	13
-Motor On	Input	16	15
-Direction Select	Input	18	17
-Step	Input	20	19
-Write Data	Input	22	21
-Write Gate	Input	24	23
-Track 00	Output	26	25
-Write Protect	Output	28	27
-Read Data	Output	30	29
-Side One Select	Input	32	31
-Ready/Disk Change	Output	34	33

QIC-36 Pinout

The QIC-36 interface is implemented through a 50-pin dual inline header. The suggested mating connector is a 3M P/N 3425-60XX, 3425-70XX or equivalent. Maximum cable length is 10 feet (3 meters).

The connector pins are numbered 1 to 50. All odd pins are signal returns and are connected to the controller board ground. Table O shows pin assignments.

Table O - QIC-36 Connector Pin Assignments

Description	Signal	Source	Pin	Return
Tape Motion Enable	GO-	C	2	1
Tape Direction Control	REV-	C	4	3
Track Select 2/3	TR3-	C	6	5
Track Select 2/2	TR2-	C	8	7
Track Select 2/1	TR1-	C	10	9
Track Select 2/0	TR0-	C	12	11
Reset (Initialize Drive)	RST-	C	14	13
Reserved (not used)	DS3-	C	16	15
Reserved (not used)	DS2-	C	18	17
Reserved (not used)	DS1-	C	20	19
Drive Select 0	DS0-	C	22	21
High Write Current	HC-	C	24	23
Read Data (Pulse Output)	RDP-	D	26	25
Upper Tape Position Code	UTH-	D	28	27
Lower Tape Position Code	LTH-	D	30	29
Drive Select Response	SLD-	D	32	31
Cartridge In Place	CIN-	D	34	33
Unsafe (No Write Protect)	USF-	D	36	35
Capstan Tachometer Pulse	TCH-	D	38	37
Write Data Signal -	WDA-	C	40	39
Write Data Signal +	WDA+	C	42	41
Threshold (35% Read Margin)	TDH-	C	44	43
High Speed Slew Select	HSD-	C	46	45
Write Enable	WEN-	C	48	47
Erase Enable	EEN-	C	50	49

Drive Jumpers

The following pages contain information on jumper settings for common hard drives. For more complete information, refer to the OEM manual available from your supplier.

Atasi 3085

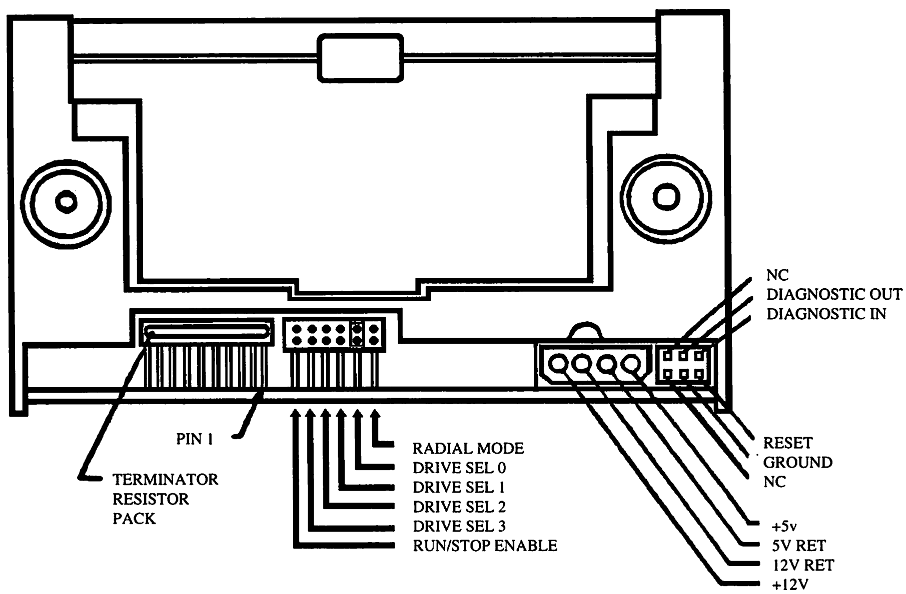


Figure 11 *– Atasi 3085 Jumper Locations*

CDC Wren III Series

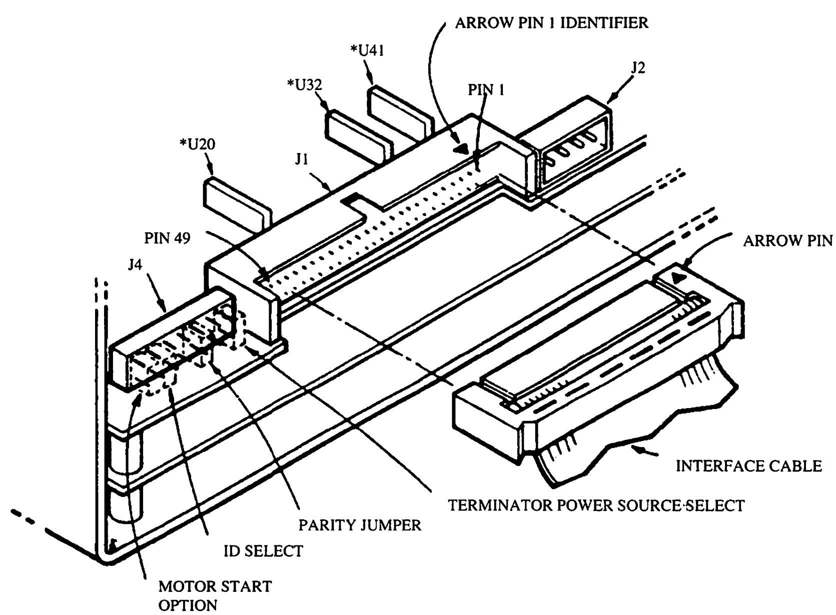
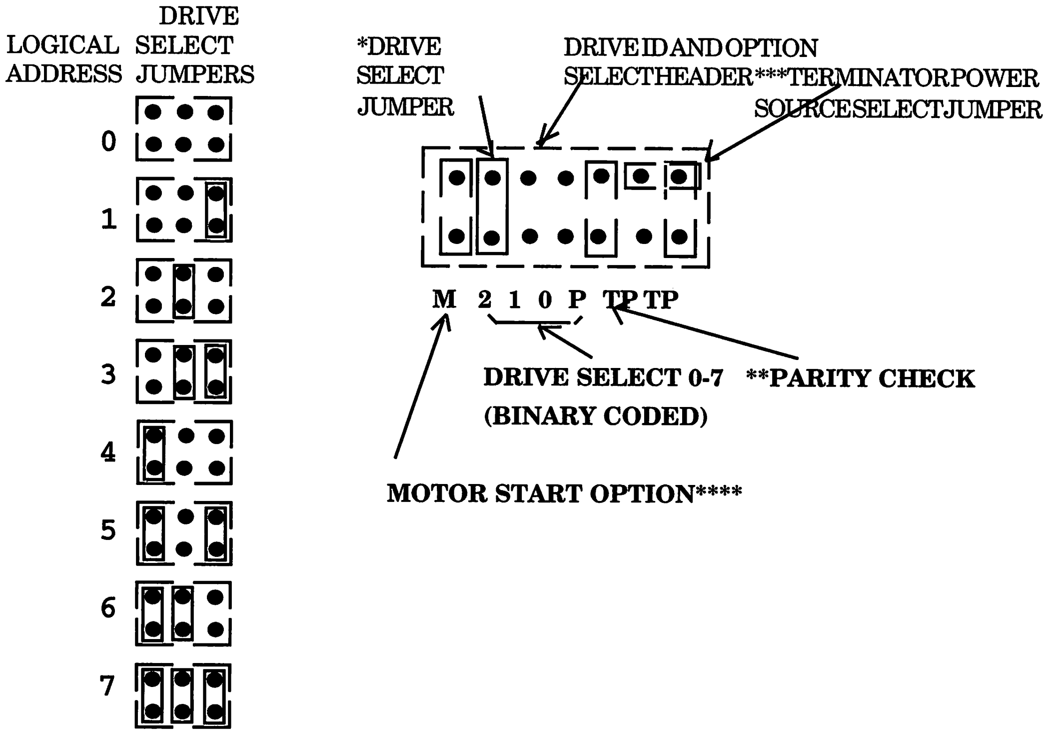


Figure 12 *– CDC Wren III Series Jumper Locations*

CSC Wren III Series (SCSI Jumpers)



* Drive ID is binary coded jumper position (most significant bit on left). i.e., jumper in position 2 would be Drive ID 4, no jumpers mean ID 0.

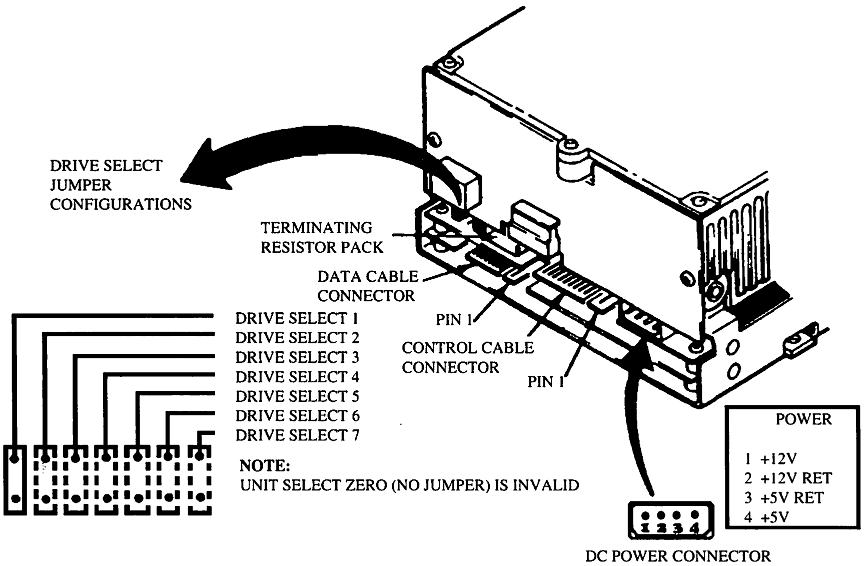
** Jumper plug installed means parity checking by the WREN III is enabled.

*** Jumper in vertical position means terminator power (+5V) is from WREN III power connector. Jumper in horizontal position means terminator power is taken from interface cable.
If unit is not terminated, TP jumper is to be left off.

**** Jumper plug installed enables Motor Start Option. In this mode of operation, the drive will wait for a Start Unit command from the Host before starting the motor. If the jumper plug is not installed, the motor will start as soon as DC power is applied to the unit.

Figure 13 *– CSC Wren III Series Jumper Location*

CDC Wren III Series (ESDI & SCSI)



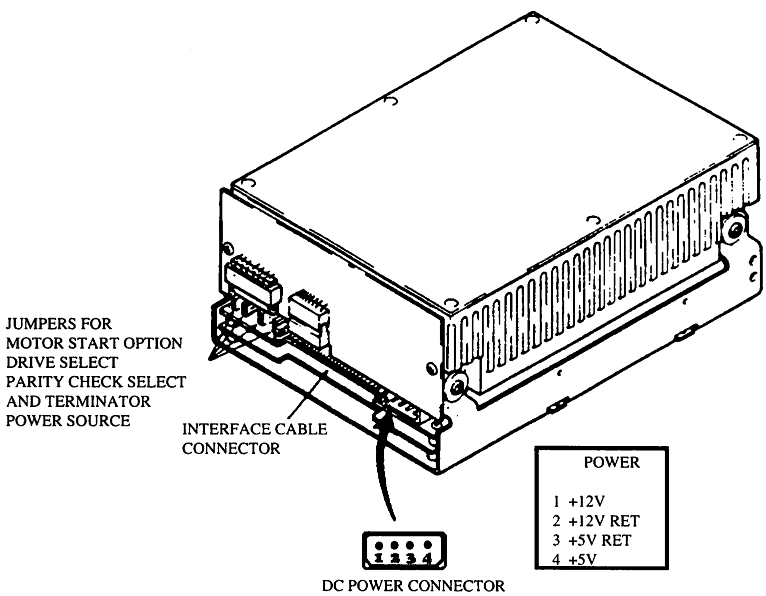


***Figure 14** – CDC Wren III Series (ESDI & SCSI) Jumper Locations*

CDC Wren V Series

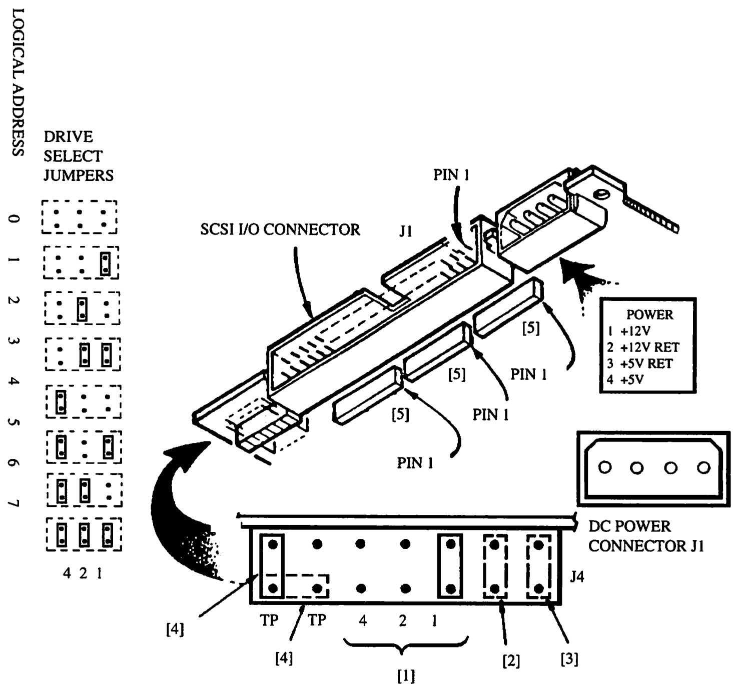


***Figure 15** – CDC Wren V Series Jumper Location*

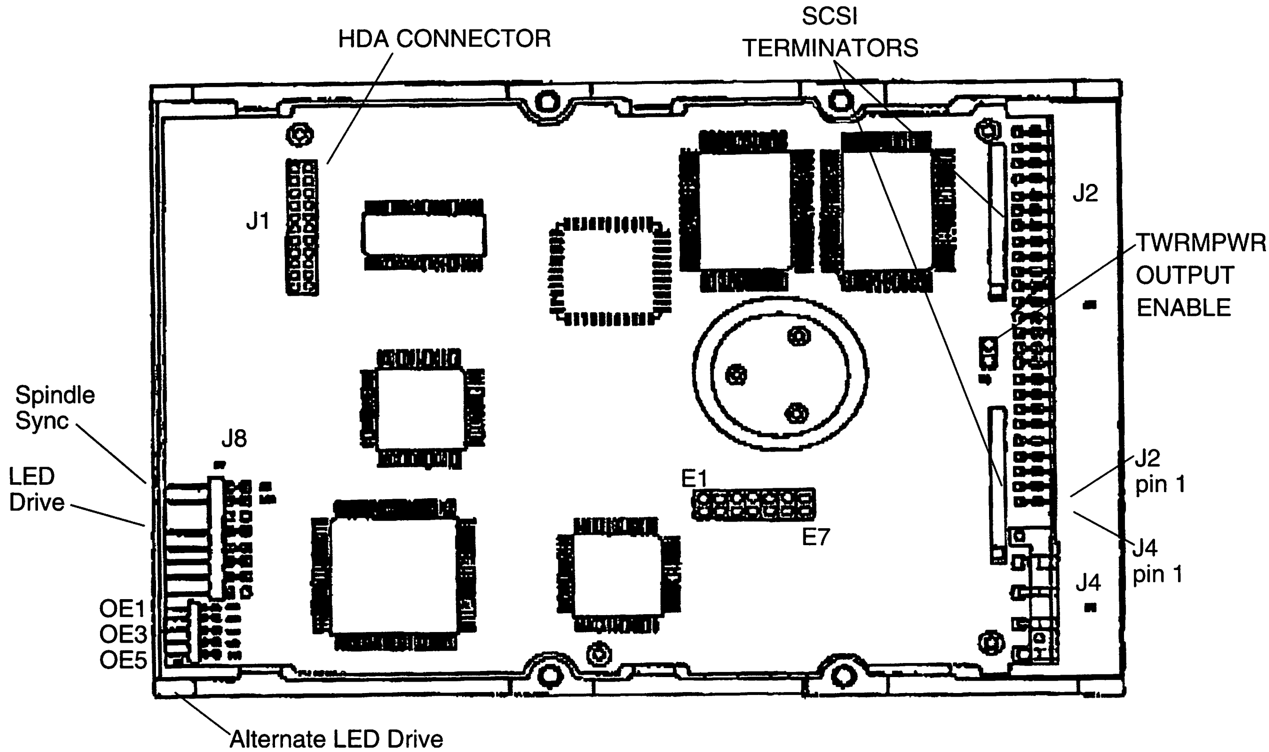
Conner IDE Drives

All Conner IDE drives use some of the jumpers shown in Table P.

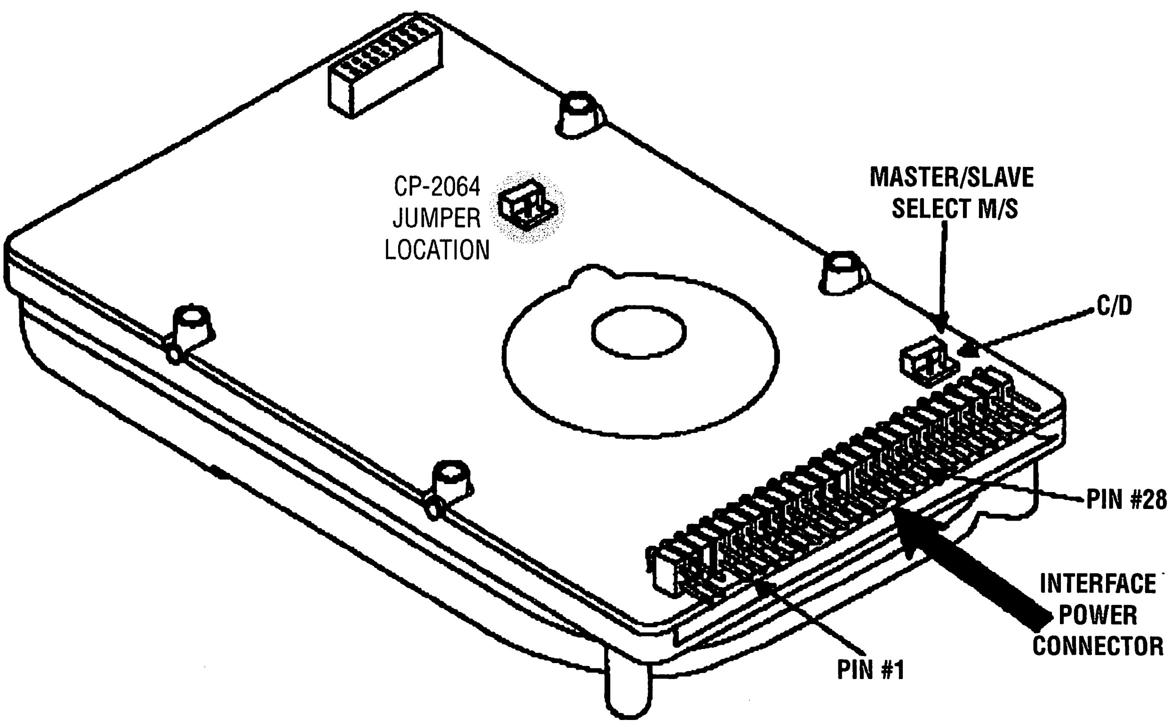
***Table P** - Conner IDE Drive Jumpers*

Jumper Configuration	ACT*	C/D	DSP**
One Drive	In	In	Out
2 Drive Master	In	In	In
2 Drive Slave	Out	Out	Out
*Some drives do not have ACT, use C/D and DSP only **Some drives do not have ACT or DSP, use C/D only.			

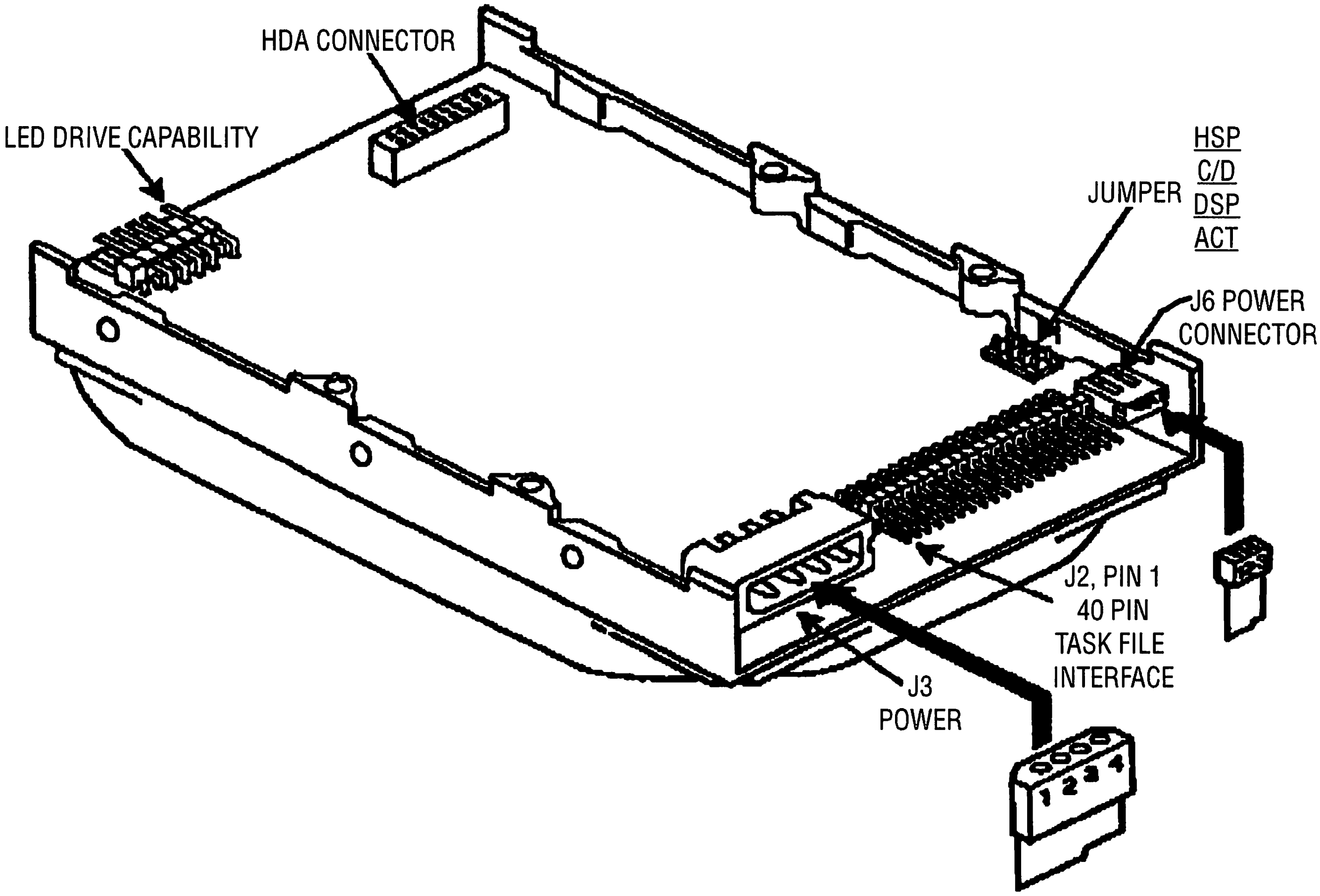
Conner CPF 1060



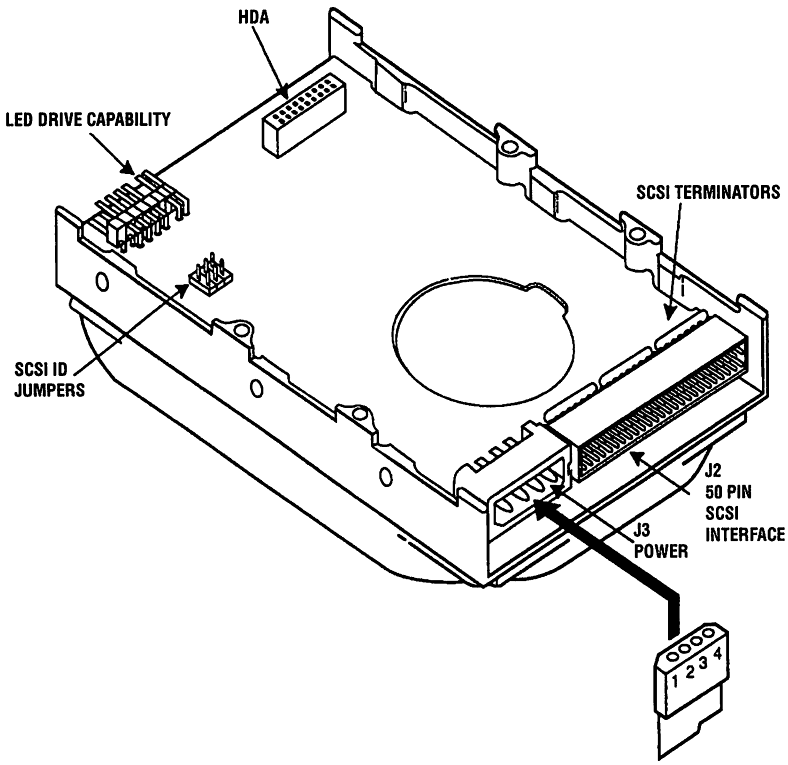
Conner 2000 Series



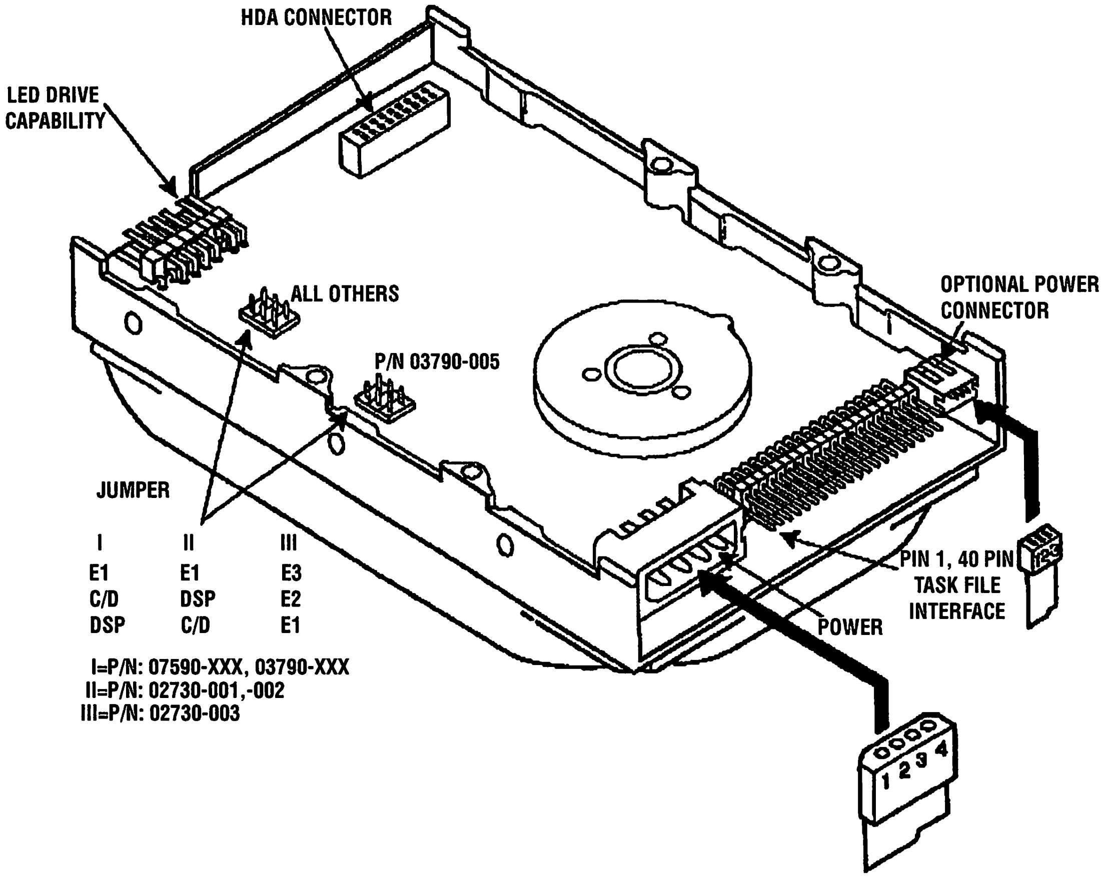
Conner 3000 series/3044



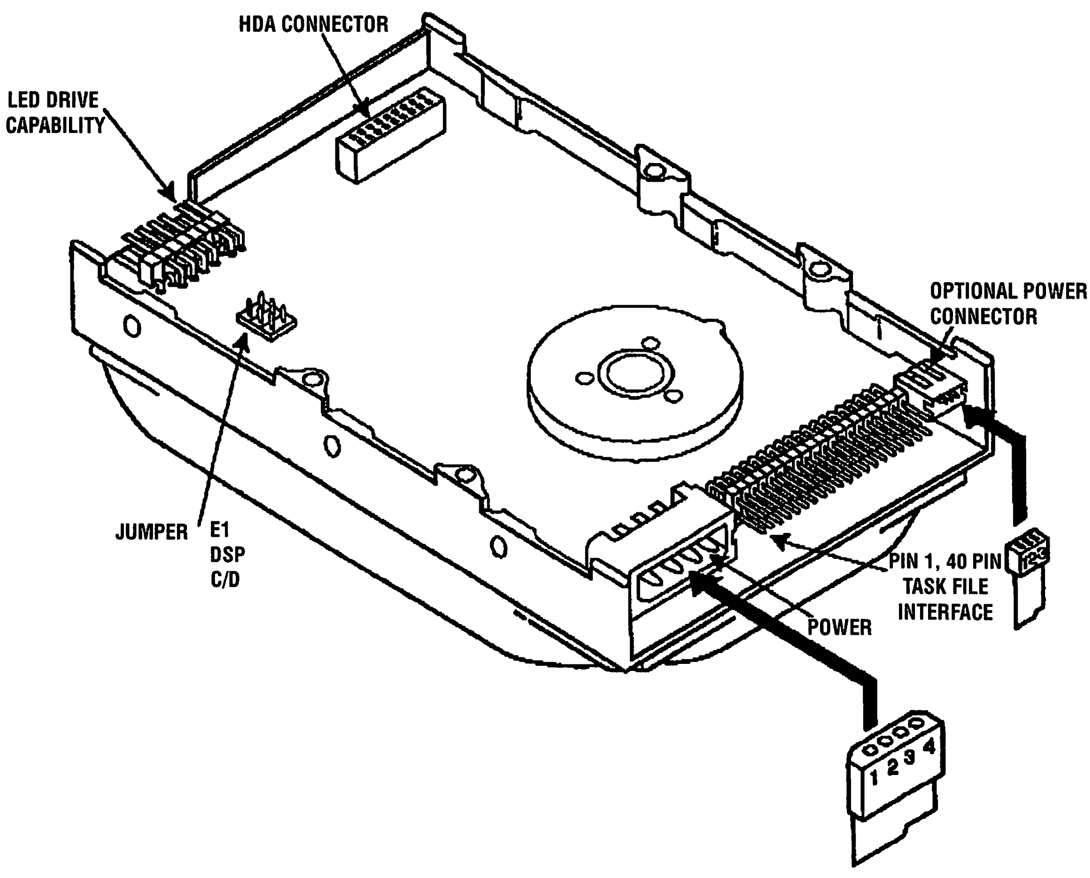
Conner 30060



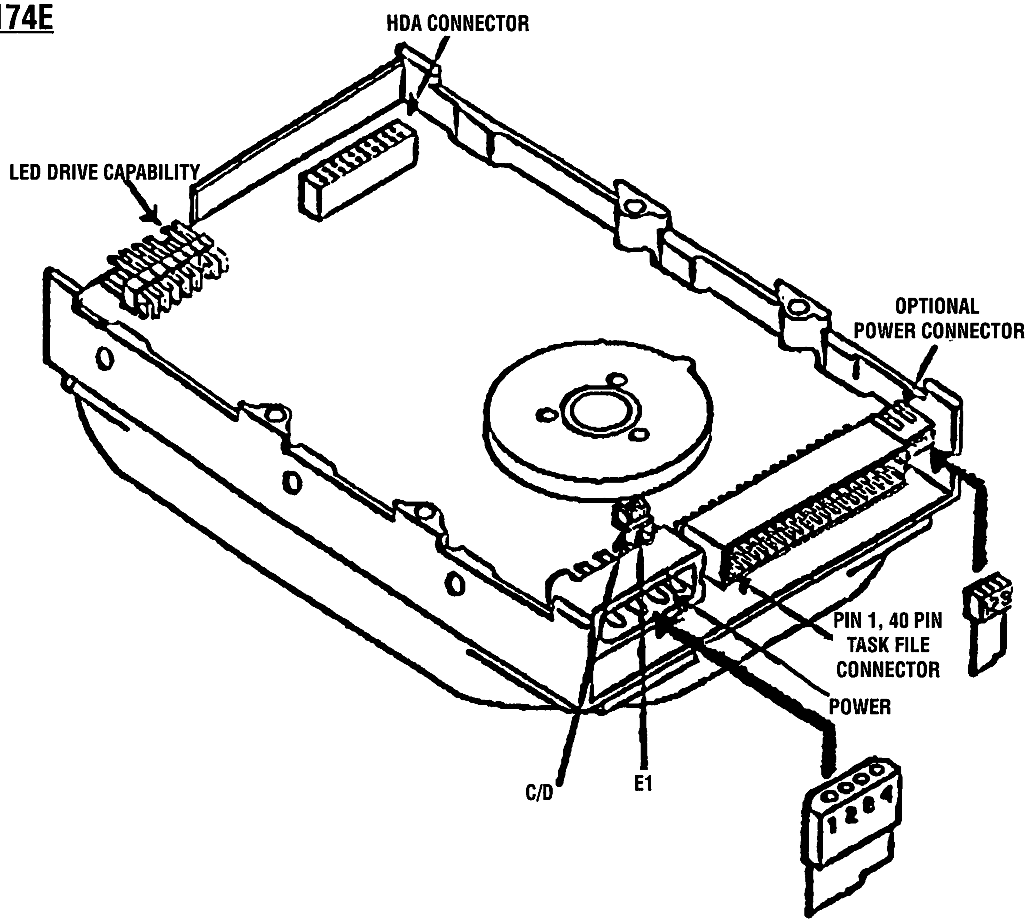
Conner 30064



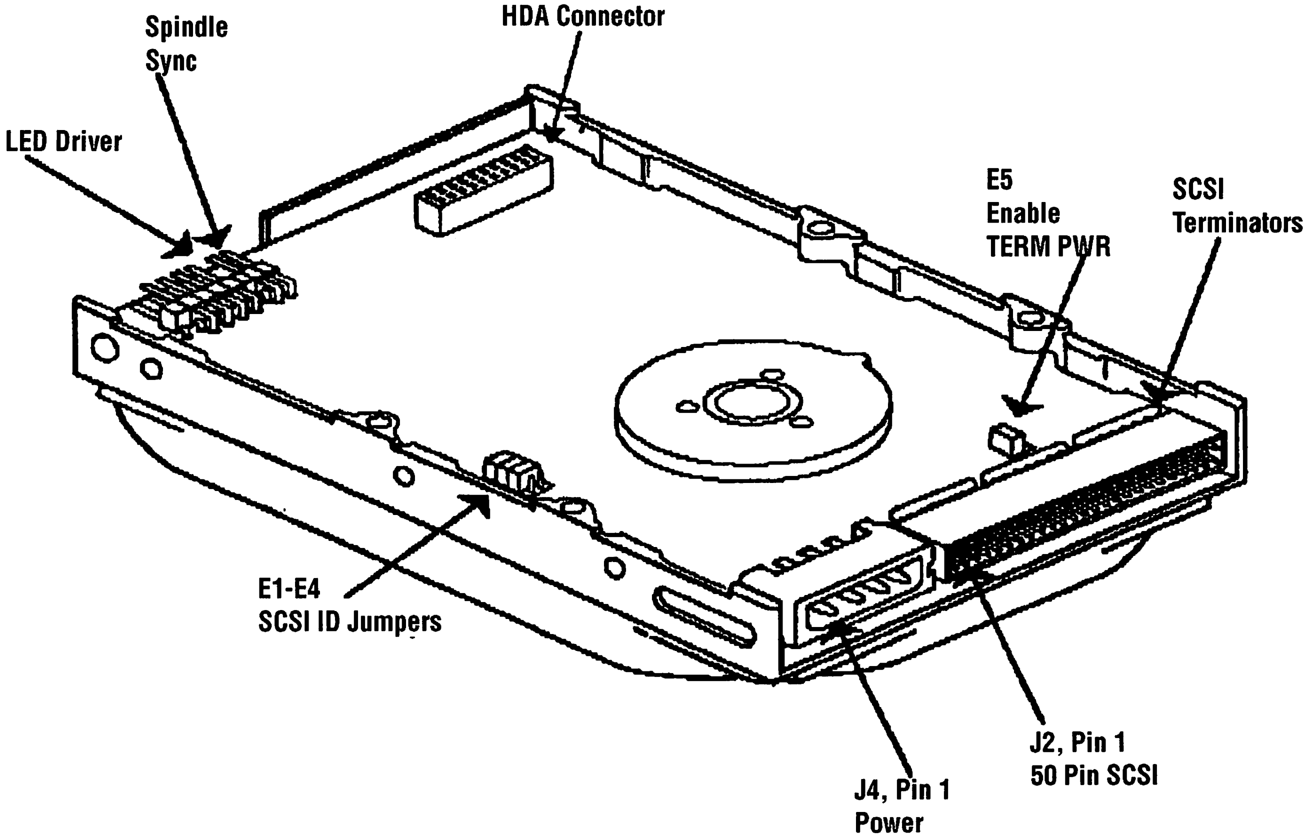
Conner 30104H



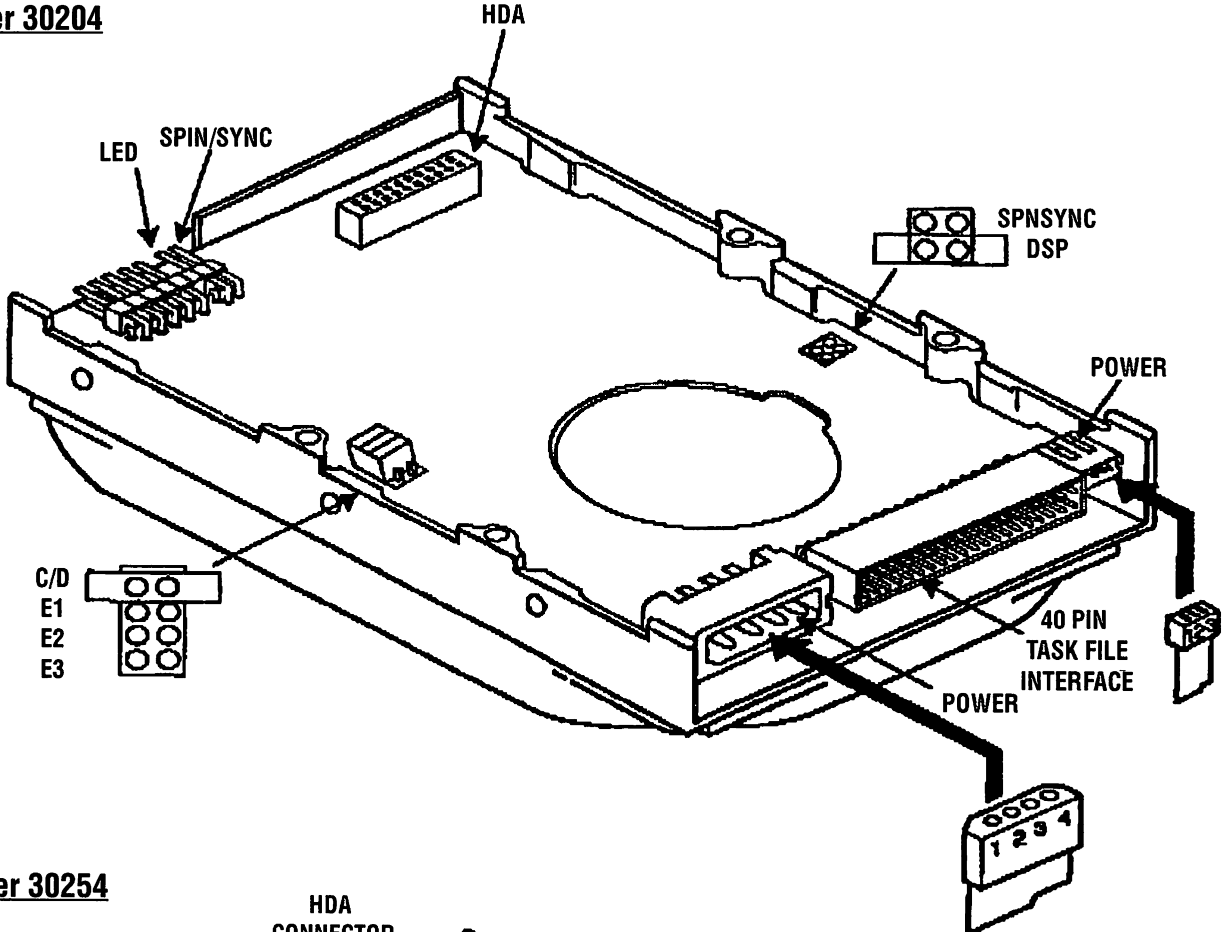
Conner 30174E



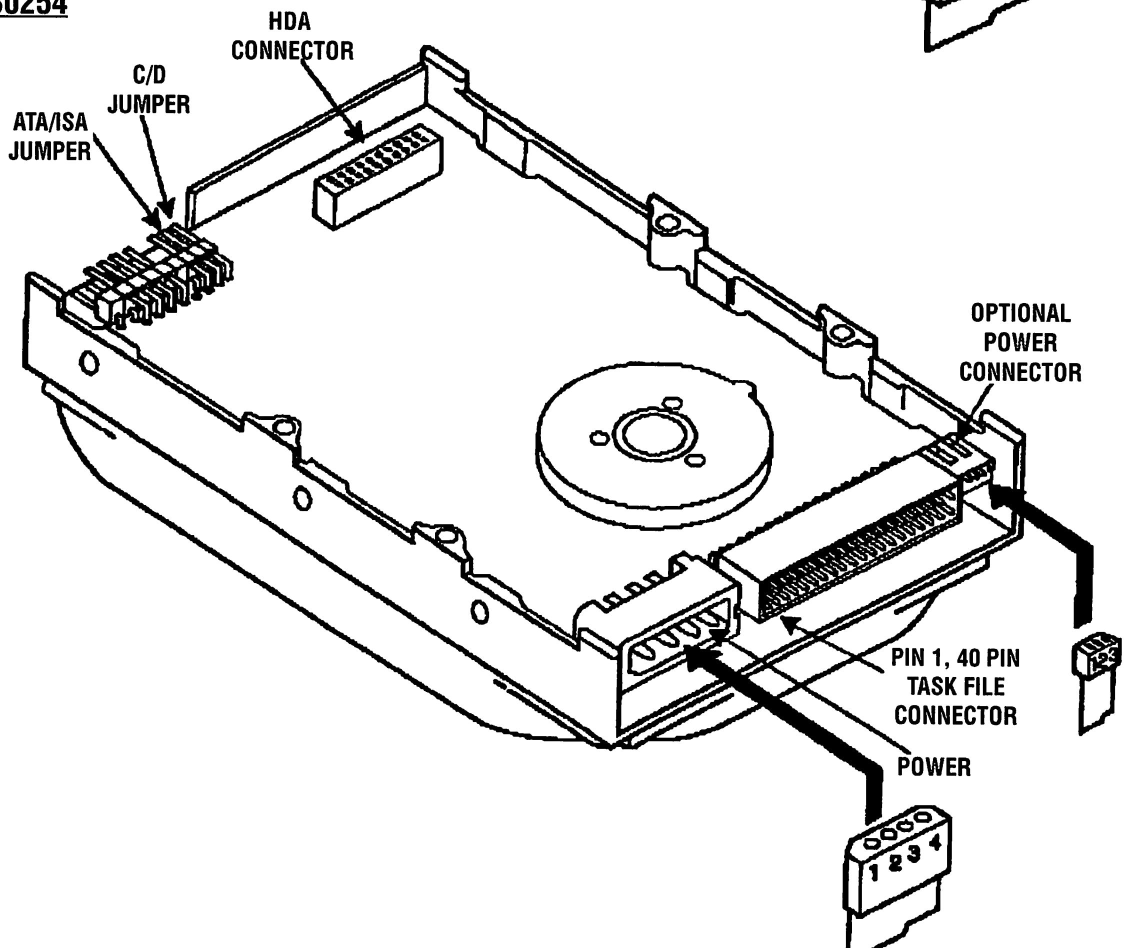
Conner 30200



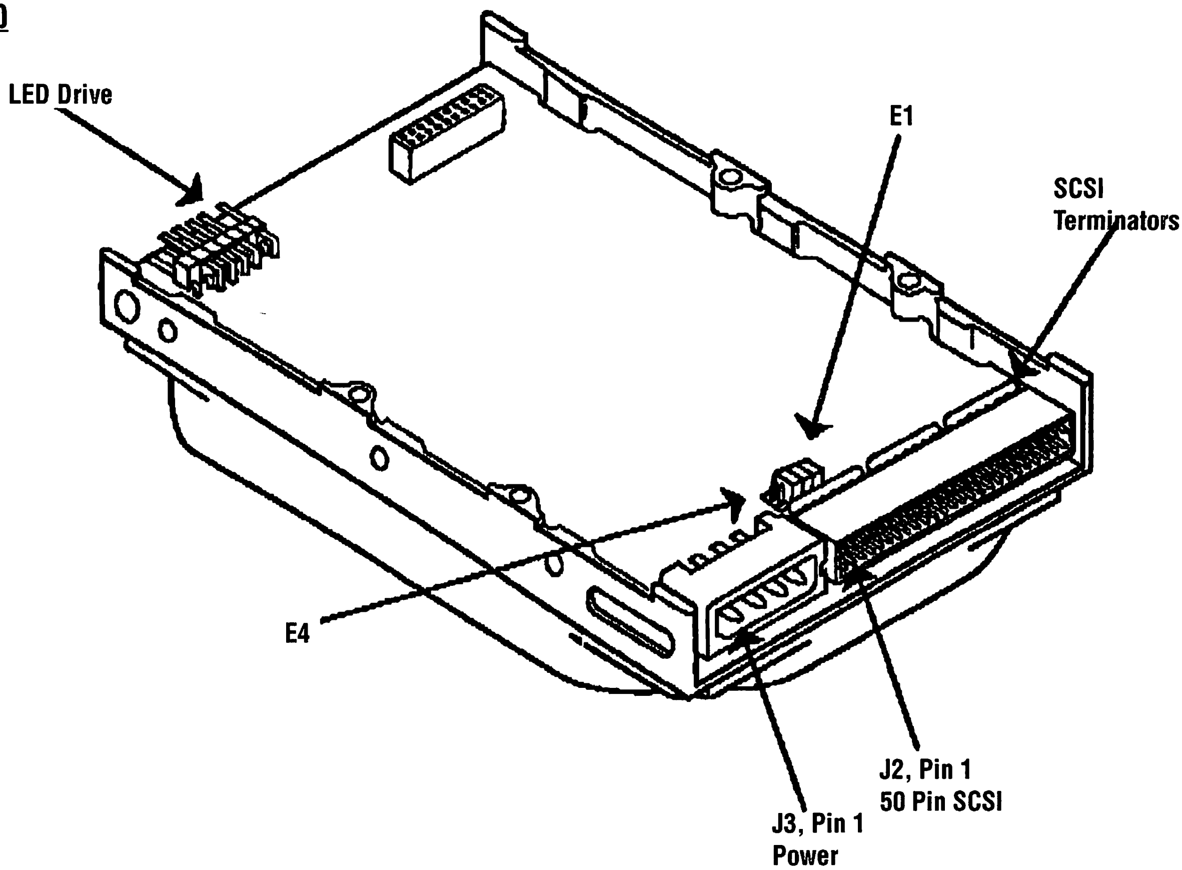
Conner 30204



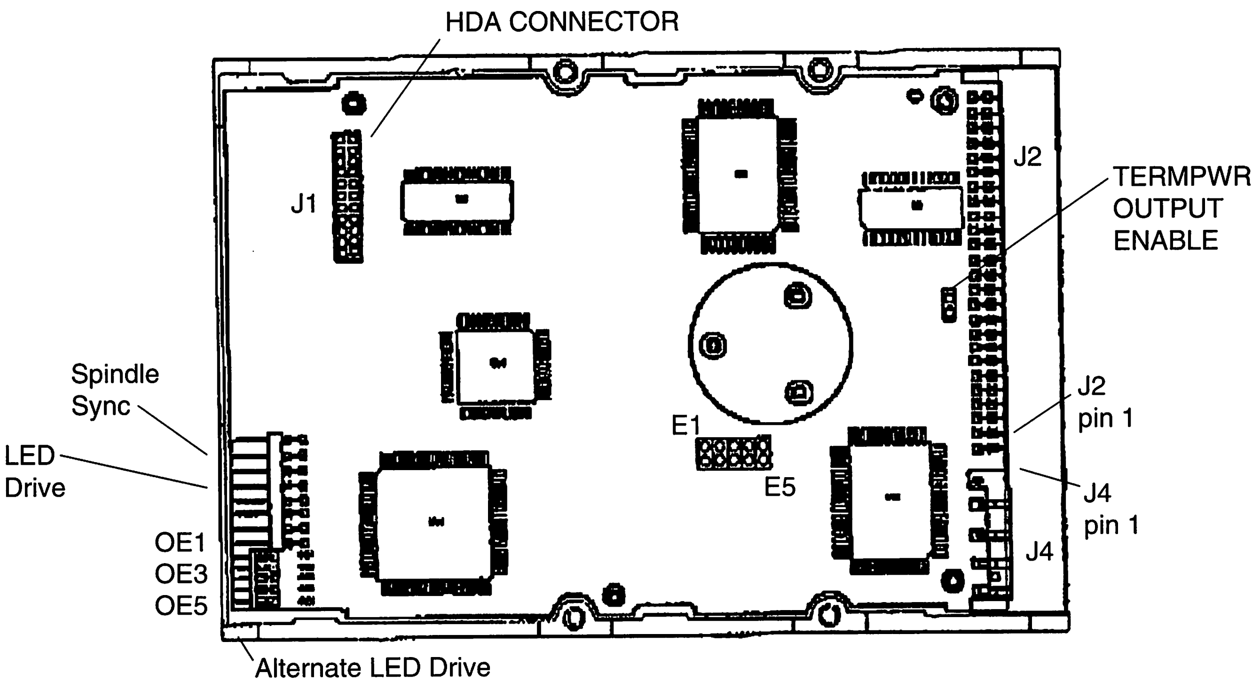
Conner 30254



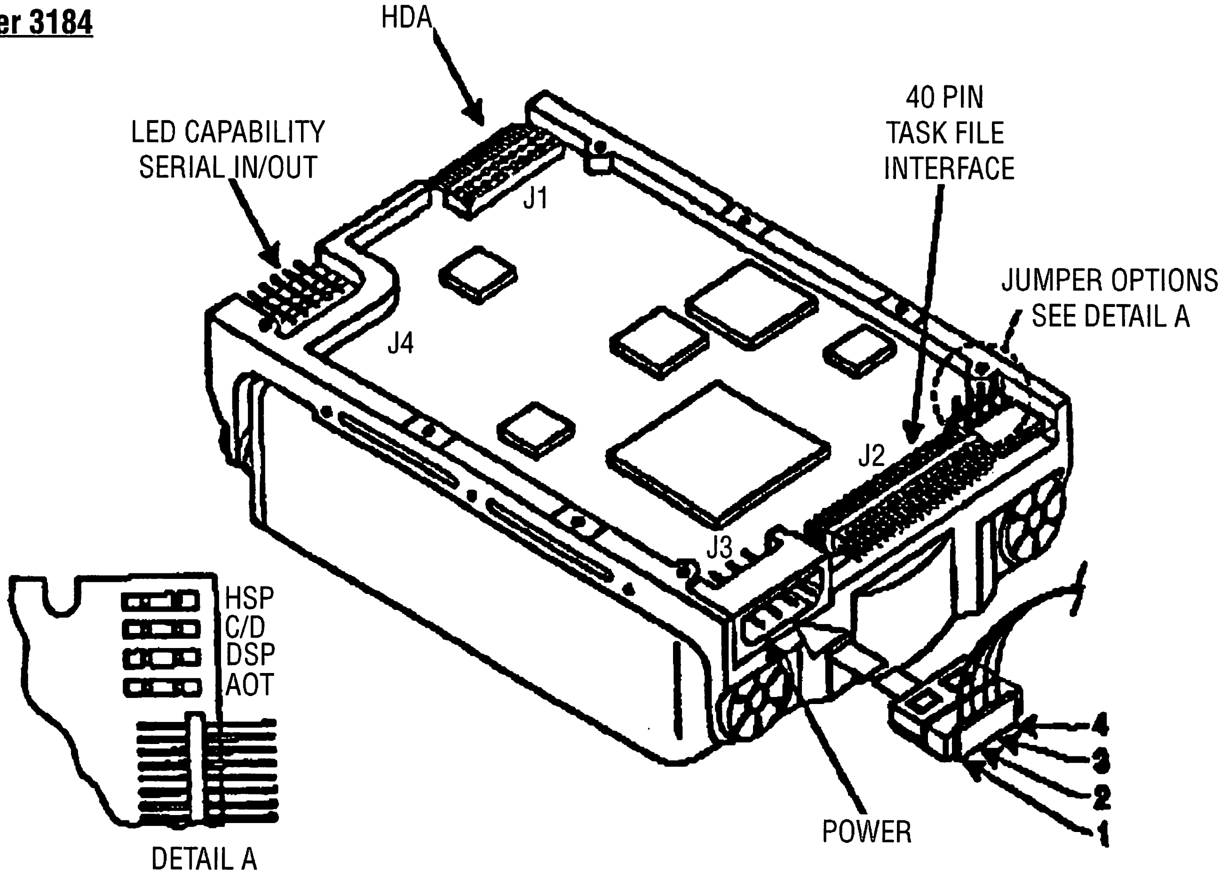
Conner 3040



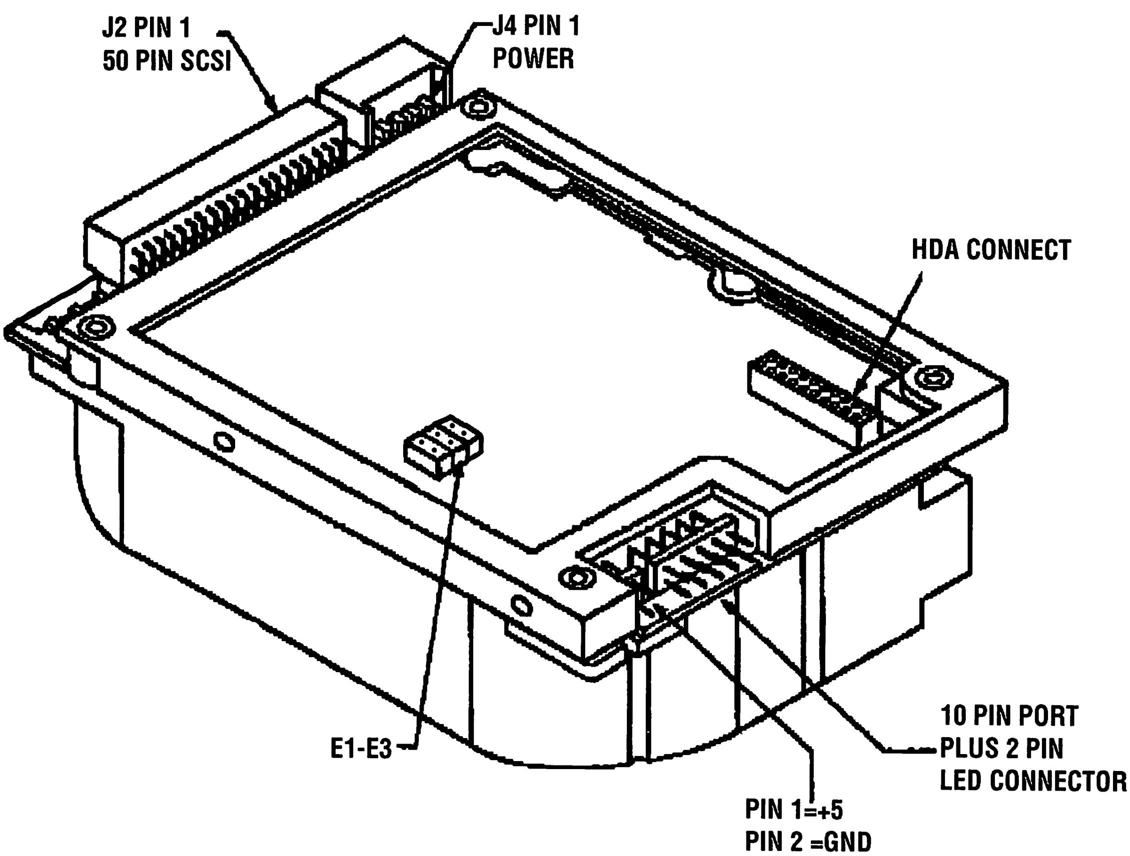
Conner 31370



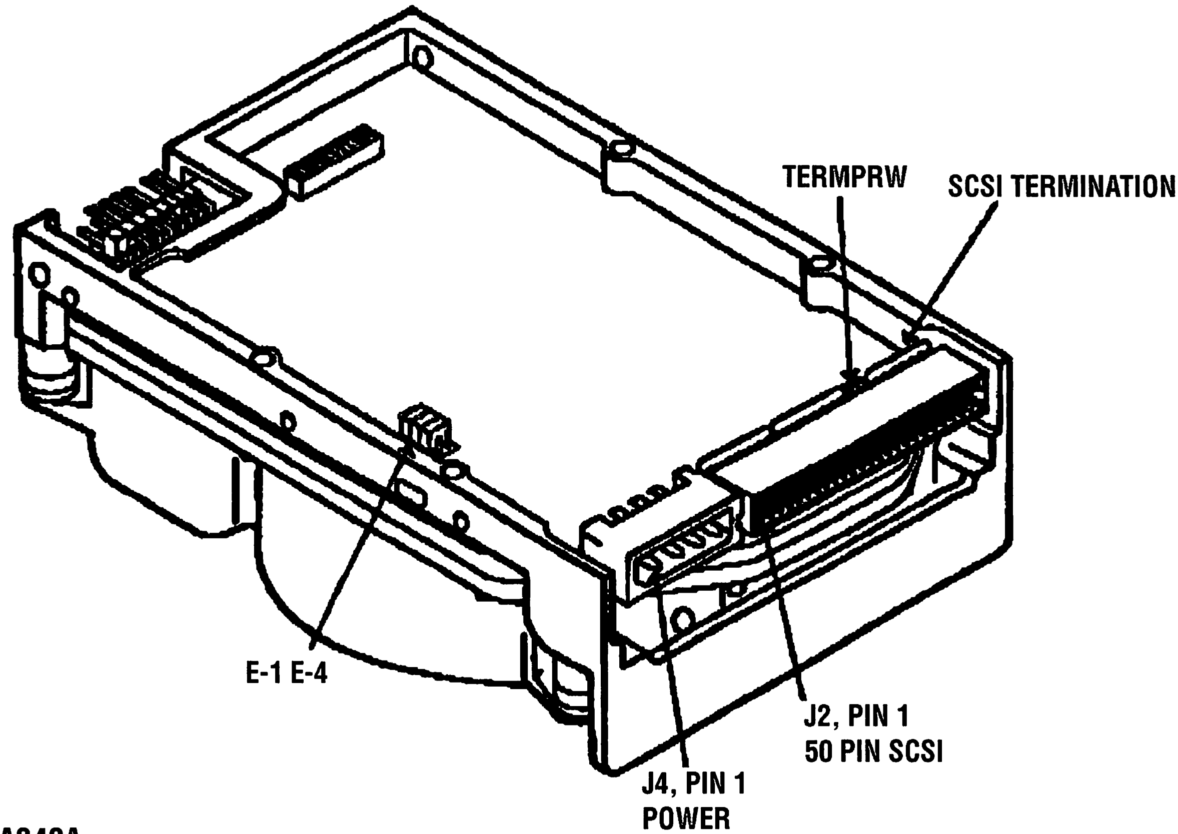
Conner 3184



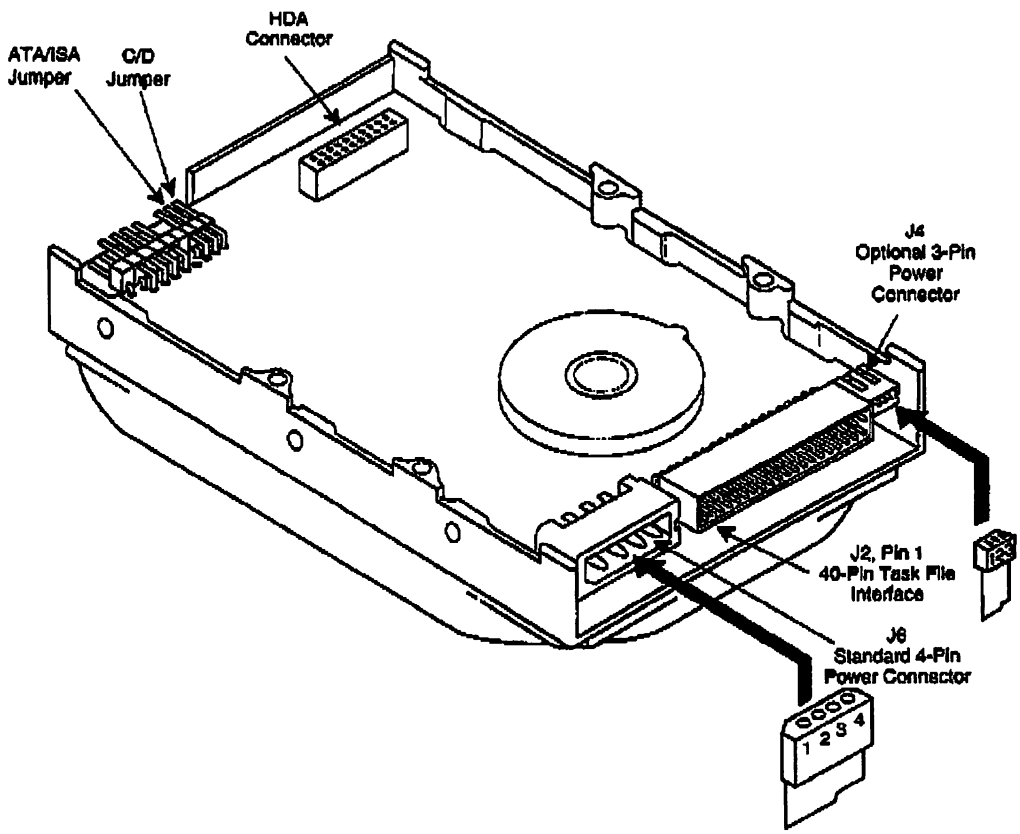
Conner 3200X



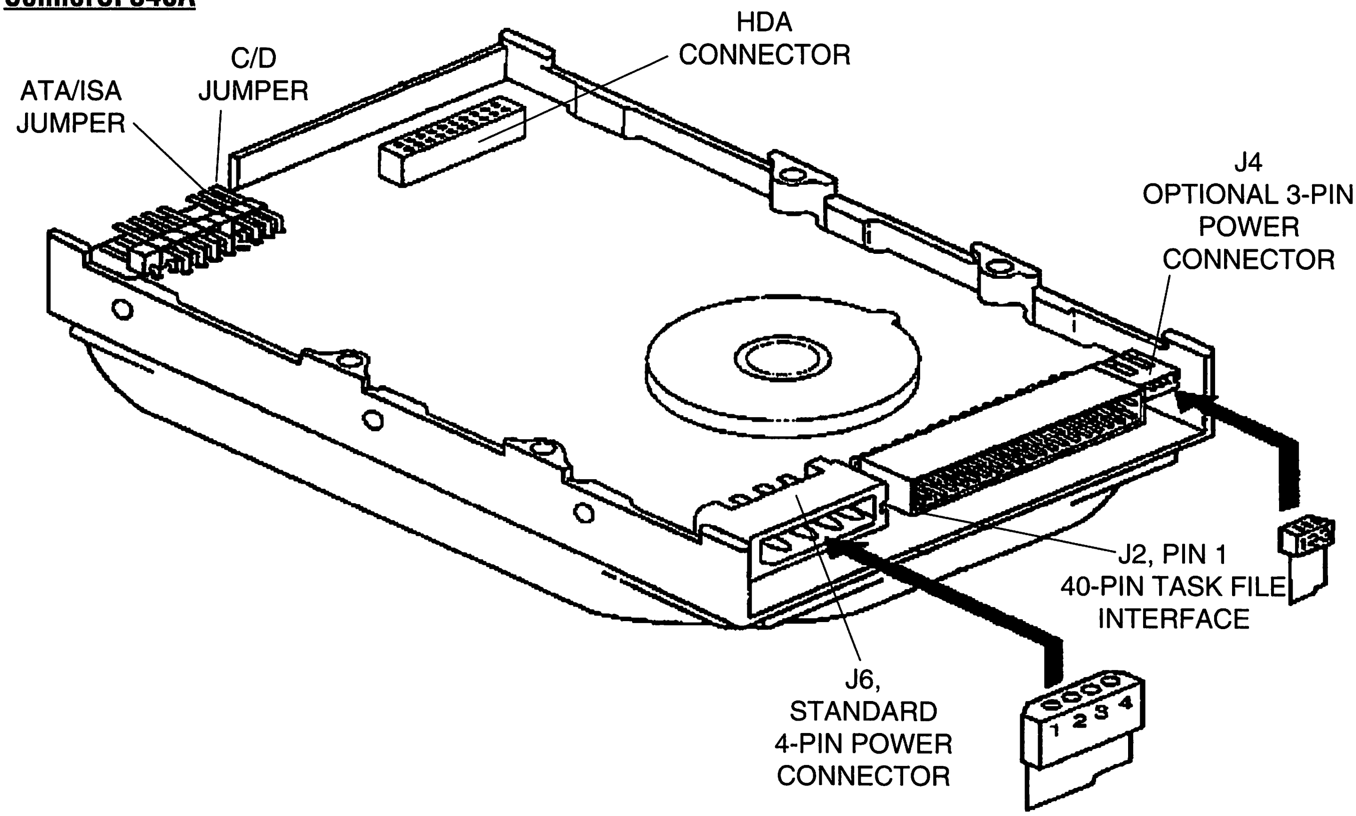
Conner 3360/3540



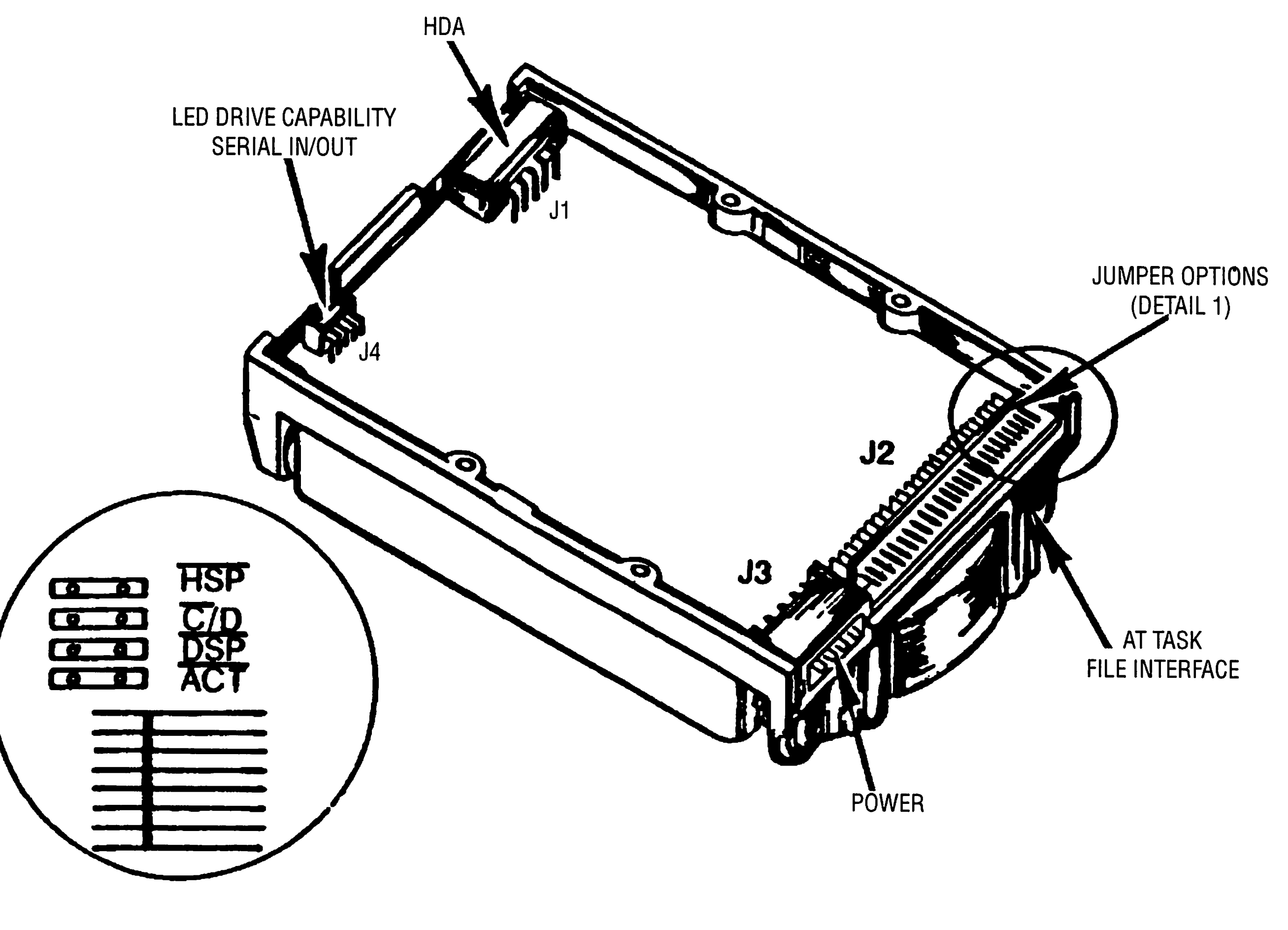
ConnerCFA340A



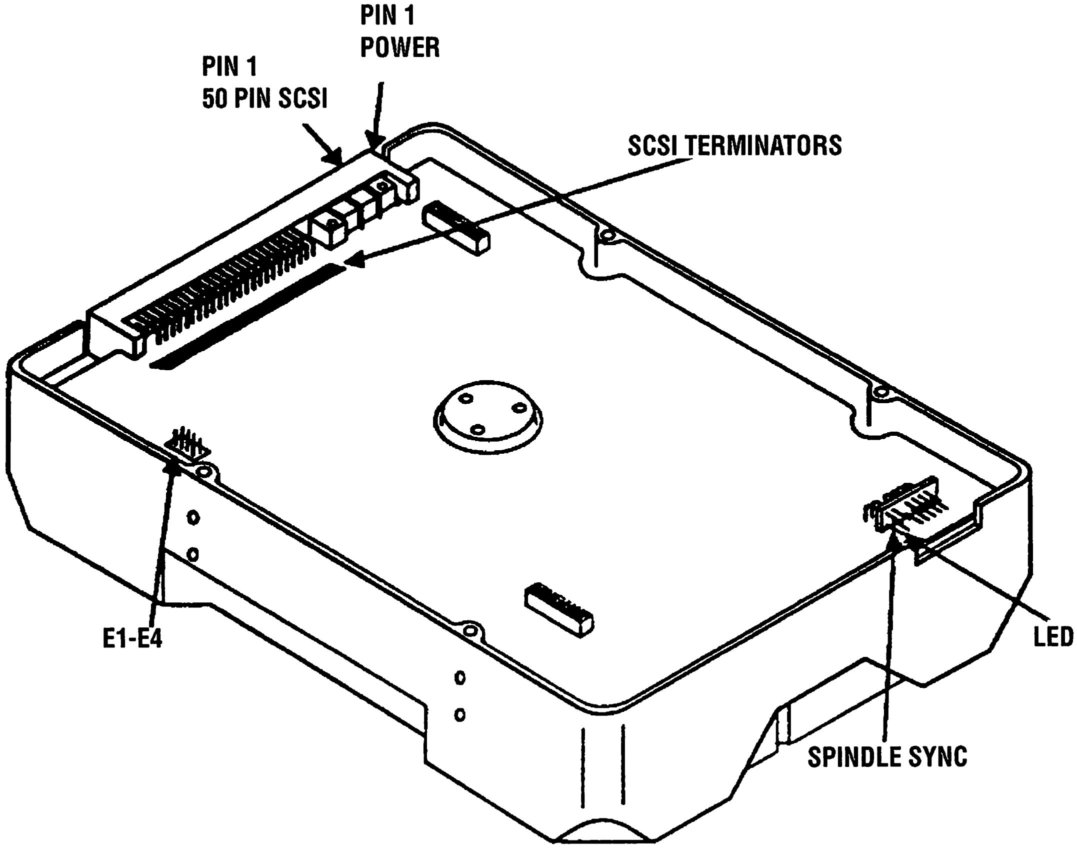
ConnerCF340A



Conner 344

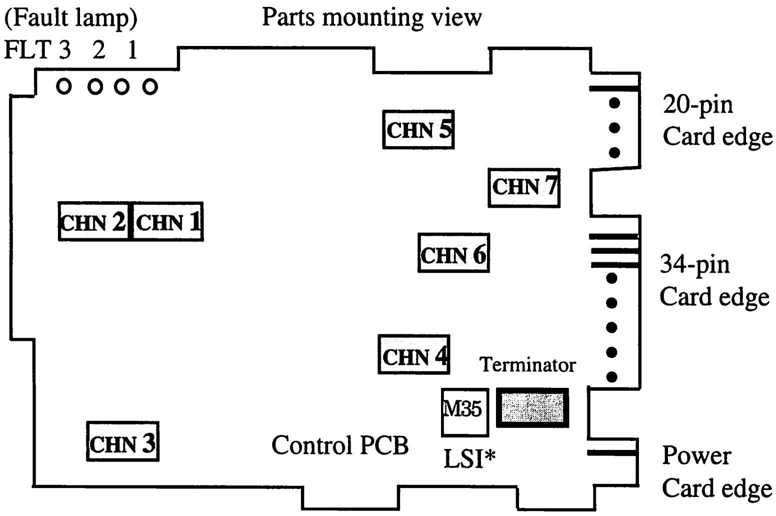


Conner 5500


PIN 1
POWER
PIN 1
50 PIN SCSI
SCSI TERMINATORS
E1-E4
LED
SPINDLE SYNC

Fujitsu 2244, 2245, 2246

All of these Fujitsu drives use identical electronics. CNH7 selects the size of the HDA.



Jumpers are inserted as follows when shipped from the factory.
CNH7: Between 1 and 2, 3 and 4, 9 and 10, and 15 and 16
CNH6: Between 1 and 2, and 15 and 16
CNH5: Between 11 and 12, and 15 and 16
CNH4: Between 5 and 6
CNH2: Between 15 and 16

The following settings are model specific.
CNH7: M2246 Between 3 and 4
M2245 Between 5 and 6
M2244 No jumpers between 3 and 4, or 5 and 6.

* Identify that the LSI (M35) is MB114T071. See Appendix in manual which describes the shorting plug settings in case that the LSI is MB113T047

Figure 16 *– Fujitsu 2244,2245, & 2246 Shorting Plug Locations*

Fujitsu 226X Series

Note: The read-ahead cache on this drive may not work with all controllers.

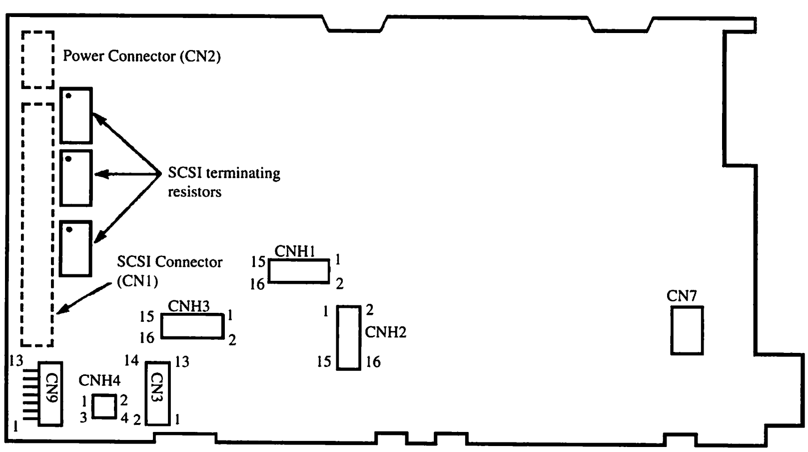


Figure 17 *– Fujitsu 226X Series Jumper Locations*

Fujitsu 226X Series (CONTINUED)

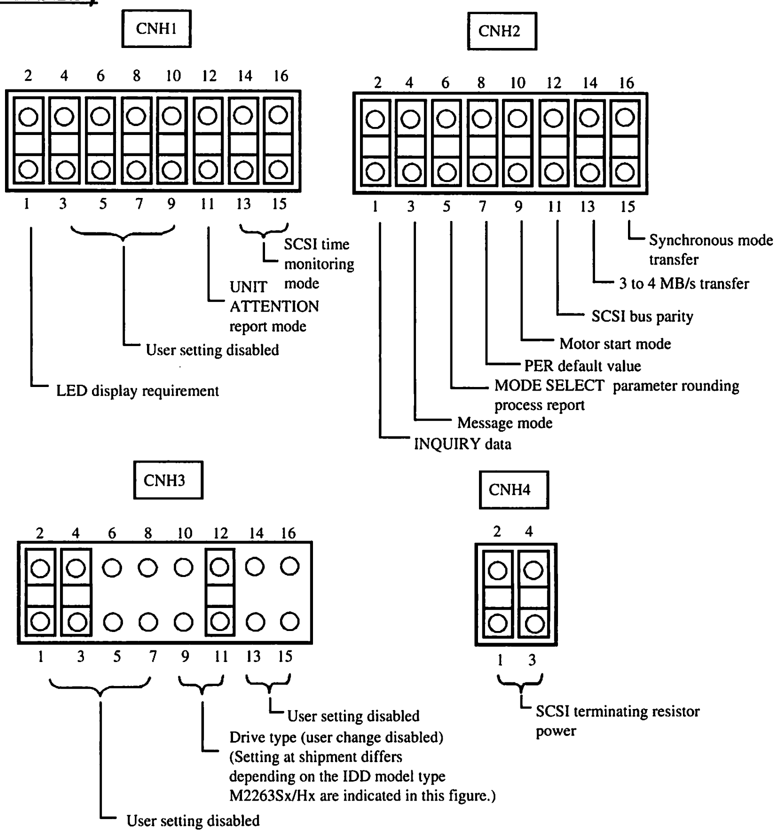


Figure 18 *– Fujitsu 226X Series Jumper Settings*

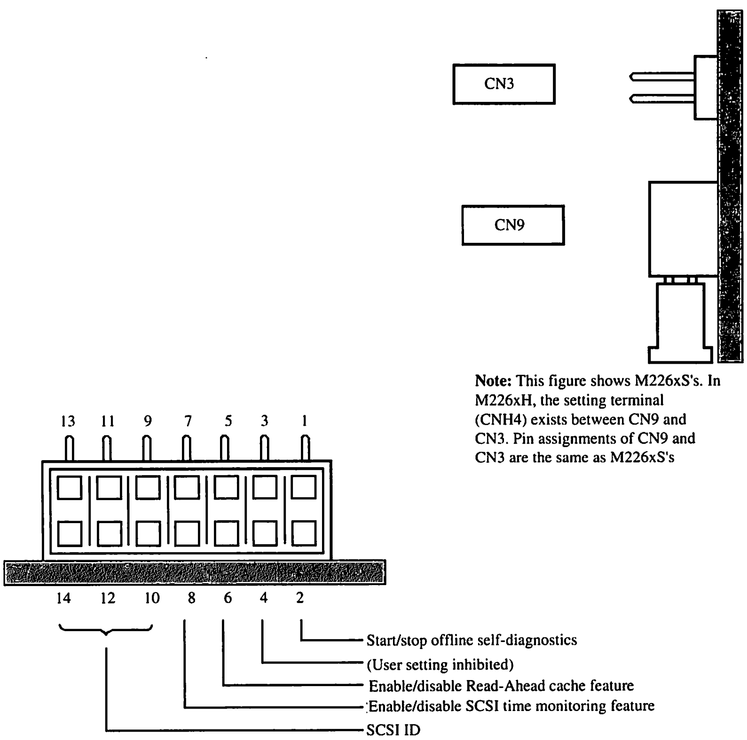
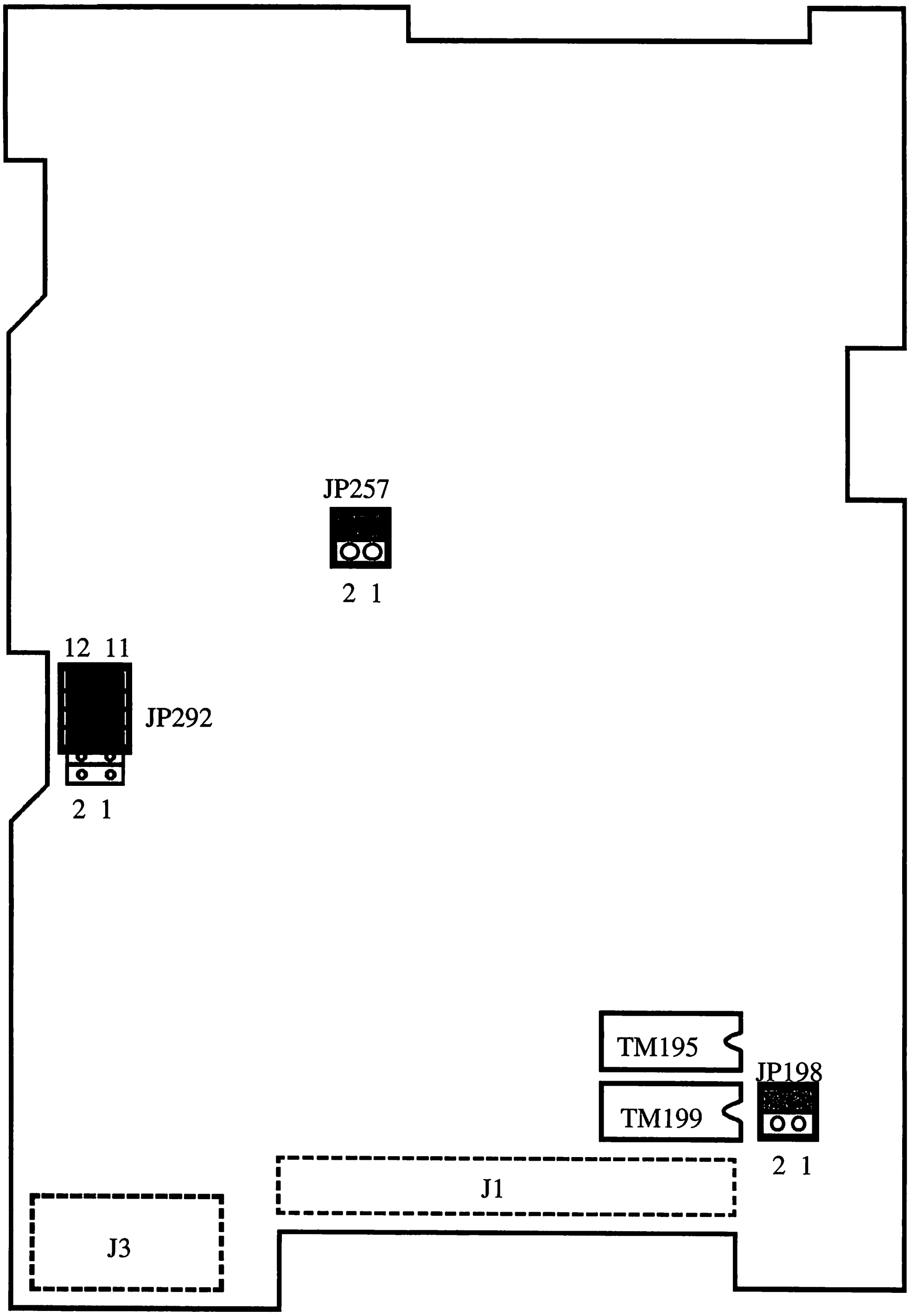


Figure 19 *– Fujitsu 226X Jumper Settings (Continued)*

Hitachi DK514C

(PCB Rev A/D2 or later)

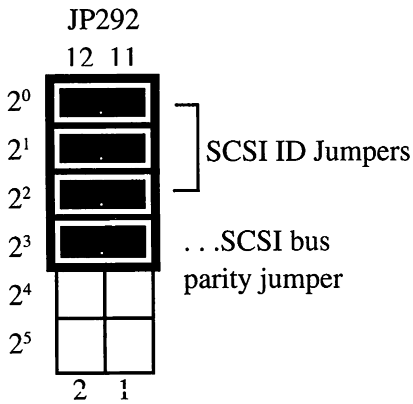


Note: The terminator of the DK514C must be removed except for the last drive of the daisy-chain.

Figure 20a *- Hitachi SZ916 PCB Default Jumper Settings*

Hitachi DK514C (Continued)

1) SCSI ID setting jumper (JP292 Bits 2^0 - 2^2)



SCSI ID Jumpers Settings			
2^2	2^1	2^0	SCSI ID#
			0
			1
			2
			3
			4
			5
			6
			7

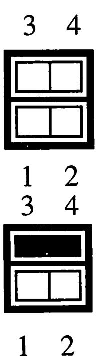
Shipped with ID# = 0

2) SCSI bus parity jumper (JP292 bit 2^3)

1: Disables SCSI bus parity
0: Enables SCSI bus parity

Note: 0 = Jumper plug installed
1 = Jumper plug removed

3) Terminator power on/off jumper (JP198 bit 2^6)



+ 5V source for terminator is supplied from the SCSI bus or the controller

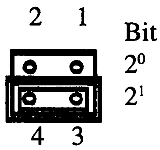
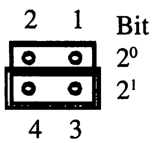
+ 5V source for terminator is supplied only from the controller (default)

■ Jumper installed   □ User changeable (Green Jumper)

Figure 20b *- Hitachi SZ916 PCB Default Jumper Settings*

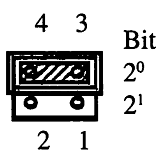
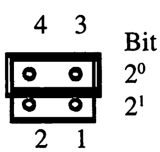
Hitachi DK514C (Continued)

4) Write protect jumper

No.	Jumper plug JP 257 bit 2^1	Meaning
1		Write protected. The DK514C Can only be read from and cannot be written to.
2		Read or Write. The DK514C is enabled for both read and write operations.

This jumper is installed in the read/write position when shipped from the factory.

5) Motor Start/Stop option jumper

No.	Jumper plug JP 257 bit 2^2	Meaning
1		When the motor start/stop option is not selected, the spindle motor is started when the DK514C power is applied. (Note 1)
2		When the motor start/stop option is selected, the spindle motor is started by using a SCSI command.

When shipped from the factory, this jumper is installed in position #1 (option not selected).

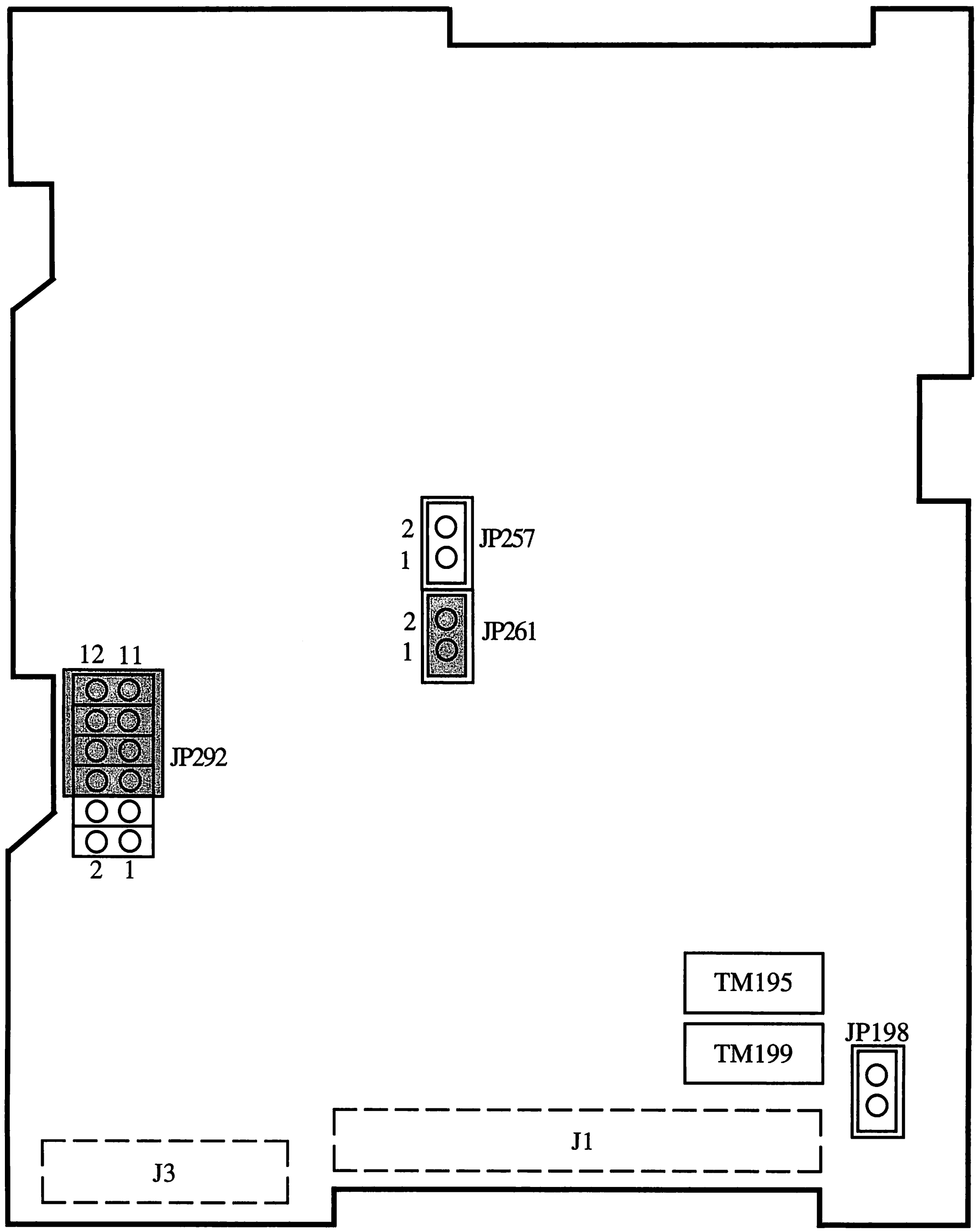
When the motor start/stop option (No. 2) is selected, the drive enters the motor stop state when its power is turned on. Use the Start/Start Unit command (1BH) to start or stop the drive.

Note 1: When the motor start/stop option is used, the controller does not respond to the host for about 35 seconds from Powerup to Drive Ready

Figure 20c *- Hitachi SZ916 PCB Default Jumper Settings*

Hitachi DK514C (Continued)

(PCB Rev A/D1 or earlier)

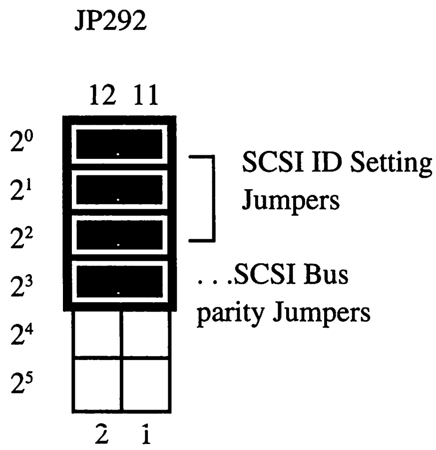


NOTE: The terminator of the DK514C must be removed except on the last drive of the Daisy Chain.

Figure 21a *- SZ916 PCB Jumper Locations*

<u>Hitachi DK514C</u> (Continued)

1) SCSI ID setting jumper (JP292 Bits 2^0 - 2^2)



SCSI ID Jumpers Settings			
2^2	2^1	2^0	SCSI ID#
			0
			1
			2
			3
			4
			5
			6
			7

Shipped with ID# = 0

2) SCSI bus parity jumper (JP292 bit 2^3)

1: Disables SCSI bus parity
0: Enables SCSI bus parity

Note: 0 = Jumper plug installed
1 = Jumper plug removed

3) Terminator power on/off jumper (JP198 bit 2^6)

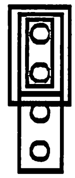
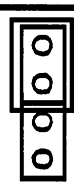

+ 5V source for terminator is supplied from the SCSI bus or the controller

+ 5V source for terminator is supplied only from the controller (default)

Figure 21b *- SZ916 PCB Jumper Locations*

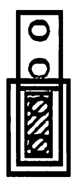
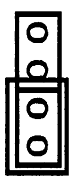
Hitachi DK514C (Continued)

4) Write protect jumper

No.	Jumper plug JP 257	Meaning
1	 2 1 JP257 2 1 (JP261)	Write protected. The DK514C can only be read from and cannot be written to.
2	 2 1 JP257 2 1 (JP261)	Read or Write. The DK514C is enabled for both read and write operations.

This jumper is installed in the read/write position when shipped from the factory.

5) Motor Start/Stop option jumper

No.	Jumper plug JP 261	Meaning
1	 2 1 JP257 2 1 (JP261)	When the motor start/stop option is not selected, the spindle motor is started when the DK514C power is applied. (Note 1)
2	 2 1 JP257 2 1 (JP261)	When the motor start/stop option is selected, the spindle motor is started by using a SCSI command.

When shipped from the factory, this jumper is installed in position #1 (option not selected).

When the motor start/stop option (No. 2) is selected, the drive enters the motor stop state when its power is turned on. Use the Start/Stop Unit command (1BH) to start or stop the drive.

Note 1: When the motor start/stop option is used, the controller does not respond to the host for about 35 seconds from Powerup to Drive Ready

Figure 21c *- SZ916 PCB Jumper Locations*

Hitachi DK 515

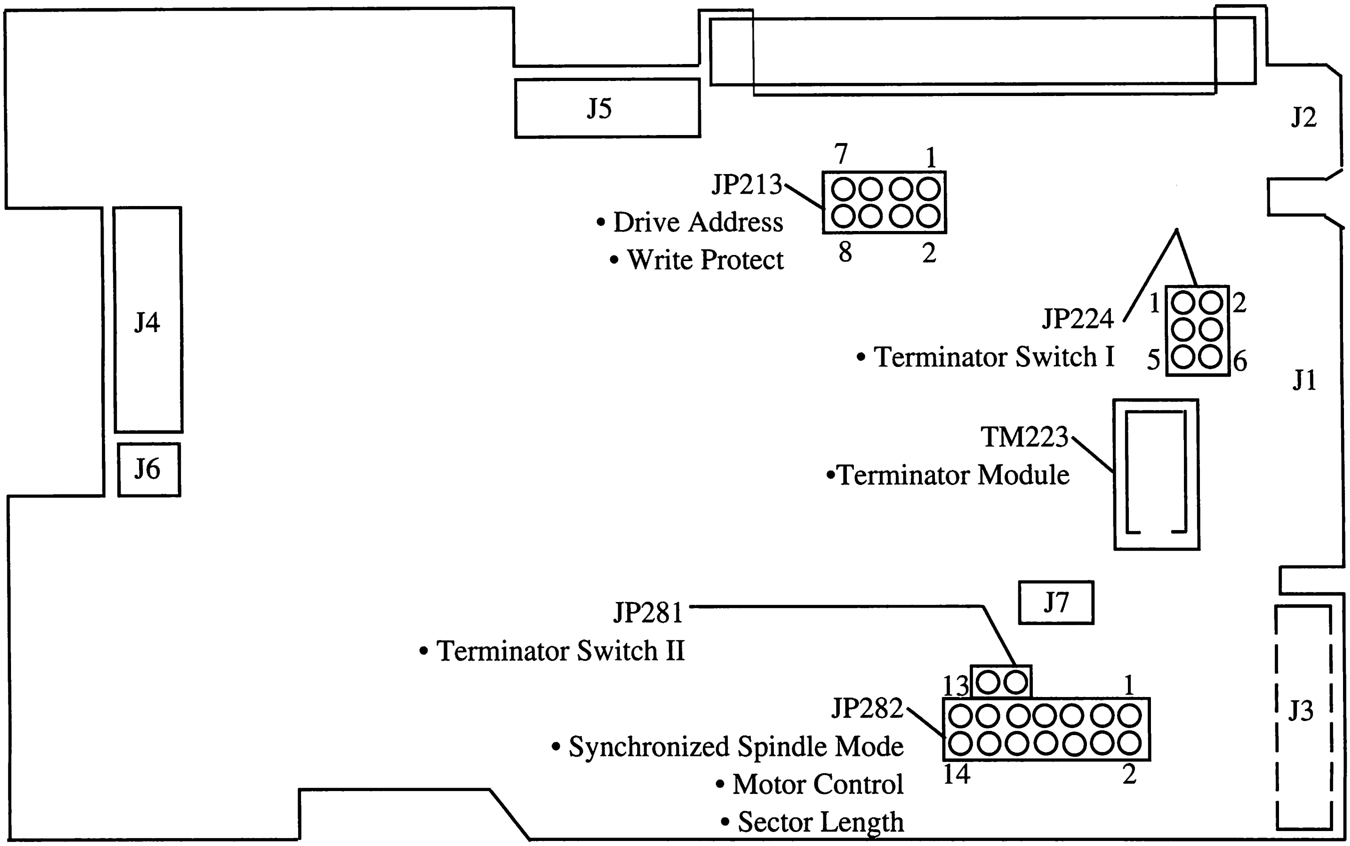


Figure 22 *- SZ931 PCB Layout (PCB Rev. 0)*

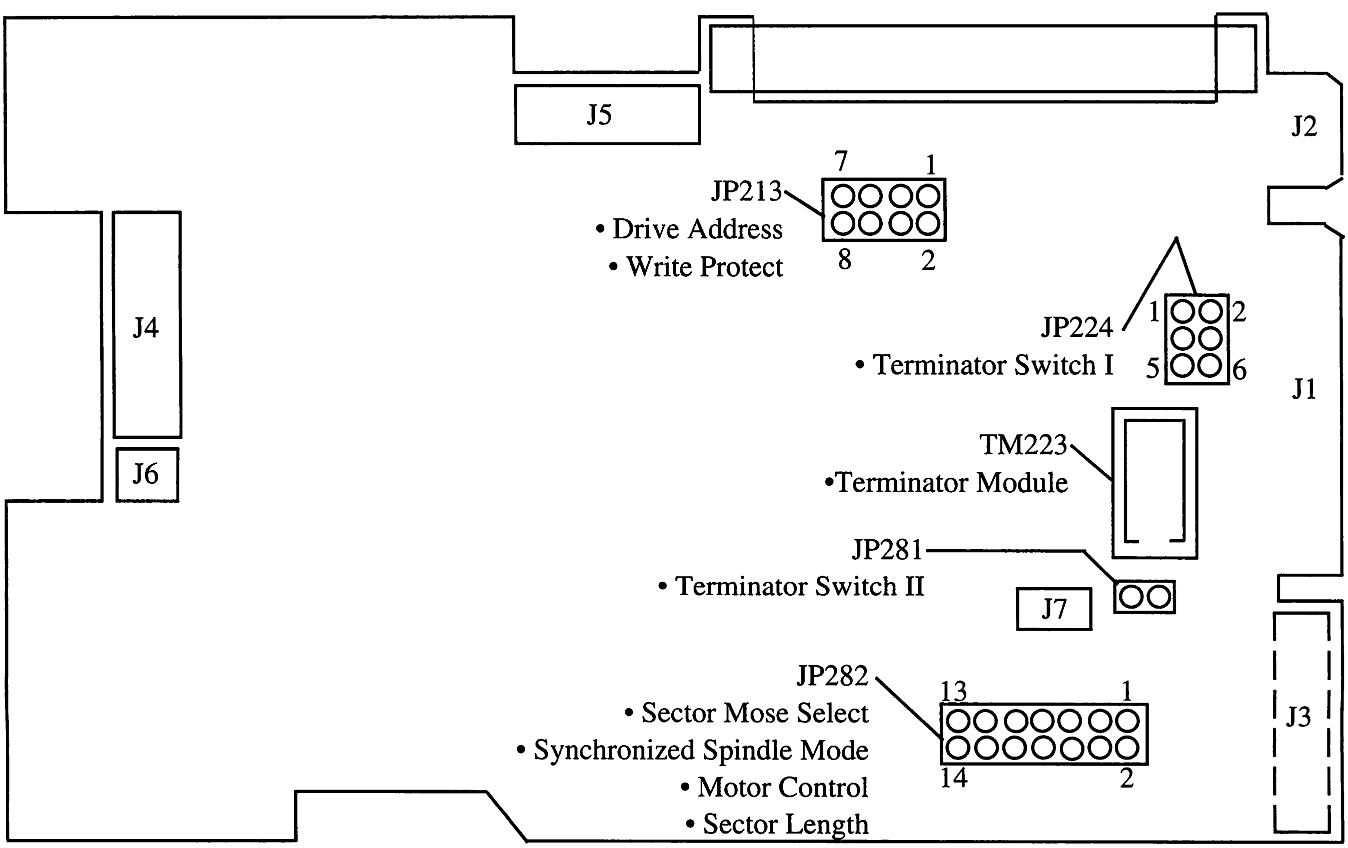


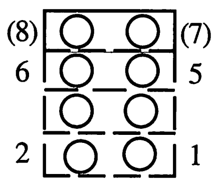
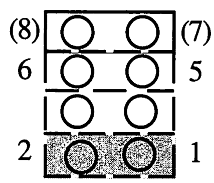
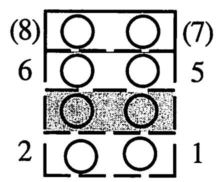
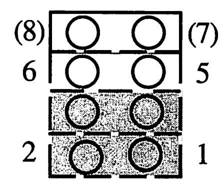
Figure 23a *- SZ931 PCB Layout (Rev. 1 or later)*

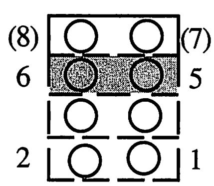
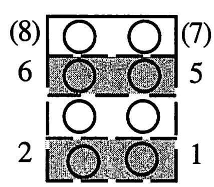
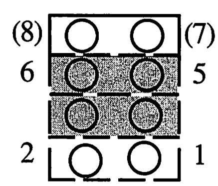
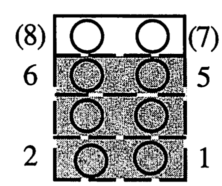
Hitachi DK515 (Continued)

(i) Drive Address Jumper (JP213, Pin 1-6)

Drive address can be selected by using the jumper switch (JP213) the jumper setting and the selected drive address is shown in the following table. Drive #0 is not used.

Jumper Settings for Drive Address

Drive No.	None	#1	#2	#3
				

Drive No.	#4	#5	#6	#7
				

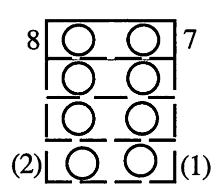
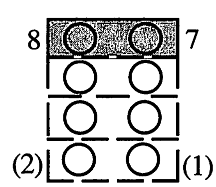
Drive #1 is selected when shipped from the factory

Figure 23b *- SZ931 PCB Layout (Rev. 0 or 1, or later)*

(ii) Write Protect Jumper (JP213, Pin 7-8)

Write operation of a drive is inhibited by setting a jumper on JP213, Pin 7-8 (Write protect mode), this condition will generate an ATTENTION status on receipt of a WRITE GATE-N signal.

Jumper Setting for Write Protect

JP213 (pins 7-8)		
Function	Write Enable	Write Protect

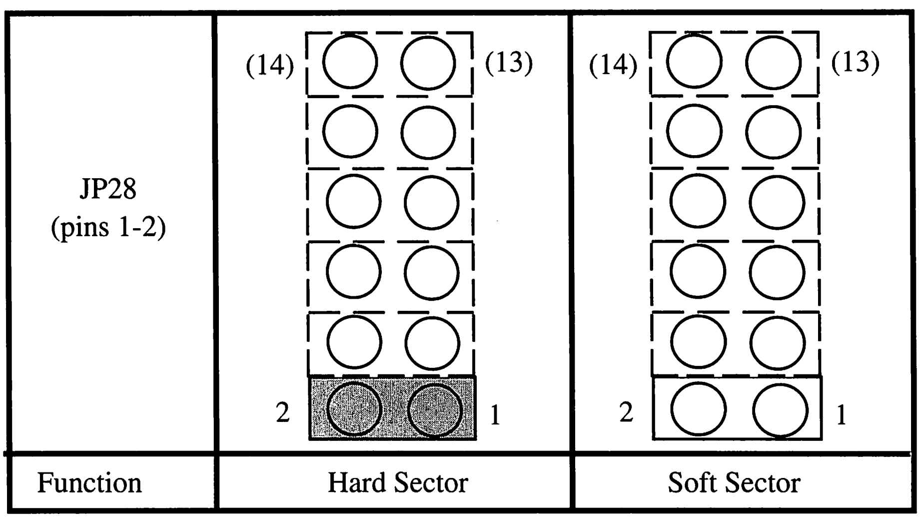
Write Enable mode is selected when shipped from the factory.

Hitachi DK515 (Continued)

(iii) Sector Mode Select Jumper (JP282, Pins 1-2)

The drive with Hard Sector mode issues SECTOR clock on J1 pin 16 and J2 pin 2, and with Soft Sector mode does ADDRESS MARK FOUND-N on J1 pin 16 and J2 pin 2. The SET CONFIGURATION command takes precedence over this jumper setting.

Jumper Setting for Sector Mode Selection



Hard Sector mode is selected when shipped from the factory

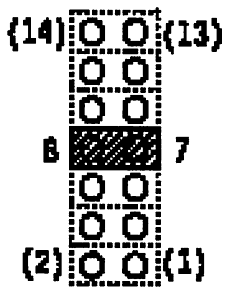
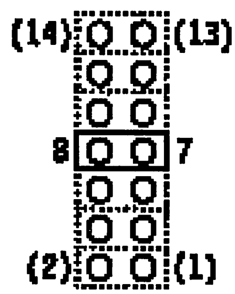
Figure 23c *- SZ931 PCB Layout (Rev. 0 or 1, or later)*

Hitachi DK515 (Continued)

(iv) Motor Control Jumper (JP282, Pins 7-8)

The Start/Stop jumper should be installed only if the controller supports remote start/stop.

Jumper Setting for Motor Start/Stop

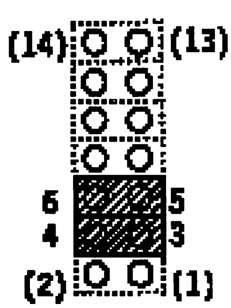
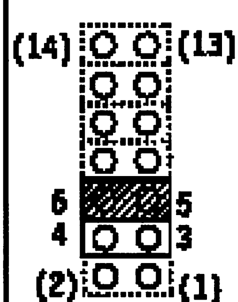
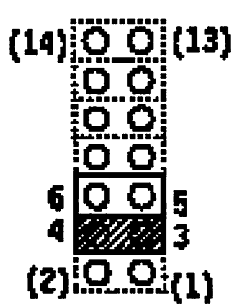
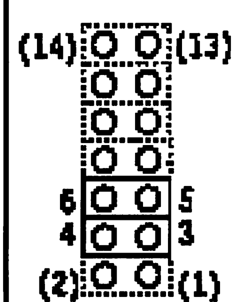
JP282 (Pins 7-8)		
Function	Not Supported	Supported

Not Supported mode is selected when shipped from the factory

(v) Synchronized Spindle Mode Select Jumper (JP282, pins 3-6).

Synchronized spindle mode can be selected by using the jumper switch (JP282, pins 3-6). This jumper setting will be aborted by the following Set Configuration command. Set the jumpers before turning on the DC power. For details, refer to DK51X Winchester Disk Drive Synchronized Spindle Feature Specification.

Jumper Setting for Synchronized Spindle Mode

				
Function	Off Line	Slave	Master	Remote

Off Line mode is selected when shipped from the factory

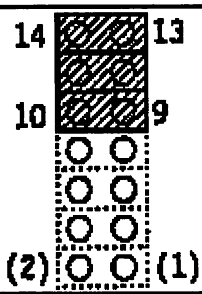
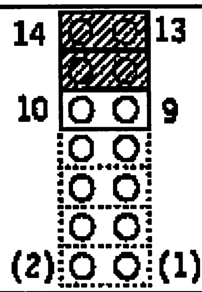
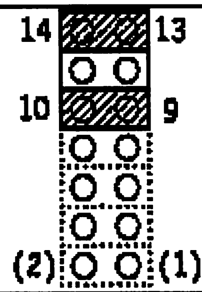
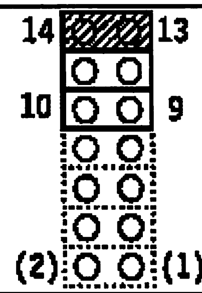
Figure 23d *- SZ931 PCB Layout (Rev. 0 or 1, or later)*

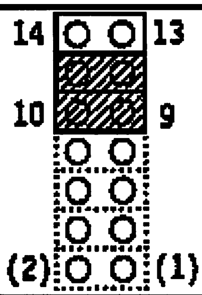
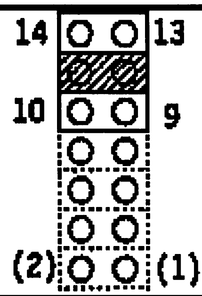
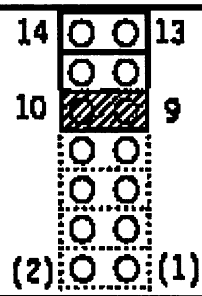
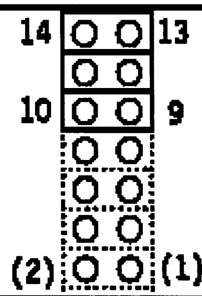
Hitachi DK515 (Continued)

(vi) Sector Length Jumper (JP282, pins 9-14)

This jumper setting function is effective with Hard Sector mode. This jumper setting will be aborted by the SET BYTES PER SECTOR command. All the applicable configurations of Bytes/Sector or Sectors/Track are listed in the following table. Set the jumper(s) before turning on the DC power.

Jumper Setting for Sector Length

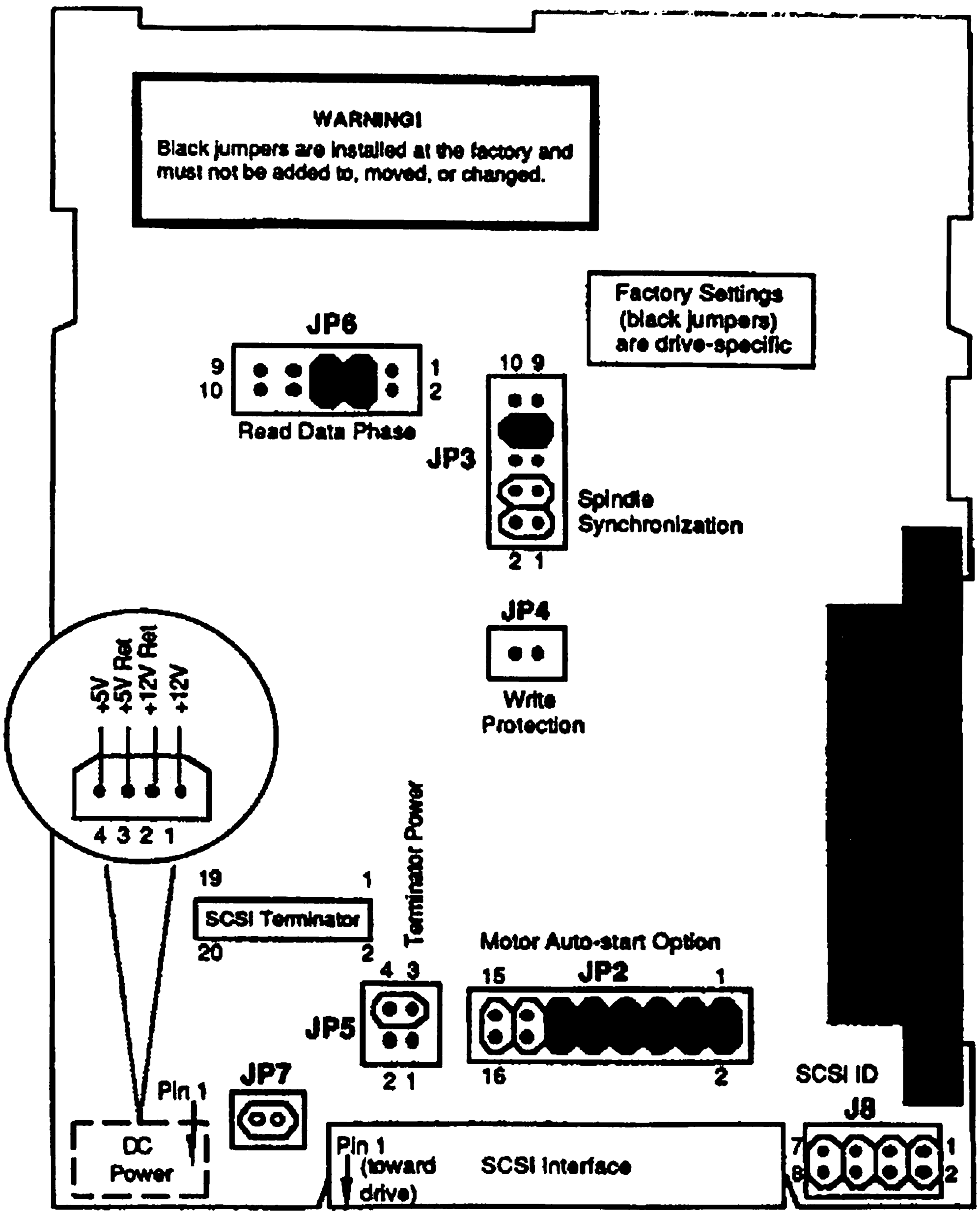
JP282 (Pins 9-14)				
Bytes Per Sector	335	338	593	602
Sectors Per Track	122	121	69	68
Data Length	256	256	512	512

JP282 (Pins 9-14)				
Bytes Per Sector	Adjustment Mode	1107	Not Used	
Sectors Per Track		37		
Data Length		1024		

122 sectors per track is selected when shipped from the factory
69 sectors per track required for PC applications

Figure 23e *- SZ931 PCB Layout (Rev. 0 or 1, or later)*

Hitachi DK516



Maxtor LXT-100

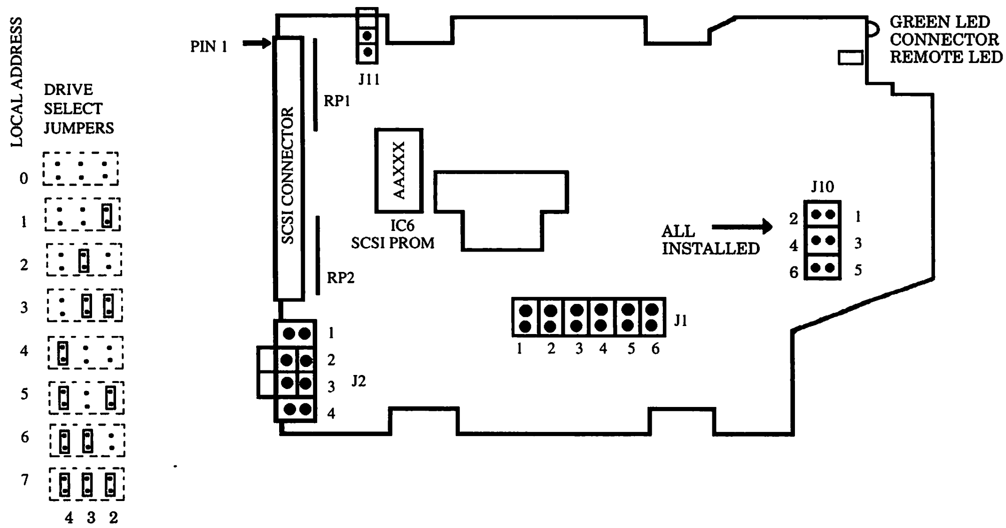


Figure 24 *- Maxtor LXT-100 Jumper Locations*

Maxtor LXT-200A

Jumper locations are identified in Figure 12, PCB Layout and Table Q Jumper Configurations.

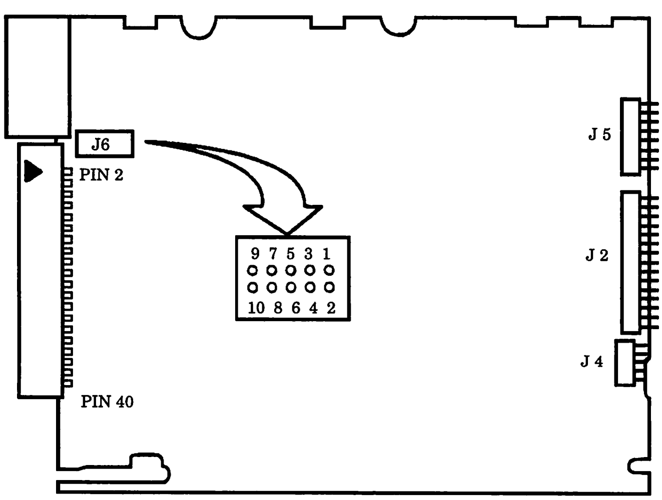


Figure 25 *- Maxtor LXT-200A PCB Layout*

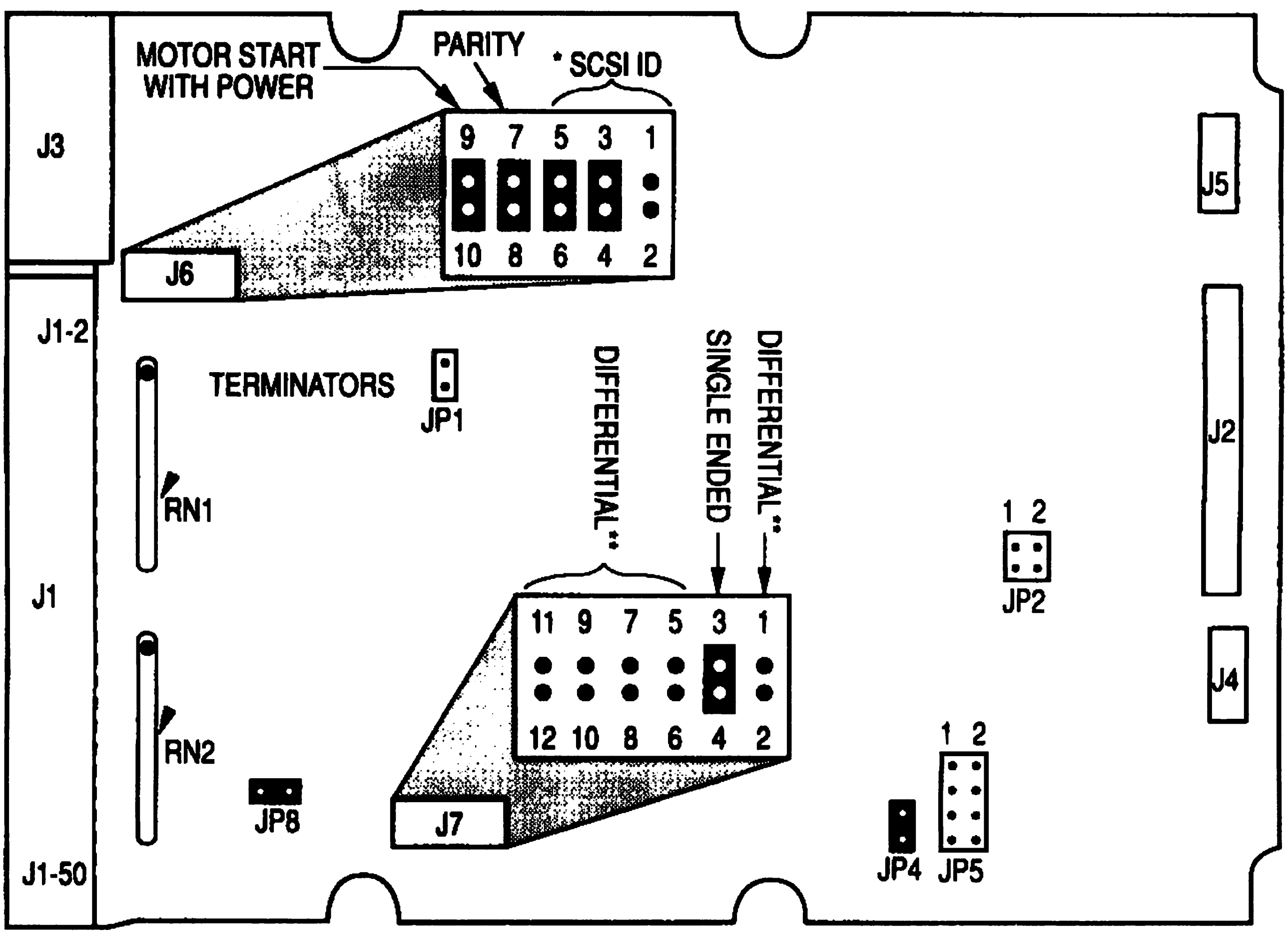
MaxtorLXT-200A (Continued)

Table Q *- Maxtor LXT-200A Jumper Configurations*

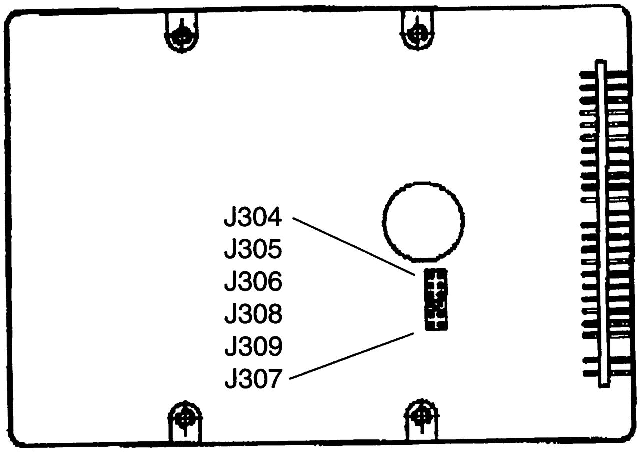
Pin Numbers		Jumper	Single Drive System	Dual Drive System	
				Master	Slave
9	10	Manufacturing Jumper*	Out	Out	Out
7	8	Two Drive System Jumper	Out	In	Out
5	6	Slave Present Jumper**	Out	Out	In
3	4	Drive Active Jumper	In	In	Out
1	2	Master/Slave Jumper	Out	Out	In

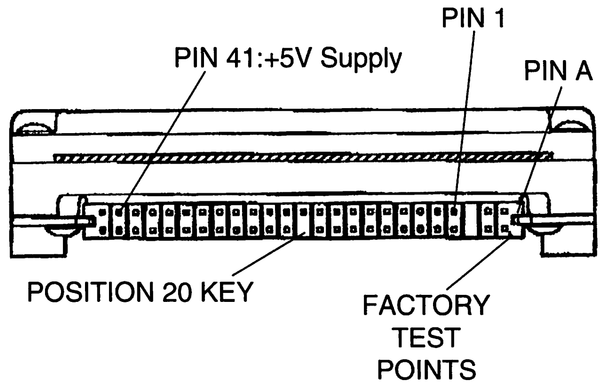
*Installation of this jumper may cause damage to the drive or loss of data.
** Not needed if both drives are LXT-200A

Maxtor MXT-1240



Maxtor 25128A and 2585A





Maxtor XT 1000/2000 Series

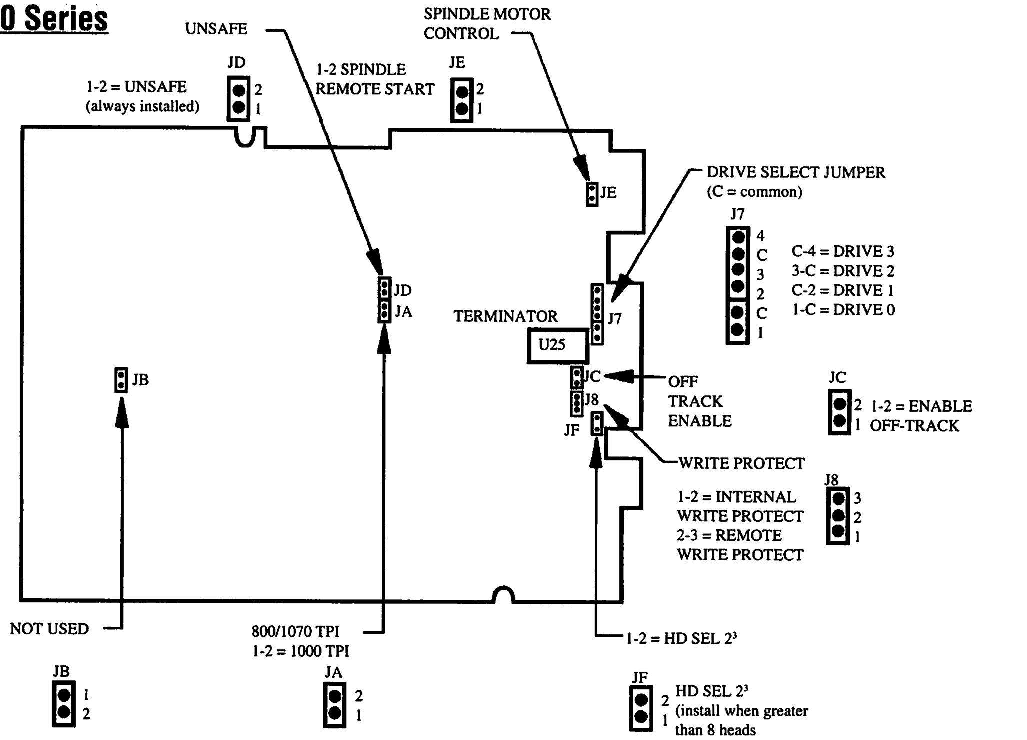


***Figure 26** – Maxtor XT 1000/2000 Series Drive Select Jumper Options*

Maxtor 4000E Series

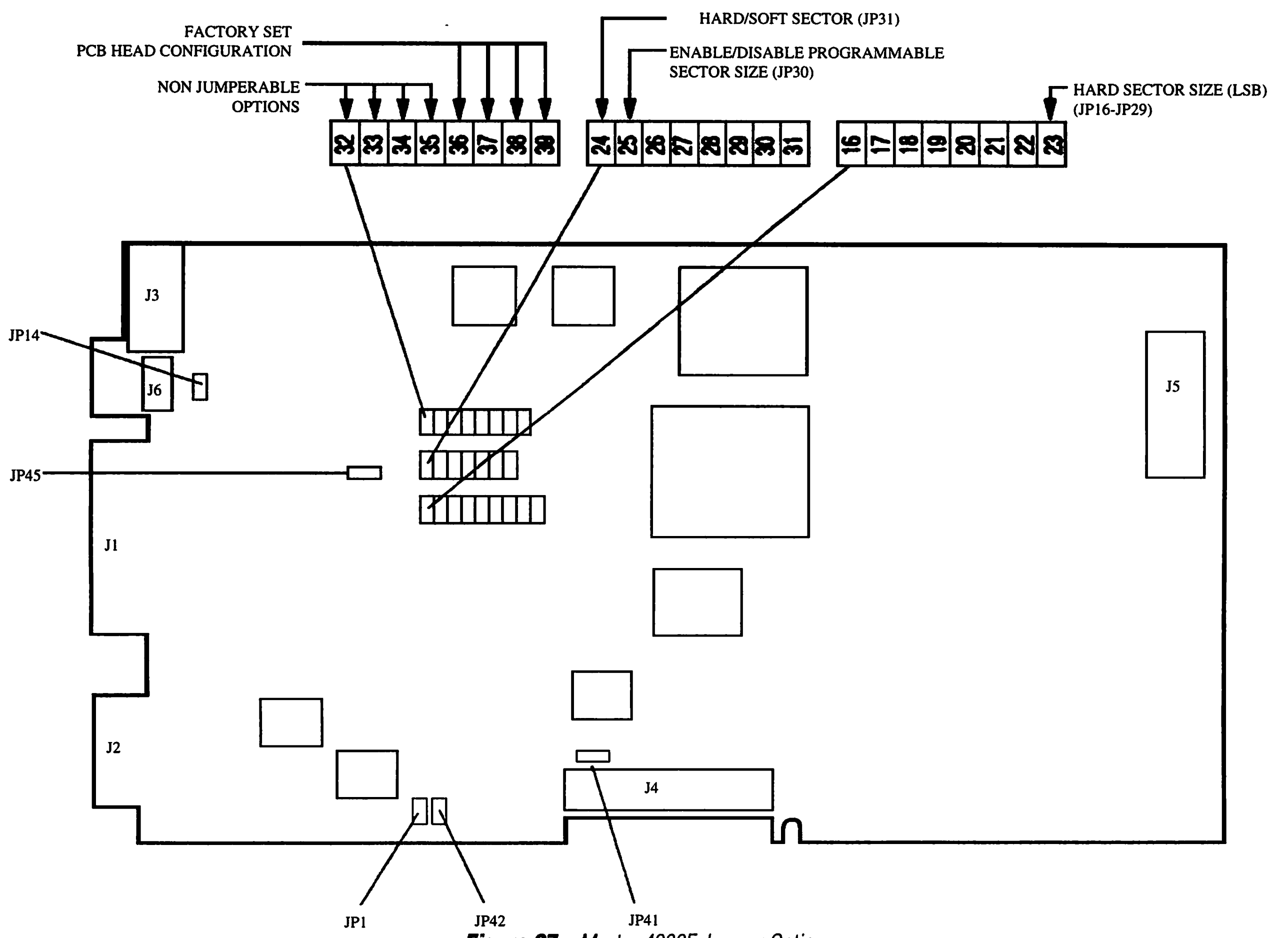


***Figure 27** – Maxtor 4000E Jumper Options*

Maxtor 4000E Series (Continued)

***Table R**– Maxtor 4000E Drive Select Jumpers*

Function	Jumper Block Pin Numbers
Drive Select 0	1-C
Drive Select 1	2-C
Drive Select 2	3-C
Drive Select 3	4-C

***Table S** – Maxtor 4000E Series, Drive Jumper Descriptions*

Jumper	Description
JP1 (in)	Used for Maintenance Testing
JP6 (in)	In = Motor Spinup Option Disabled Out = Remote Motor Spinup Option Enabled
DS1-DS7 (DS1 in)	Drive Select
JP14 (out)	In = Write Protected Out = No Write Protection
JP16-JP29	Unformatted Hard Sector Size in Bytes Jumpers, LSB = JP16, MSB = JP29
JP30	In = Enables programming of the hard sector size through the interface Out = Disables this function
JP31	In = Soft Sector Mode Out = Hard Sector Mode
JP32-JP35	PCB Head Configuration
JP41	Test Connection, Not a jumperable option
JP42 (in)	Used for manufacturer testing
Note: JP4, JP5, JP15, JP36, JP37, JP38, JP39, JP40, and JP41 are not jumperable options. The only customer configurable options are JP6, JP14, JP16-JP29, JP30, JP31, and DS1-DS7.	

Maxtor Panther SCSI

BASIC PC INSTALLATION STEPS

1. To set the drive to ID 0, remove jumpers from pins 1-2, 3-4, and 5-6 of connector J2.

2. JP13 is the parity jumper. When removed, it enasbles odd parity. When installed, it disables odd parity.

3. Set the drive type in the AT BIOS table to NOT INSTALLED. Your SCSI host bus adapter's ROM or driver will properly configure the drive.

4. The last physical device on the SCSI bus must be terminated.

5. Install the 50 pin connector. Install the power connector. The drive is now ready for partition ing.

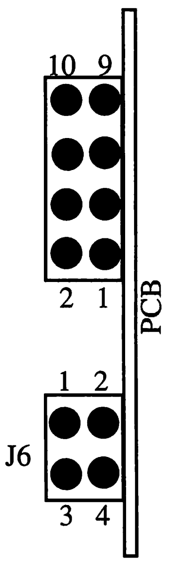
JUMPER NUMBER	DESCRIPTION
JP5	Slave Sync. Termination In = Slave Sync. Terminated to 150 ohms.
JP6	Master Sync. Termination In = Master Sync. Terminated to 150 ohms.
JP10	SCSI Termination Power (Host) In = Power Supplied by Host
JP11	SCSI Termination Power (Drive) In = Power Supplied by Drive
JP13	SCSI Parity Disable In = Parity Disabled.

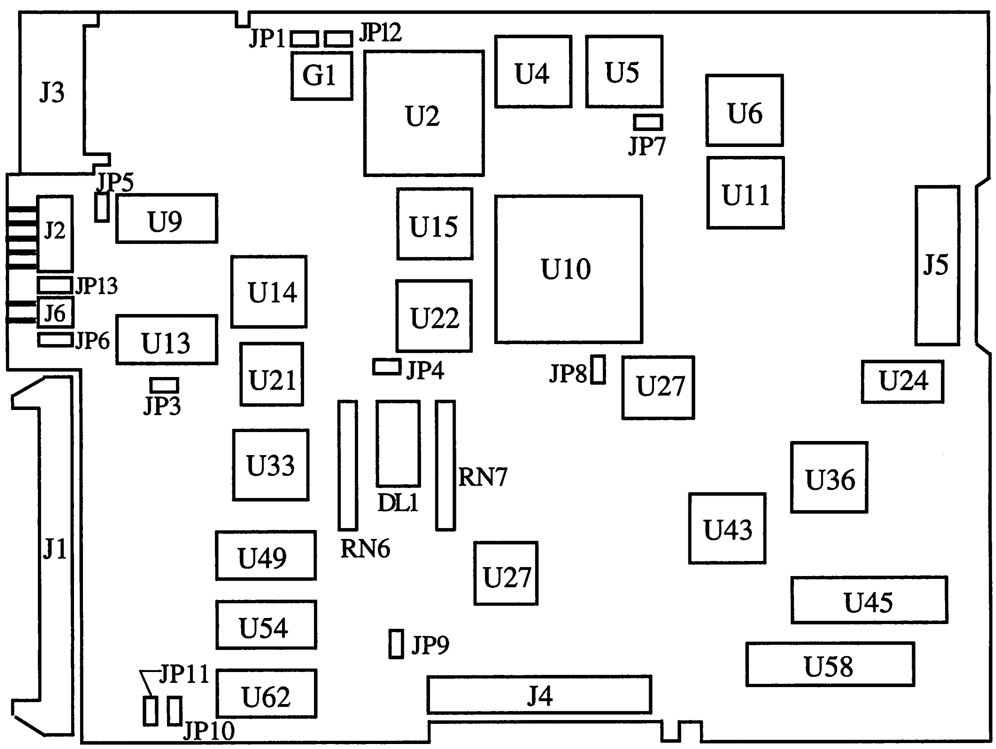
JP1	JP2	MODE
Out	Out	Start by ID sequence
Out	In	Start after 11-13 second delay
In	Out	Wait for START command
In	In	Start when power is applied

J2 CONNECTOR PINS	SCSI DEVICE SETTINGS
Pins 2, 4, 6	SCSI ID
Pin 8	Write Protect
Pin 9	Remote - LED
Pin 10	Remote + LED

NOTE: 1, 3, 5, and 7 are tied to ground.

WRITE PROTECT	J2 PINS 7-8
Enabled	Jumpered
Disabled	Not Jumpered





Maxtor XT-4000S

BASIC AT INSTALLATION STEPS

1.To set the drive to ID 0, remove JP36 and JP37. NOTE: These two jumpers are located approximately 3 inches behind the blue, 50-pin IDC connector.

2. JP40 is the parity jumper. When installed, it enables odd parity. When removed, it disables odd parity.

3. Set the drive type in the AT BIOS table to NOT INSTALLED. Your SCSI host adapter's ROM or driver will properly configure the drive.

4. The last physical device on the SCSI bus must be terminated.

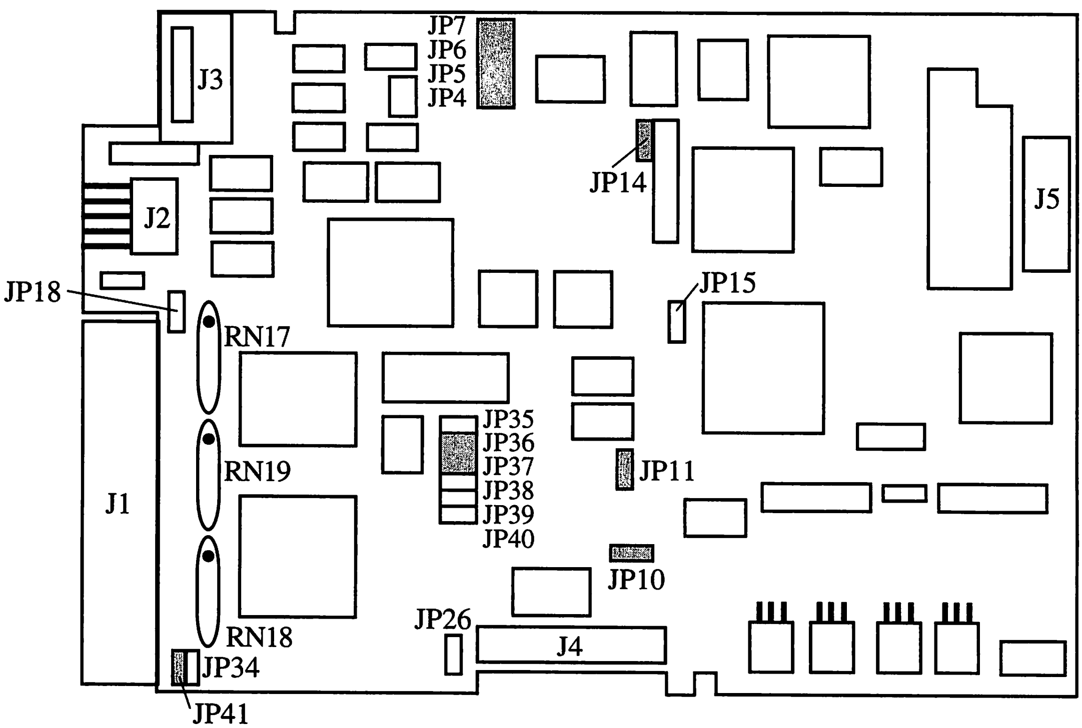
5. Install the 50-pin connector. Install the power connector. The drive is now ready for partitioning.

SPIN OPTIONS

JP14 Spin with Power	JP38 Spin Delay	MODE
Out	Out	Start by ID sequence
Out	In	Wait for Start command
In	Out or In	Start when power applied

JUMPER	DESCRIPTION
JP4 (F)	Manufacturing Use
JP5 (F)	Manufacturing Use
JP6 (F)	Manufacturing Use
JP7 (F)	Manufacturing Use
JP10 (F)	Manufacturing Use
JP11 (F)	Manufacturing Use
JP14 (CC)	Spin with Power (see chart)
JP15(F)	Manufacturing Use
JP18 (CC)	Disable Write Protection Option
JP26 (F)	Manufacturing Use
JP34(CC)	Termination Power
JP35 (CC)	Drive ID Selection (see SCSI ID chart)
JP36 (CC)	Drive ID Selection (see SCSI ID chart)
JP37 (CC)	Drive ID Selection (see SCSI ID chart)
JP38 (CC)	Spin Delay Option (see chart)
JP39 (F)	Manufacturing Use
JP40 (CC)	Parity Enabled
JP41 (CC)	Termination Power

F = Factory Set
CC = Customer Configurable



Maxtor XT-8000S

BASIC AT INSTALLATION STEPS

1. To set the drive to ID 0, remove JP36 and JP37. NOTE: These two jumpers are located approximately 3 inches behind the blue, 50-pin IDC connector.

2. JP40 is the parity jumper. When installed it enables odd parity. When removed, it disables odd parity.

3. Set the drive type in the AT BIOS table to NOT INSTALLED. Your SCSI host bus adapter's ROM or driver will properly configure the drive.

4. The last physical device on the SCSI bus must be terminated.

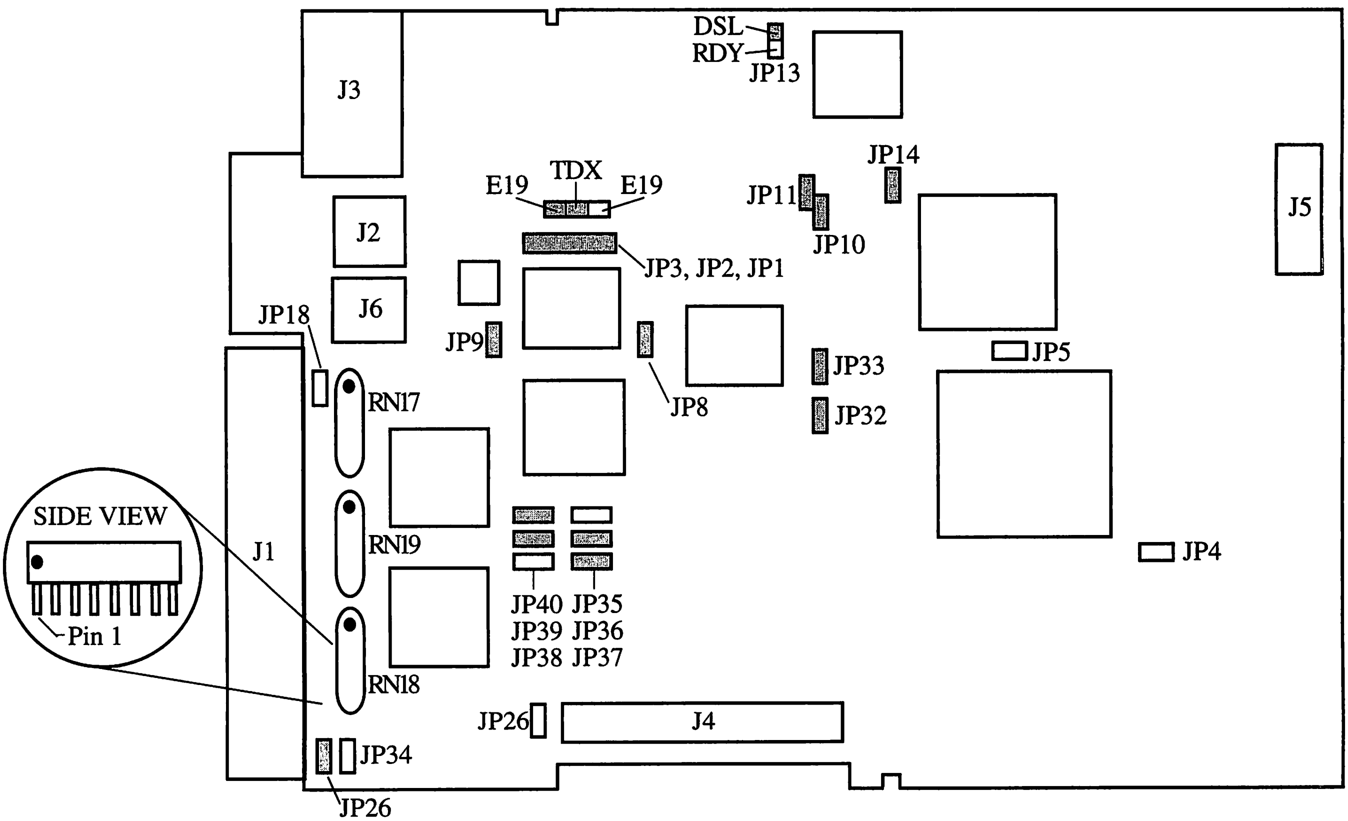
5. Install the 50-pin connector. Install the power connector. The drive is now ready for partitioning.

SPIN OPTIONS

JP14 Spin with Power	JP38 Spin Delay	MODE
Out	Out	Start by ID sequence
Out	In	Wait for Start command
In	Out or In	Start when power applied

JUMPER	DESCRIPTION
JP4 (F)	Manufacturing Use
JP5 (F)	Manufacturing Use
JP6 (F)	Manufacturing Use
JP7 (F)	Manufacturing Use
JP10 (F)	Manufacturing Use
JP11 (F)	Manufacturing Use
JP14 (CC)	Spin with Power (see chart)
JP15(F)	Manufacturing Use
JP18 (CC)	Disable Write Protection Option
JP26 (F)	Manufacturing Use
JP34(CC)	Termination Power
JP35 (CC)	Drive ID Selection (see SCSI ID chart)
JP36 (CC)	Drive ID Selection (see SCSI ID chart)
JP37 (CC)	Drive ID Selection (see SCSI ID chart)
JP38 (CC)	Spin Delay Option (see chart)
JP39 (F)	Manufacturing Use
JP40 (CC)	Parity Enabled
JP41 (CC)	Termination Power

F = Factory Set
CC = Customer Configurable



NOTE: Shaded jumpers are installed at the time of shipment for standard default configuration.

Maxtor XT-8000SH

BASIC PC INSTALLATION STEPS

1. To set the drive to ID 0, remove jumpers from pins 1-2, and 3-4 of connector J2.

2. Set the drive type in the AT BIOS table to NOT INSTALLED. Your host bus adapter's ROM or driver will properly configure the drive.

3. The last physical device on the SCSI bus must be terminated.

4. Install the 50-pin connector. Install the power connector. The drive is now ready for partitioning.

SPIN OPTIONS

JP14 Spin with Power	JP38 Spin Delay	MODE
Out	Out	Start by ID sequence
Out	In	Wait for Start command
In	Out or In	Start when power applied

JUMPER	DESCRIPTION
JP4 (F)	Manufacturing Use
JP5 (F)	Manufacturing Use
JP6 (F)	Manufacturing Use
JP7 (F)	Manufacturing Use
JP10 (F)	Manufacturing Use
JP11 (F)	Manufacturing Use
JP14 (CC)	Spin with Power (see chart)
JP15(F)	Manufacturing Use
JP18 (CC)	Disable Write Protection Option
JP26 (F)	Manufacturing Use
JP34(CC)	Termination Power
JP35 (CC)	Drive ID Selection (see SCSI ID chart)
JP36 (CC)	Drive ID Selection (see SCSI ID chart)
JP37 (CC)	Drive ID Selection (see SCSI ID chart)
JP38 (CC)	Spin Delay Option (see chart)
JP39 (F)	Manufacturing Use
JP40 (CC)	Parity Enabled
JP41 (CC)	Termination Power

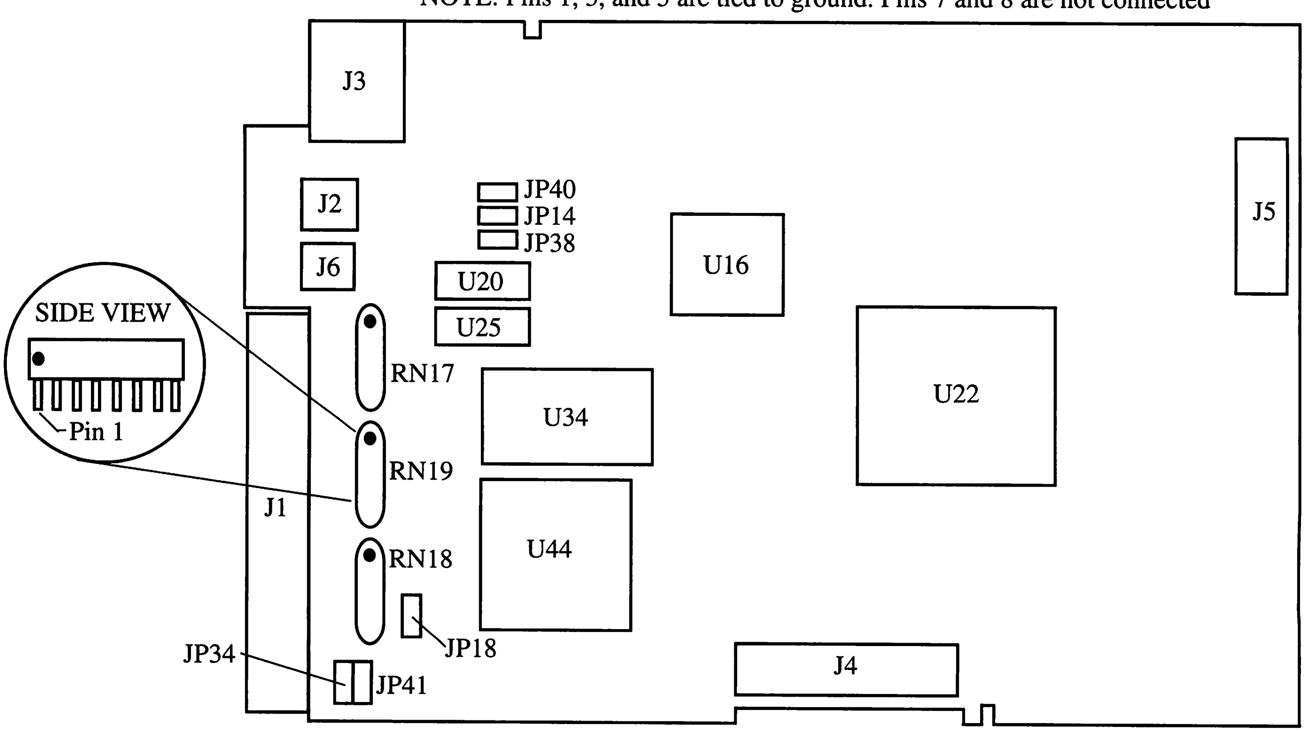
F = Factory Set
CC = Customer Configurable

J6 CONNECTOR

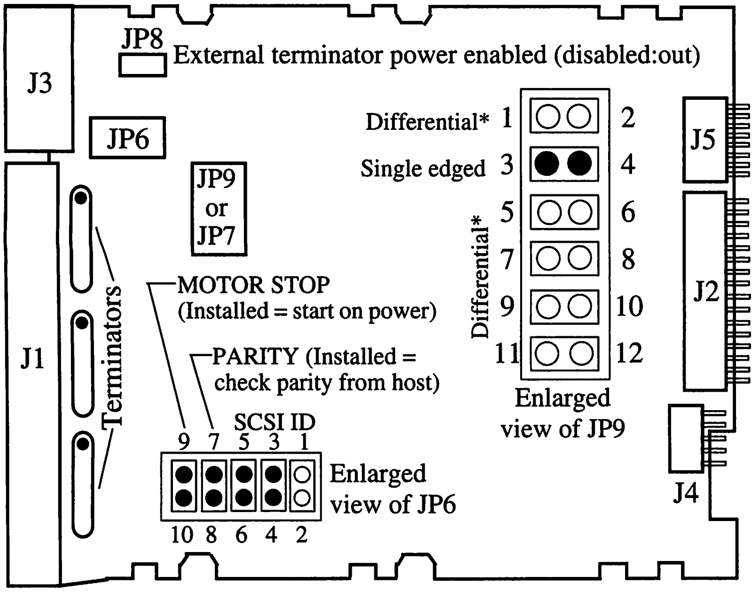
PIN 5 GRD	PIN 3 GRD	PIN 1 MASTER
PIN 6 (key)	PIN 4 SLAVE	PIN 2 SLAVE

J2 CONNECTOR PINS	SCSI DEVICE SETTINGS
Pin 2	SCSI ID
Pin 4	SCSI ID
Pin 6	SCSI ID
Pin 9	Remote + LED
Pin 10	Remote - LED

NOTE: Pins 1, 3, and 5 are tied to ground. Pins 7 and 8 are not connected



Maxtor LXT-SCSI



SCSI ID	Priority	Pins 5&6 (MSB)	Pins 3&4	Pins 1&2 (LSB)
0	Lowest	Out	Out	Out
1	↑	Out	Out	In
2		Out	In	Out
3		Out	In	In
4		In	Out	Out
5		In	Out	In
6	↓	In	In	Out
7	Highest	In	In	In

In = Installed, Shorted
Out = Not Installed, Open

NOTE: JP6 is present on all PCBs. JP8 and JP7/JP9 may not be present on your PCB.
* Optional differential operation requires a tailgate PCB to be installed.

Maxtor XT 8000E Series

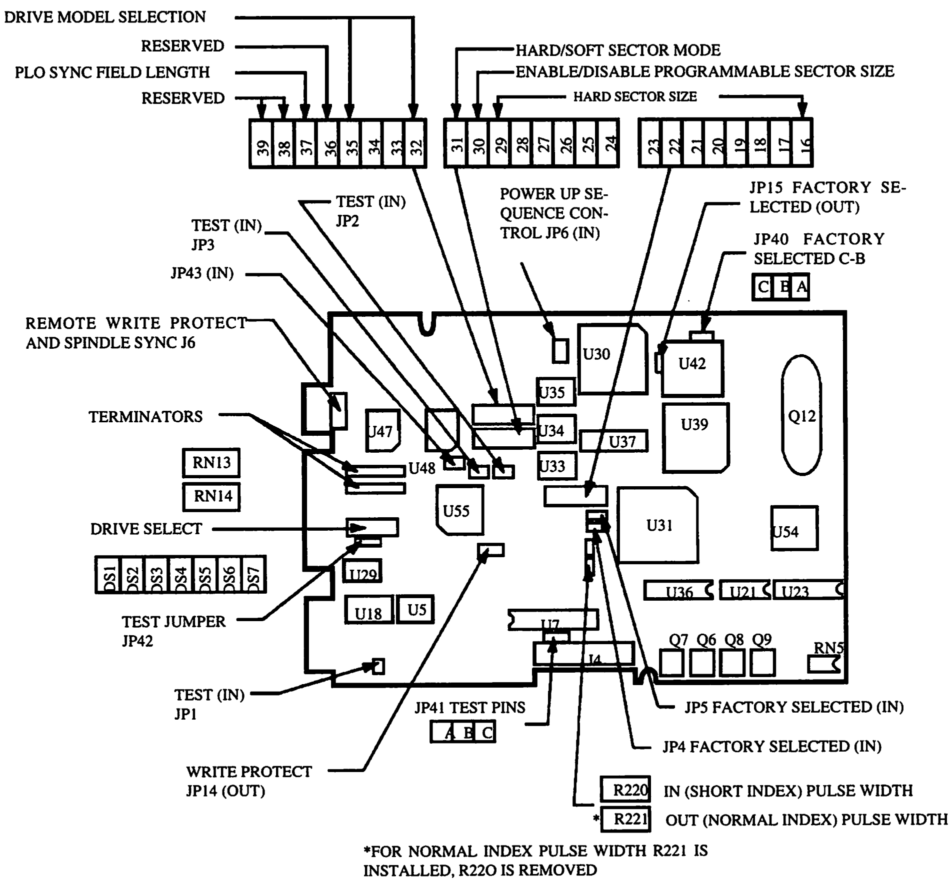


Figure 28 – *Drive Jumper Options (PCB P/N 1014150)*

Maxtor XT 8000E Series (Continued)

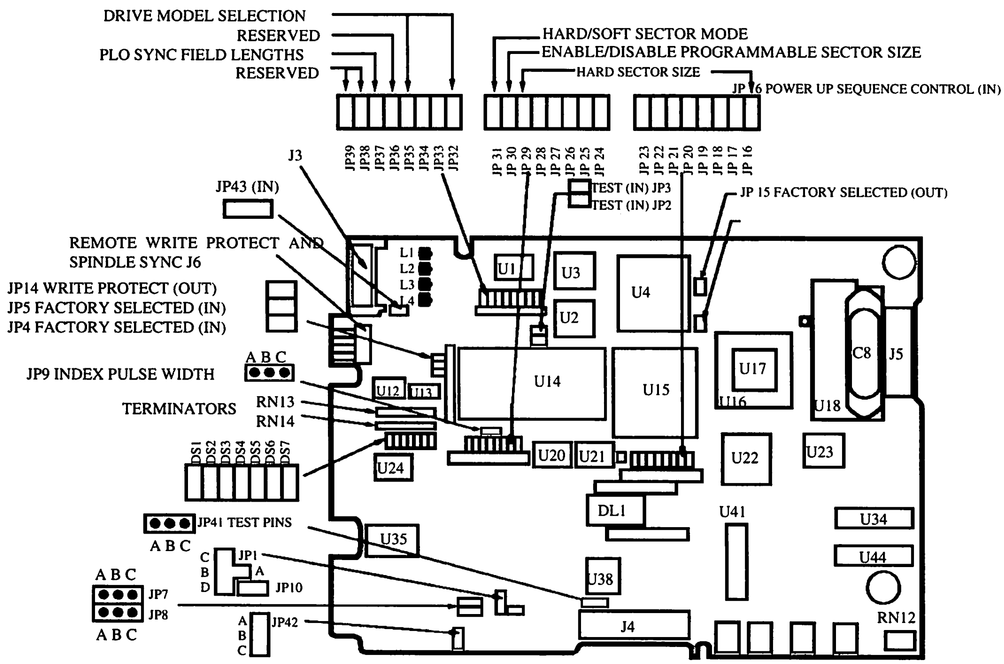


Figure 29 *– Drive Jumper Options (PCB P/N 1015468)*

Micropolis 132X Series

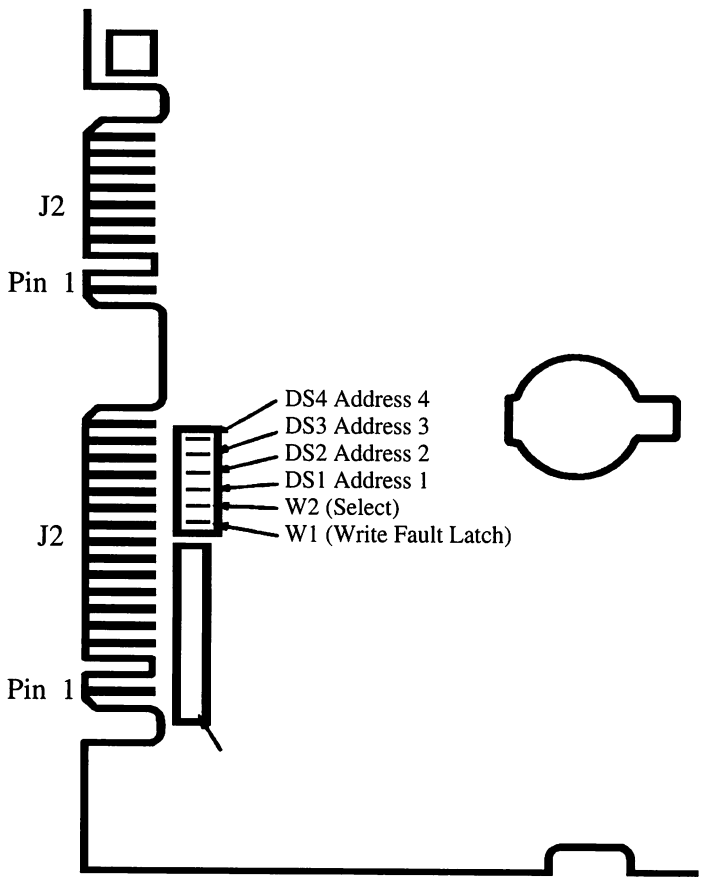


Figure 30 *– Micropolis 132X Drive Jumper Options*

Micropolis 135X Series

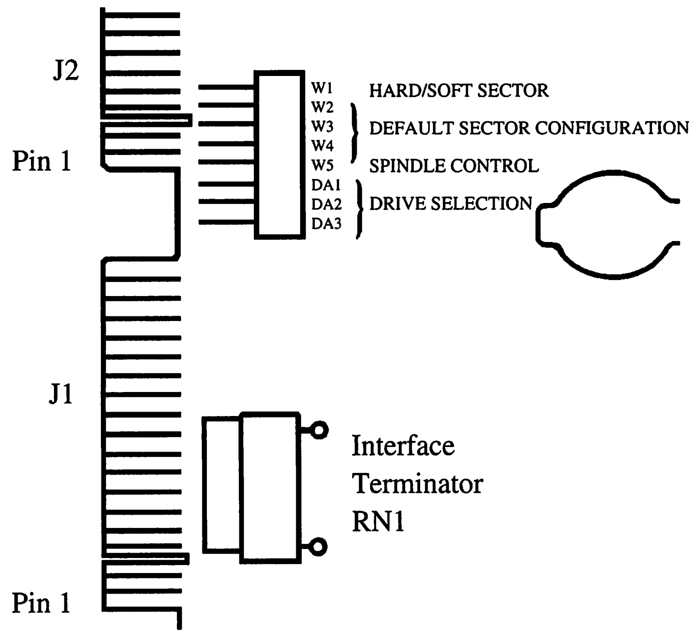


Figure 31 *– Micropolis 135X Jumper Settings*

Micropolis 137X Series

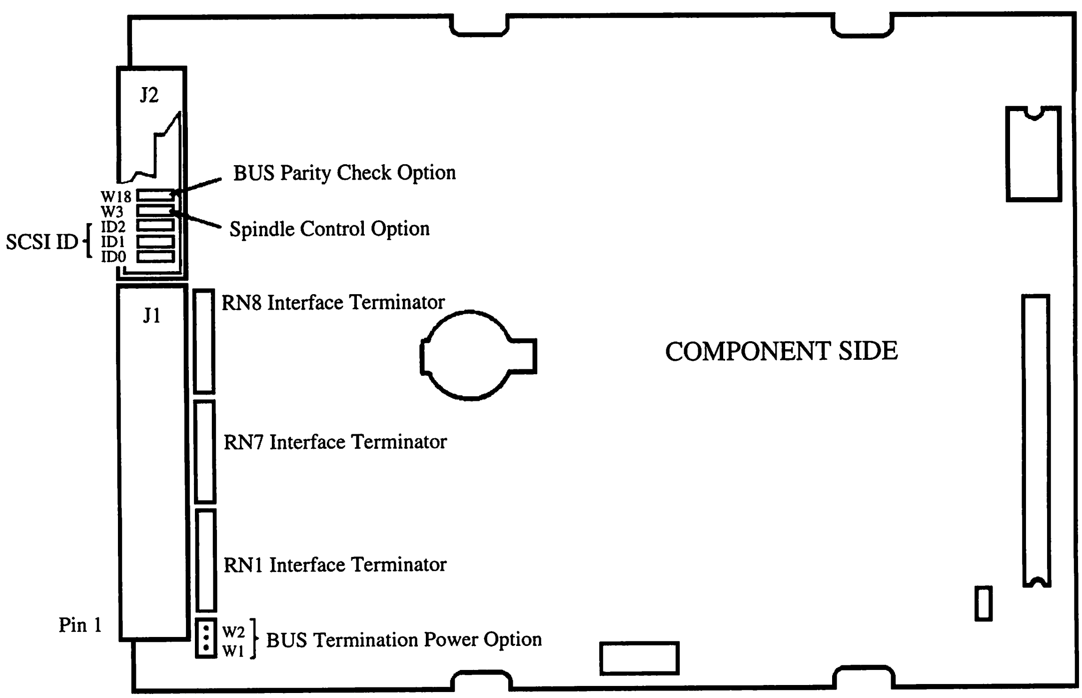


Figure 32 *– Micropolis 137X Jumper Settings*

Micropolis 155X Series

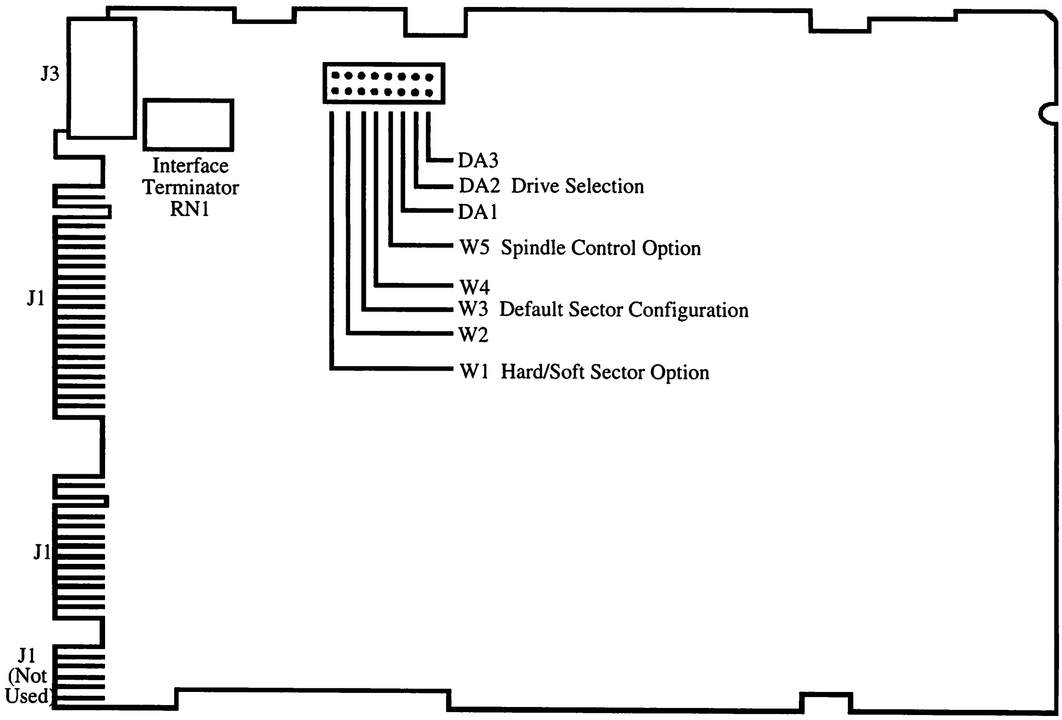


Figure 33 *– Micropolis 155X Jumper Settings*

Micropolis 157X Series

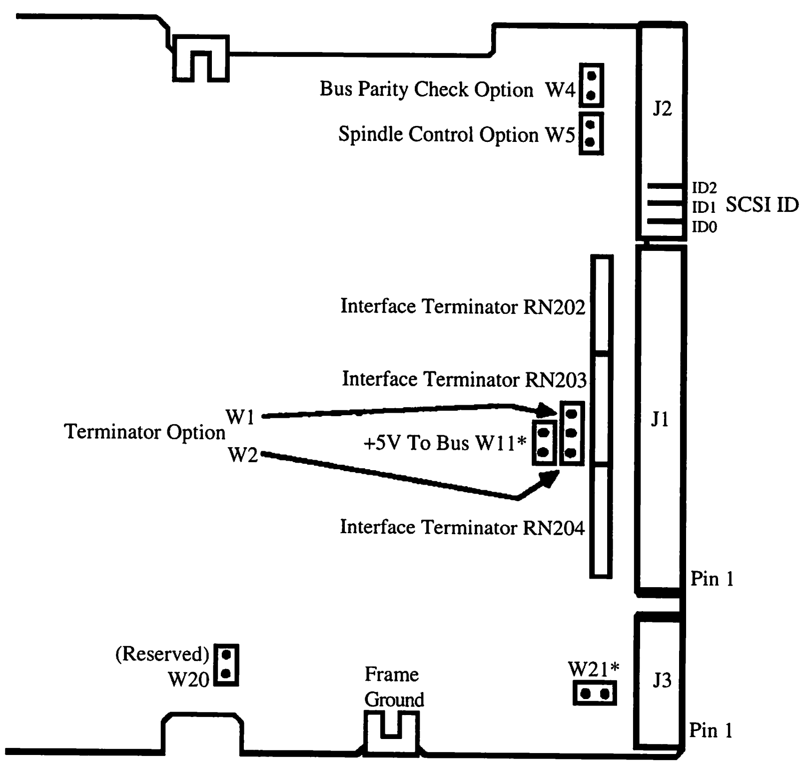


Figure 34 *– Micropolis 157X Jumper Settings*

Miniscribe 9380 E Drives

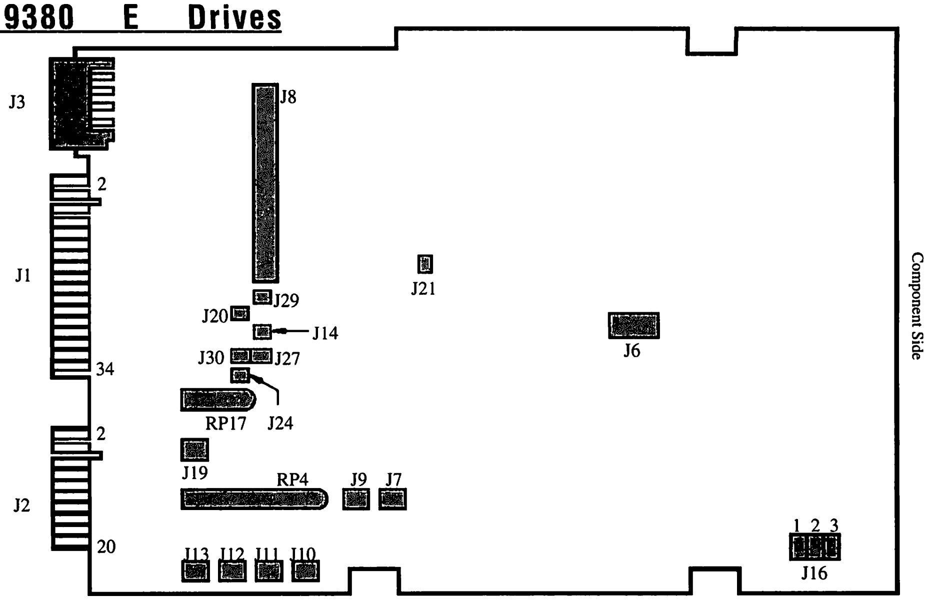


***Figure 35** – Miniscribe 9380E Jumper Locations*

***Table T** – 9380E Option Jumpers and Test Point Description*

Option Jumpers

J7	Start/Stop Spindle Motor Enable
J9	Diagnostic Jumper
J10 J11	Head Configuration

Heads	J10	J11
7	S	O
11	O	S
13	S	S
15	O	O

Sectors	J12	J13	J19	
34	S	O	O	
35	O	O	O	
36	O	S	O	
SOFT	S	S	S	(Controller will select Sector #)

Drive Select Address Configuration

Drive	J16-1	J16-2	J16-3
None	0	0	0
1	1	0	0
2	0	1	0
3	1	1	0
4	0	0	1
5	1	0	1
6	0	1	1
7	1	1	1

Terminators: RP4, RP17

Note: These 7 jumpers must be installed for drive operation:
J14, J20, J21, J24, J27, J29, and J30.

Miniscribe 9380S Drives

J701 is a group of two pairs of jumper pins. The first pair controls terminator power supplied by the target, while the second pair controls power supplied from elsewhere on the bus.

***Table U** – Miniscribe 9380S Jumper Settings*

SCSI TERMINATOR POWER		J701-1	J701-2
Local Terminator Power		ON	OFF
Remote Terminator Power		OFF	ON
Additional Jumper Definitions			
J7 J9 J10,J11 J12,J13,J19	Start/Stop Spindle Motor Enable Diagnostic Jumper Head Configuration Sector Setting		
Note: These 7 jumpers must be installed for drive operation: J14, J20, J21, J24, J27, J29, and J30.			
Terminating Resistors:	RP701 and RP702		
Drive Select Address	**J601-1**	**J601-2**	**J601-3**
SCSI Address 0	OFF	OFF	OFF
SCSI Address 1	OFF	OFF	ON
SCSI Address 2	OFF	ON	OFF
SCSI Address 3	OFF	ON	ON
SCSI Address 4	ON	OFF	OFF
SCSI Address 5	ON	OFF	ON
SCSI Address 6	ON	ON	OFF
SCSI Address 7	ON	ON	ON
SCSI Parity Enable	**J602-2**		
SCSI Parity Enabled	OFF		
SCSI Parity Disabled	ON		

Priam 514, 519

Table V *– Option/Select Switch Settings*

Position	Switch ON
POS-6	Priam Unique Mode
POS-5	Radial Option
POS-4	Drive Select 4
POS-3	Drive Select 3
POS-2	Drive Select 2
POS-1	Drive Select 1

Priam 617, 628, 638

Table W *– Drive Select Jumpers*

Drive Selected	Switch Position		
	1	2	3
NONE	OFF	OFF	OFF
1	ON	OFF	OFF
2	OFF	ON	OFF
3	ON	ON	OFF
4	OFF	OFF	ON
5	ON	OFF	ON
6	OFF	ON	ON
7	ON	ON	ON

Table X *– Sector Settings*

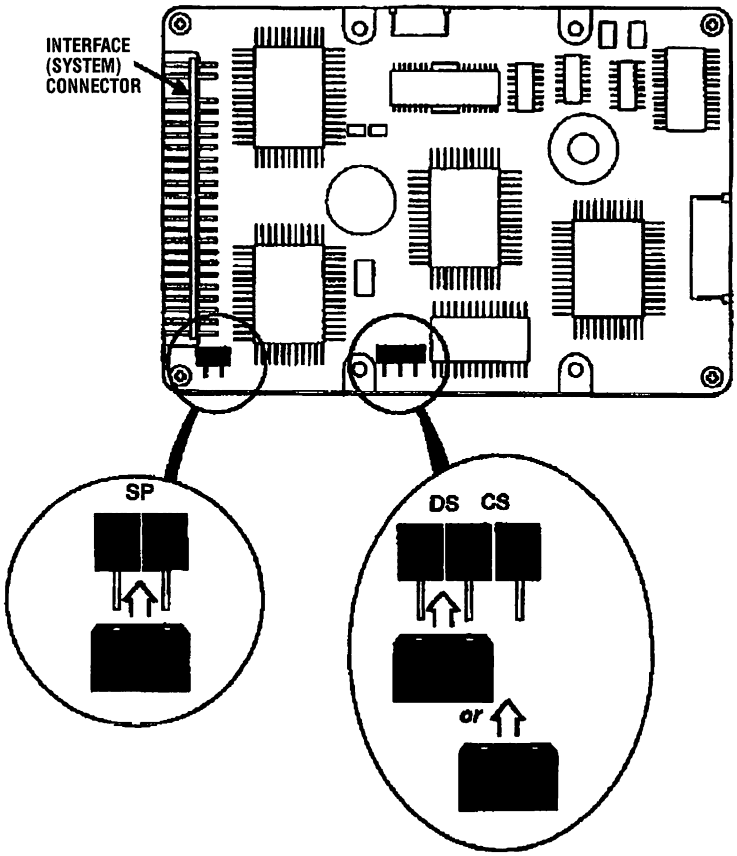
S1-4	S1-5	Physical Size in Bytes	Logical Size in Bytes	Track Capacity
OFF	OFF	Reserved Setting	-	-
OFF	ON	64 Sectors of 324	256	16,384
ON	OFF	36 Sectors of 578	512	18,432
ON	ON	19 Sectors of 1096	1024	19,456

Priam 717, 728, 738

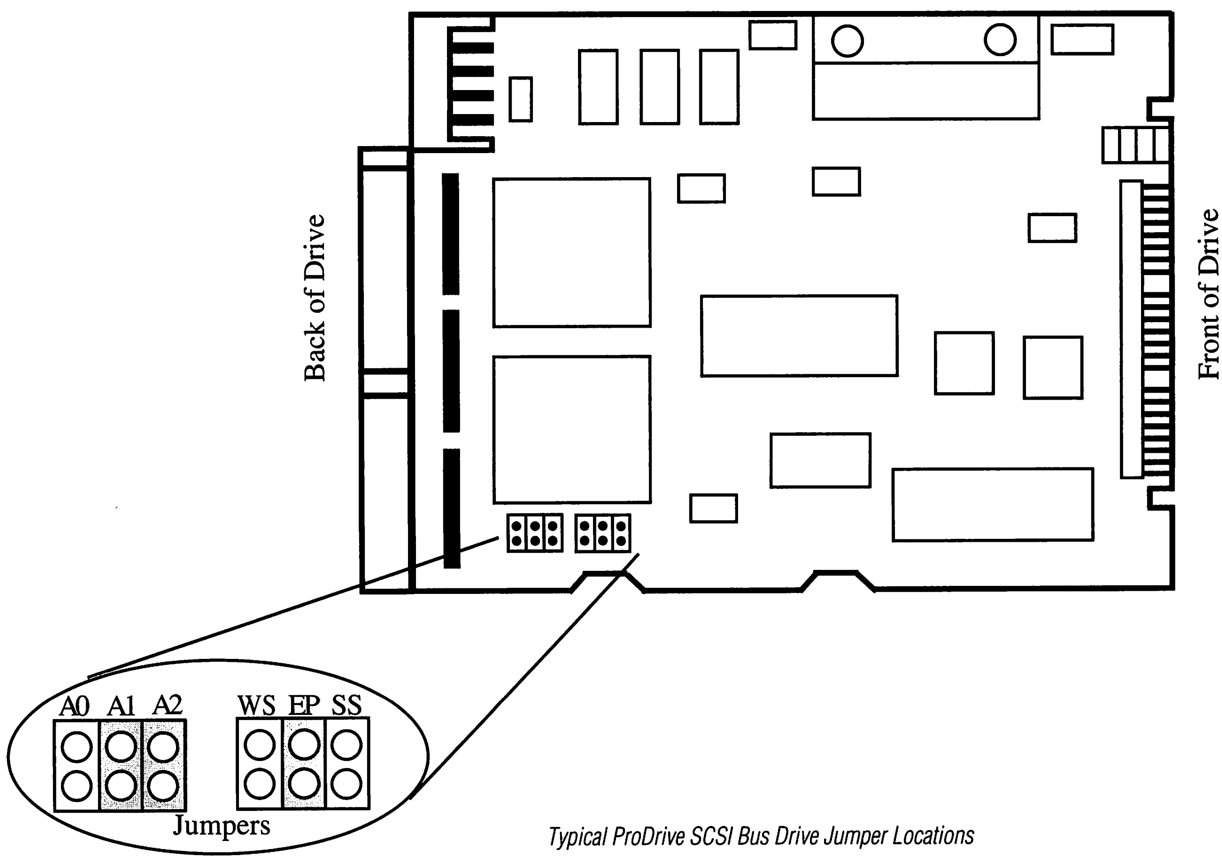
***Table Y** – Jumper Settings*

J11 Jumpers	Setting	Function	
1-2		Device ID 1	
3-4		Device ID 2	
5-6		Device ID 4	
7-8	ON	Auto Sequence Up	
9-10	ON	Parity Enable	
11-12	see below	Block Size 1	
13-14	see below	Block Size 2	
	11-12	**13-14**	
	OFF	OFF	Block Size set by Mode Select Command (15H)
	ON	OFF	256 Byte Blocks
	OFF	ON	512 Byte Blocks
	ON	ON	1024 Byte Blocks
15-16	ON	Unit Attention Disabled	
17-18	(output)	-Drive Ready	
19-20		Enable Write Protect	
Other Jumpers	**Setting**	**Function**	
W6*	Open	Soft SCSI Bus Reset	
W6**	Installed	Hard SCSI Bus Reset	
W5**	Installed	Auto Sequence Up Delay	
W3*	Installed	Terminator Power to J1-26	

Quantum Go-Drive AT Jumpers



Quantum PRODRIVE Series



Typical ProDrive SCSI Bus Drive Jumper Locations

Seagate 5.25" MFM/RLL Drives

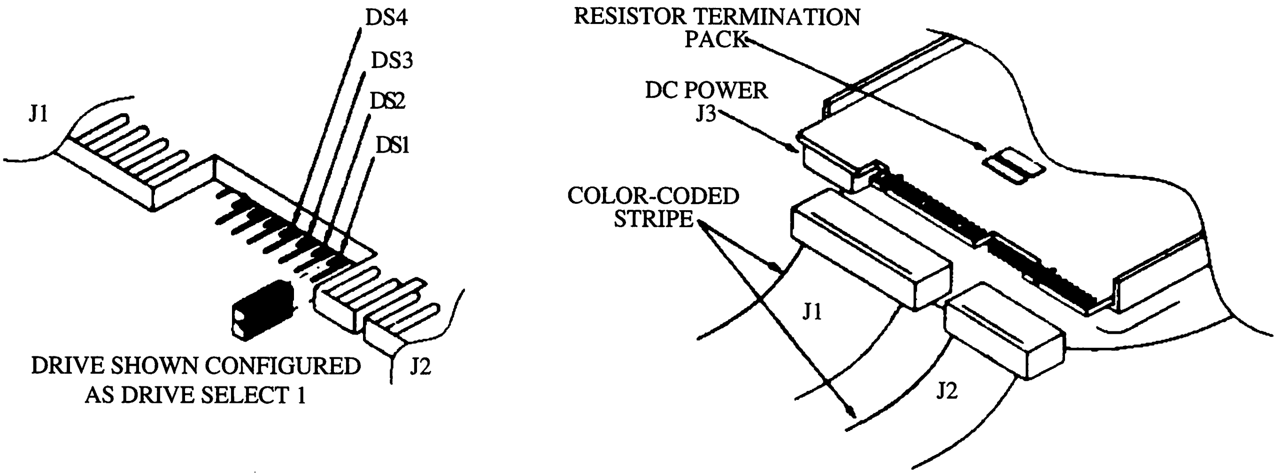


Figure 36 *– Half-Height Interface Connectors*

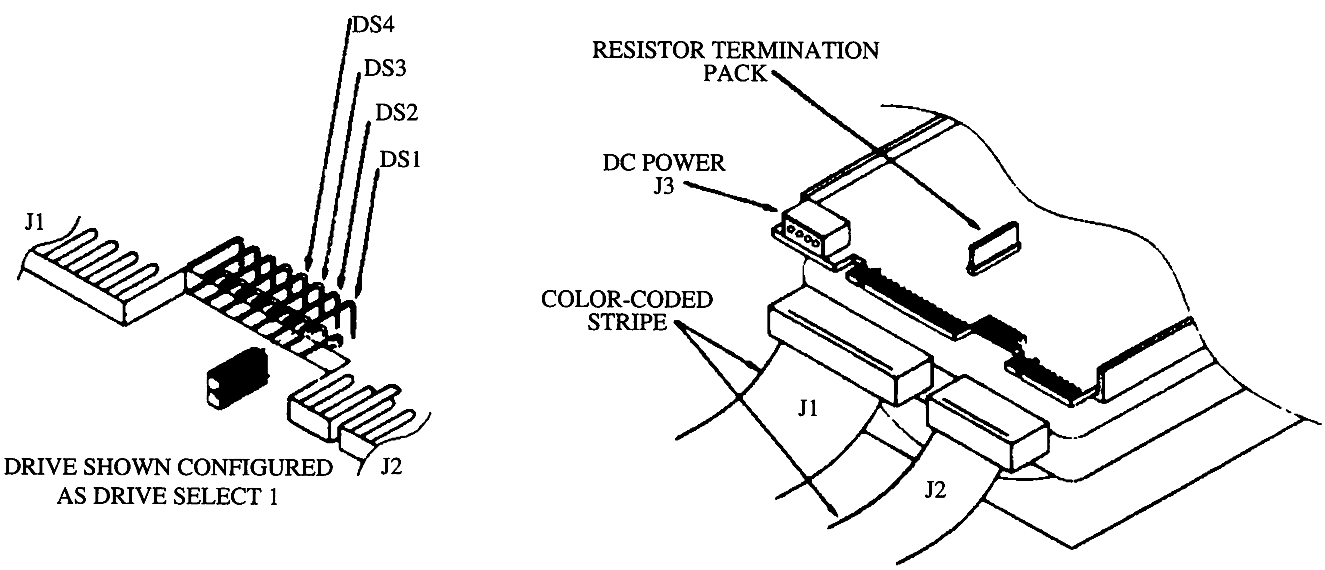


Figure 37 *– Full-Height Interface Connectors*

Seagate 3.5" MFM/RLL Drives

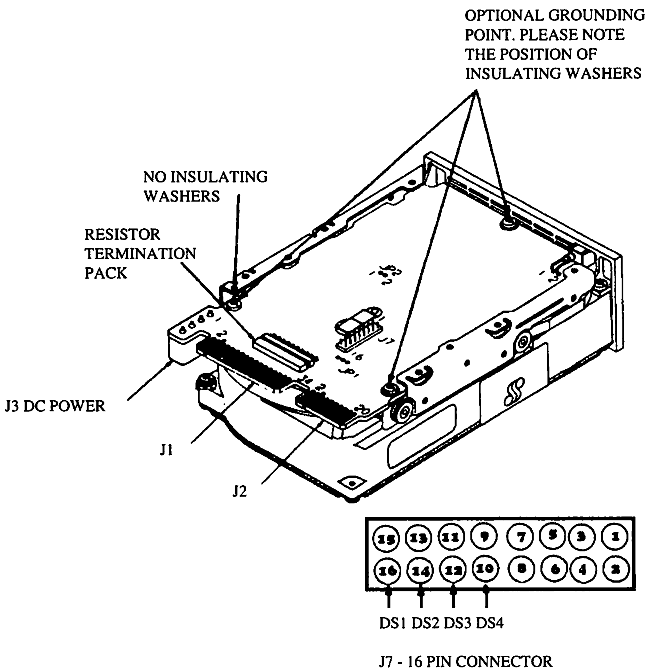


Figure 38 *– 3.5" Interface Connectors*

Seagate SCSI Drives

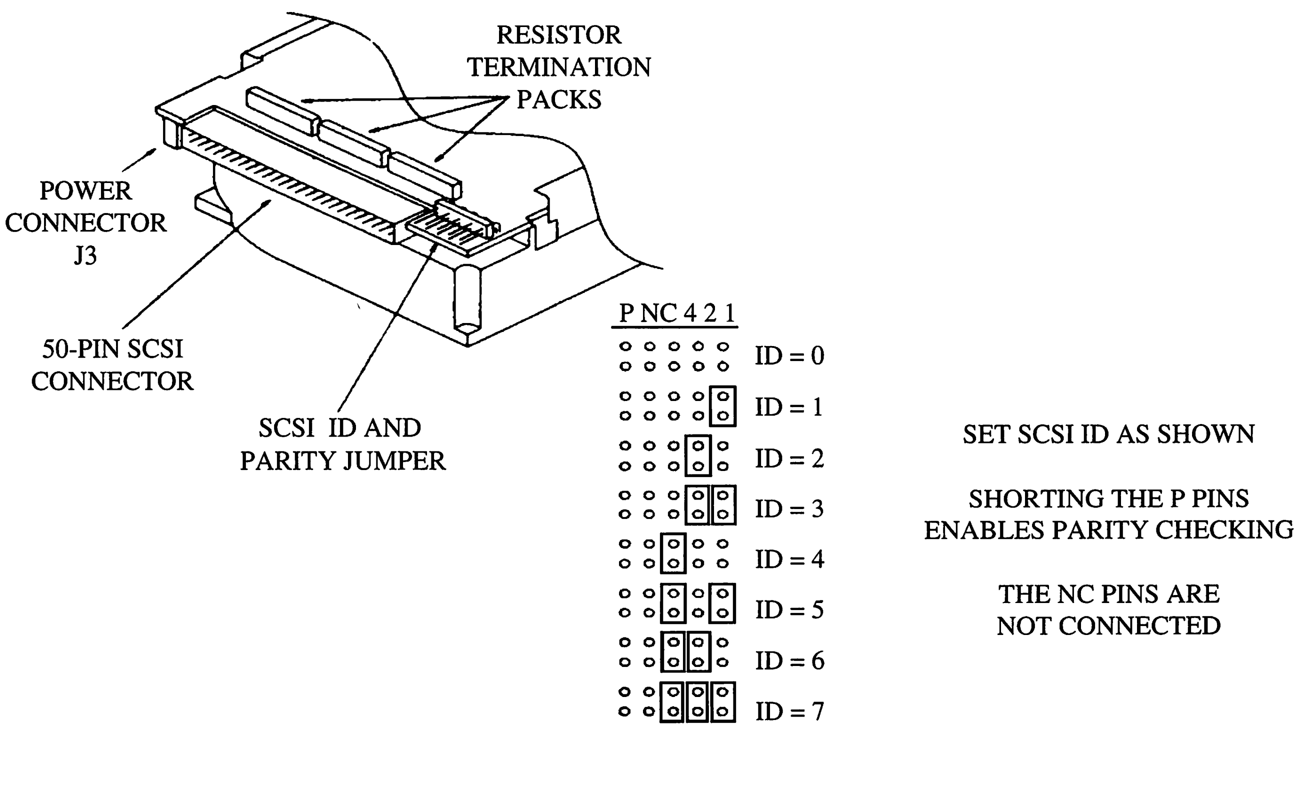
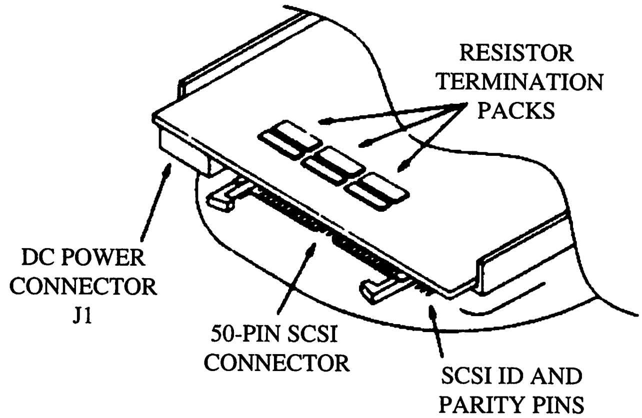
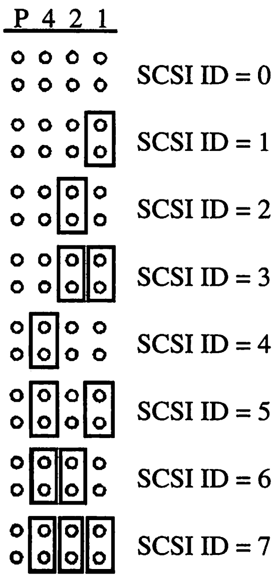


Figure 39 *– 3.5" SCSI Interface Connectors*

Seagate SCSI Drives (Continued)





SCSI ID JUMPERS

SELECT THE DESIRED SCSI ID WITH JUMPERS.
INSTALL THE OPTIONAL P-JUMPER TO ENABLE
PARITY.

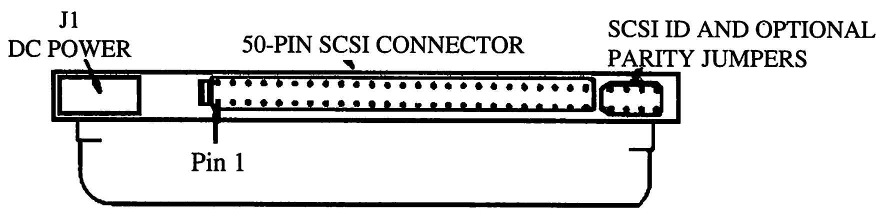


Figure 40 *– 5.25" SCSI Interface Connectors*

CSC Benchmark Tests

About The Benchmarks

CSC has selected several popular high performance drives and controllers for review on the following pages.

The average seek times listed are those purported by the manufacturer and what we actually tested. Seek times were tested on Flexstar testers of the type used for factory final test. The transfer rates listed are those achieved in our test platform computers. Our VESA test machines are typical 60MHz Pentium clone motherboards. Our ISA test machine has an OPTI chipset set to a 12.5MHz AT-bus speed. Our EISA machine uses an Intel chip set. The transfer rates are the average of several random and sequential tests.

We have included the manufacturers reliability rating in power on hours (POH). One year of continuous operation is 8760 POH. So a drive with a Mean Time Between Failures (MTBF) rating of 50,000POH, should last for an average of 5.7 years before failing. The MTBF rating for drives which are operated at elevated temperatures or used in heavy seek applications (such as network servers) should be derated by 50%. Since higher MTBF specifications translate into higher sales for drive manufacturers, this specification is often exaggerated. Experience has taught us not to take MTBF ratings over 100,000 too seriously.

Factory MTBF figures often include an ambiguous correction factor for "infant mortality." Since CSC also sells and services drives, we have included our own off the record comments on reliability. These comments are based on the number of drives returned to us for service.

SCSI DRIVES

MAXTOR MODEL MXT-1240S
Formatted Capacity - 1200 MB
Rated Average Seek - 8 ms
Tested Average Seek - 7.8 ms
Transfer Rate - 20-44 Mbit/sec
Servo System - Embedded
Rated MTBF - 250,000 POH
Average transfer rate in VESA test with CSC VESA FastCache - 3300 KB/sec

The Maxtor "magic" is the highest performance 3.5" Maxtor drive available. Although Maxtor only rates this drive at 200,000 POH, our service department found a high return rate on early drives due to thermal offtrack problems. These problems appear to be solved in the newer revisions, and this top performer now appears nearly as reliable as it's famed 5.25" counterparts.

IBM MODEL 0662 (*Martin's Choice!)
Formatted Capacity - 4030 MB
Rated Average Seek - 10 ms
Tested Average Seek - 9.2 ms
Transfer Rate - 36-48 Mbit/sec
Servo System - Embedded
Rated MTBF - 200,000 POH
Transfer rate in ISA test system with CSC FastCache - 2120 KB/sec
Average transfer rate in VESA test with CSC VESA FastCache - 3300 KB/sec

The IBM 0662 is a unique drive in that it is actually a striped disk array comprised of two 3.5" drives built into a 5.25" form factor. The imbedded SCSI-II array controller has 1MB of cache, and overall performance is excellent. Sustained data transfer rates on outer tracks reached almost 7MB/sec in sequential mode. The 0662 is a solid design built upon the field proven 3.5" 0664 series HDA's with MR heads. These drives are popular in network servers and other applications where long term reliability is imperative.

MAXTOR MODEL 7545S
Formatted Capacity - 540 MB
Rated Average Seek - 10 ms
Tested Average Seek - 10.8 ms
Best Transfer Rate - 3180 KB/sec
Servo System - Embedded
Rated MTBF - 300,000 POH
Transfer rate in ISA test system - 1420 KB/sec
Average transfer rate in VESA test - 1780 KB/sec

Maxtor's 7545 is their current "top of the line" 3.5" drive. We were able to sneak out an evaluation unit before production shipping. To be honest, we were less than impressed. The 7545 ran smoothly and quietly, but performance was mediocre at best. In terms of transfer rates, performance was fair.

IDE DRIVES

MAXTOR MODEL LXT 535 A
Formatted Capacity - 535 MB
Rated Average Seek - 15 ms
Tested Average Seek - 15.3 ms
Transfer Rate - 155 MB/sec sustained
Servo System - Embedded
Rated MTBF - 150,000 POH
Transfer rate in ISA test system with FlashCache64 1550 KB/sec

Maxtor's LXT drive series uses an innovative shock mounting system which is not found in any other 3.5" drive we've seen. Since 3.5" drives often end up in laptop and portable computers which are subject to rough handling, good shock mounting and a good head latch mechanism are important. The Maxtor LXT series uses rubber shock mounts to suspend the entire HDA within an aluminum shell. A nice side effect of this mounting system is that the drive is extremely quiet. These drives are so quiet, that it's nearly impossible to tell when they are spinning

The SCSI version of Maxtor's LXT-200 series uses the same quiet, rugged HDA as the IDE version mentioned above. This drive also uses a 3 zone recording technique to achieve high capacity without sacrificing reliability. This drive is our first choice in a large capacity 3.5" unit.

MAXTOR MODEL 7245A
Formatted Capacity - 245 MB
Rated Average Seek - 15 ms
Tested Average Seek - 15.3 ms
Transfer Rate - 1120 KB/sec
Servo System - Embedded
Rated MTBF - 150,000 POH
Transfer rate in ISA test system - 1120 KB/sec

Maxtor's 7000 series drives in 340MB and 245MB capacities feature a reduced parts count. To the manufacturer, that translates into more profit. As Lee Iococa said, "Parts left out never require service." These simple drives are also highly reliable. The 7245 model is an evolutionary successor to the field proven 7213. Firmware and zone changes are probably the only differences. These drives are quite reliable, but also more sensitive to shock than most. These are a great low cost choice for building up inexpensive PC clones.

SCSI Controllers

Manufacturer....................Adaptec
Model...............................1542CF
Bus...................................ISA

Adaptec has been building SCSI controllers longer than anyone, and they are the standard for compatibility. The "EZ-SCSI" software offers easy integration into UNIX, Novell, and OS/2 environments. One small disadvantage to these ISA based bus mastering controllers is that performance may decrease when more than 16MB of memory is installed. The overall performance of these industry standard Adaptec cards is superior most of the DPT and Ultrastor cards we have tested.

Manufacturer......................CSC
Model................................FastCache64
Cache................................Up to 64MB
Bus....................................ISA

CSC has sold thousands of drives for PC applications. In response to customer demands for a low cost caching SCSI controller, we have designed and developed the CSC FlashCache 64. This board supports up to 7 SCSI devices (including tape, WORM, M-O optical, and hard drives) and includes a 4 drive floppy controller which supports the new 2.88MB 3.5" drives. Since the size of the on-board cache is frequently the limiting factor in caching card performance, our engineers designed the board to expand up to 64MB using standard SIMMS.

These cards have proven extremely effective in PC workstation applications and work great with Microsoft DOS and Windows™. Although we are slightly biased, we feel that the FlashCache 64 still represents on of the best ISA controller buys on the market.

Manufacturer........CSC
Model..........VESA AK-47 SCSI-II Controller
Cache....................None
Bus........................VESA VL-Bus

When we upgraded our own PC's to local bus video, we wondered what the extra VL-BUS slot was for. Out of necessity, we designed the VESA FASTCACHE. Our technicians nicknamed it the AK-47 or "Adaptec Killer". This board uses one of the fastest SCSI chips available and connects it directly to the high speed local bus! This board offers almost all of the features of the CSC FastCache with much higher performance. Flash BIOS, 2.88MB support, 4 floppy operation and SCSI-II compatibility are all standard. The second production fun of these cards is available now, and the new caching version should be available soon after the seventh Hard Drive Bible is printed. Want more information? Call us today and let us send you the specifications.

Manufacturer........CSC
Model....................VESA VLB Wide SCSI-II Cache Blaster
Cache...................128K of 20ns Fast SRAM
Bus........................VESA

When some of our engineers weren't satisfied with the performance of the AK-47, they decided to go all out! We decided to incorporate an ultra fast SRAM Cache for top performance in multitasking environments and switch to WIDE SCSI. The wide SCSI interface can double performance in most applications, and the FAST 32 bit wide level - II SRAM cache means the motherboard almost never has to wait for data! This board includes all the features of the original AK-47 like Flash BIOS, 2.88MB support and 4 floppy operation. Call today for more information on this hot new product.

Manufacturer..................DTC
Model..............................3290
Cache..............................4MB
Bus.................................EISA

Many network servers use both EISA motherboards and SCSI disk drives. The DTC 3290 offers a low cost solution which supports up to 7 SCSI devices. The 3290 offers an "Adaptec compatible" mode which mimics the hardware "mailbox" interface of the Adaptec 154X series of controllers. This compatibility mode is ideal for UNIX and Novell versions which have Adaptec support built into the kernel. The overall performance of the DTC 3290 is superior to the DPT and Ultrastor cards we have tested.

Manufacturer..................DTC
Model.............................3280A
Cache..............................None
Bus.................................ISA

The 3280 is the best buy we've found in a low cost SCSI controller. Software drivers are available for Novell, DOS, OS/2 and Xenix. These controllers work well in nearly all motherboards. At under $100 wholesale, the price/ performance ratio can't be beat.

Floppy Drives

At present, the computer industry seems to have standardized on the 5 floppy drives listed below. 1.2 and 1.44MB drives are the most popular, although low density 360K diskettes are most commonly used for software distribution.

Note: some early 1.2MB drives used a data transfer rate of 300KHz when reading 360K disks.

Industry Standard Floppy Drives

Capacity	Tracks	Transfer Rate	Form Factor	Tracks/Inch
360K	40	250KHz	5.25"	48
1.2 MB*	40/80	250/500KHz	5.25"	48/135
720K	40	250KHz	3.50"	48
1.44MB	40/80	250/500KHz	3.50"	48/135
2.88MB	80	1000KHz (1MHz)	3.50"	135

The floppy drive list below is designed to aid in identifying some of the more common floppy drives.

Manufacturer	Model Number	Capacity	No. of Tracks	Form Factor
ALPS	FDD-2124	180KB	40	5.25 HH
AT&T	KS-23114	720KB	80	5.25 HH
AURORA TECH	FD350 (SCSI)	-	-	3.50 HH
	FD525 (SCSI	-	-	5.25 HH
CANNON	531	360KB	40	5.25 HH
	MD 5501	1.2MB	80	5.25 HH
CDC	9409	360KB	40	5.25 FH
	9409T	720KB	80	5.25 FH
	9429	720KB	80	5.25 HH
CHINON	FJ205	1.44MB	135	2.00
	C354	720KB	80	3.50 HH
	C359	1.44MB	80	3.50 HH

Manufacturer	Model Number	Capacity	No. of Tracks	Form Factor
CHINON (Con't)	C502	360KB	40	5.25 HH
	C506	1.2MB	80	5.25 HH
	F2506	1.2MB	80	5.25 HH
EPSON	SMD-1040	1.44MB	135	3.50 HH
	SMD-340	1.44MB	135	3.50 HH
	SMD-349	1.4MB	135	3.50 HH
	SMD-380	720KB	80	3.50 1"
	SMD-389	720KB	80	3.50 HH
	SD-520	360KB	40	5.25 HH
	SD-521	360KB	40	5.25 HH
	SD-621L	360KB	48	5.25 HH
	SD-680L	1.2MB	96	5.25 HH
IBM	1006	1.2MB	80	5.25 HH
	1027	720KB	80	3.50 HH
	1056	720KB	80	3.50 HH
	1063	1.44MB	80	3.50 HH
	1066	1.2MB	80	5.25 HH
	1072	1.44MB	80	3.50 1"
	1106	2.88MB	-	3.50 1"
	3057	1.44MB	80	3.50 HH
FUJITSU	M2532	720KB	80	3.50 HH
	M2537	1.44MB	80	3.50 HH
	M2551A	360KB	40	5.25 FH
	M2552A	720KB	96	5.25 FH
	M2553A,K	1.2MB	80	5.25 FH

Manufacturer	Model Number	Capacity	No. of Tracks	Form Factor
MITSUBISHI	MF353AF,B,BA,C	720KB	135	3.50 HH
	MF355A,AF,B,C	1.44MB	135	3.50 1.0"
	4852	360KB	40	5.25 FH
	4853	720KB	80	5.25 HH
	4854	1.2 MB	80	5.25 HH
	MF501A,B,C	360KB	48	5.25 HH
	MF504A,B,C	1.2MB	96	5.25 HH
	289-63	-	-	8.00 HH
MITSUMI	D 352T2	2.88MB	80	3.50 1"
	D 357P	720KB	80	3.50 HH
	D 359P	1.44MB	80	3.50 HH
	D503V	360KB	40	5.25 HH
	D509V	1.2MB	80	5.25 HH
MPI	51-S	180KB	40	5.25 HH
	52-S	360KB	40	5.25 FH
NEC	FD-1335H	1.44MB	80	3.50 1.0"
	FD-1157C	1.2MB	80	5.25 HH
	FD-1165FQ	-	-	8.00 HH
OLIVETTI	XM4311	360KB	40	5.25 HH
PACIFIC RIM	U1.44	1.44MB	80	3.50 HH
	U4	2.88MB	80	3.50 1.0"
	U720	720KB	80	3.50 HH
	U1.2	1.2MB	80	5.25 HH
	U360	360KB	40	5.25 HH

Manufacturer	Model Number	Capacity	No. of Tracks	Form Factor
PANASONIC	JU-257	1.44MB	80	3.50 1"
	JU-259A	2.88MB	80	3.50 1"
	JU-475	1.2MB	80	5.25 HH
QUME	542	360KB	40	5.25 FH
	842	-	-	8.00 FH
SANYO	FDA-5200	360KB	40	5.25 HH
SEIKO	8640	720KB	80	5.25
SHUGART	SA400L	180KB	40	5.25 FH
	SA455	360KB	40	5.25 HH
	SA460	360KB	40	5.25 FH
	SA800-1	-	-	8.00 FH
	SA800-2	-	-	8.00 FH
	SA860	-	-	8.00 HH
	SA900-1	-	-	8.00 FH
SIEMENS	FDD100-5	180KB	40	5.25 FH
SONY	MPF-11	720KB	135	3.50 HH
	MPF-17	1.44MB	135	3.50 HH
TANDON	65-4	720KB	80	5.25 HH
	65-8	1.2MB	80	5.25 HH
	75-8	1.2MB	80	5.25 HH
	TM100-1A	180KB	40	5.25 FH
	TM100-2A	360KB	40	5.25 FH
	TM100-4	720KB	80	5.25 FH
	TM101-4A	720KB	80	5.25 FH

Manufacturer	Model Number	Capacity	No. of Tracks	Form Factor
TANDON (Con't)	848-02	-	-	8.00
TEAC	FD-235FN	720KB	135	3.50 1.0"
	FD-235HFN	1.44MB	135	3.50 1.0"
	FD-235J	2.88MB	135	3.50 1.0"
	FD-50A	180KB	40	5.25 FH
	FD-55A	180KB	40	5.25 HH
	FD-55BR,BV	360KB	40	5.25 HH
	FD-55E	360KB	40	5.25 HH
	FD-55FV	720KB	80	5.25 HH
	FD-55GFR,GFV,GR	1.2MB	80	5.25 HH
TEC	FB501	180KB	40	5.25 HH
TOSHIBA	FDD4603	720KB	80	3.50 HH
	FDD 6471	360KB	40	5.25 FH
	FDD6784	1.2MB	80	5.25 HH
	FDD6882	1.2MB	80	5.25 HH
	ND-3521	720KB	80	3.50 1.0"
	ND-354A	720KB	80	3.50 1.0"
	ND-3561	1.44MB	80	3.50 1.0"
	PD-211	2.88MB	80	3.50 1.0"
	ND-0401	360KB	40	5.25 HH
	ND-0801	1.2MB	80	5.25 HH
YE-DATA	646	720KB	80	3.50 HH

Optical Disk Drive Technology

There is a constant struggle between the optical and magnetic disk drive manufacturers. Respected industry analysts have predicted that optical drives will replace magnetics in the near future. But hard drive designs keep improving and optical drive manufacturers constantly struggle to approach the capacity and performance of magnetic drives.

In theory, the density of optical media can exceed that of magnetic media. In practice, an optical disk drive engineer faces the same problems encountered in hard drive design. Recording density is limited by the ability to design a manufacturable system with precise mechanical alignment.

The main advantage of today's optical storage devices is removability. Nearly all optical drives feature rugged removable media. This optical media is generally much less expensive than an equivalent hard disk. At the time of this printing a good 1GB magnetic hard disk drive costs around $1000. The equivalent optical drive about $1500. The performance of the magnetic drive is roughly twice that of the optical drive. But adding an additional 1GB by purchasing an extra optical cartridge costs only $150. The total cost for 3GB of storage with the optical drive is $1950, but the total cost of a magnetic system is $3000! Optical removability makes sense in applications where large amounts of data can be partitioned on cartridges but must be stored with immediate access. Optical drives are popular in applications like online network backup and graphic image storage.

Optical disk drives can be divided into three basic categories: CD-ROM, WORM, and Erasable. CD-ROM drives are read-only devices. CD-ROM disks are mass produced from a glass master using expensive equipment. The cost of producing a CD-ROM disk using this equipment is low in volume. CD-ROM's produced one at a time are called "one-off" disks. One-off's are produced using a CD compatible WORM disk.

CD-ROM drives

CD-ROM disks are the future of software distribution. Instead of distributing programs floppy diskettes, software manufacturers are switching to CD-ROM. In quantity, a 650MB CD-ROM costs around 65¢ to produce. This compares with a cost of 25¢ each for six 1.44MB floppy diskettes. The immense storage capacity, low production cost, and inherent difficulties in making unauthorized copies make CD-ROM attractive to software manufacturers. When this article was written, the cost of a CD-ROM drive in large quantity had dropped below $100.

WORM Drives

The acronym W.O.R.M. stands for Write Once, Read Many. WORM drives use a laser to ablate (burn) tiny pits in optical media. Once these pits are burned, they cannot be erased. The WORM compensates for this limitation by offering immense storage capacity and removable media. WORM media is also usually much cheaper than erasable optical media.

Driver software is used with WORM drives so that the inability to erase is invisible to the operating system. When files are erased or changed, the old files are mapped out and the available capacity of the WORM disk decreases.

Though the present trend is moving away from WORM drives toward erasable optical drives, the low cost and good performance of WORM drives still offers an economical solution for data storage where fast access is required.

Erasable Optical Drives

Modern erasable optical drives offer an alternative to large capacity magnetic drives. Although the performance and reliability of erasable optical drives has not yet matched magnetic drives, removability makes them attractive in many applications.

Erasable optical drives do not require driver software for most operating systems since they are functionally identical to hard disk drives. Driver software is needed only for "hot cartridge" changing of the media while operating system is running.

Newer erasable opticals record on both sides of the media and store 1000MB or more (unformatted) per cartridge. Erasable optical media is constantly coming down in price, and is now cost-effective for on-line backup.

The newer MaxOptics erasable optical drives offer access times approaching hard disks. These drives are among the highest performance optical drives available.

Optical Drive Specifications

Optical Drive List

Manufacturer	Model Number	Form Factor	Type	Capacity	Access Time	Interface	Media	Audio
A.D.I.C	Data Optic 600	5.25	WMRM	594MB	67ms	SCSI	-	-
A.D.S.I.	MQO-151	5.25	WMRM	594MB	95ms	SCSI	-	-
	MVO-151	5.25	WMRM	594MB	95ms	SCSI	-	-
	MZO-151	5.25	WMRM	594MB	95ms	SCSI	-	-
	Optical/HSC	5.25	WMRM	594 MB	95ms	SCSI	-	-
Accel	AEO650	5.25	WMRM	650MB	95ms	SCSI	-	-
Allegro	PVCD650S	5.25	RO	650MB	340ms	Prop.	-	-
Alphatronix	IDQ10-M	5.25	WMRM	650MB	83ms	Q-BUS	-	-
	IDQ20-D,T,S,R	5.25	WMRM	1300MB	83ms	Q-BUS	-	-
	IDU10-M	5.25	WMRM	650MB	83ms	UNIBUS	-	-
	IDU20-D,T,S,R	5.25	WMRM	1300MB	83ms	UNIBUS	-	-
	IMC10-M	5.25	WMRM	616MB	83ms	SCSI(M)	-	-
	IMC20-D,T,S,R	5.25	WMRM	1232MB	83ms	SCSI(M)	-	-
	IPA10-M	5.25	WMRM	650MB	83ms	XT/AT	-	-
	IPA20-D,T,S,R	5.25	WMRM	1300MB	83ms	XT/AT	-	-
	IPN10-M	5.25	WMRM	650MB	83ms	XT/AT	-	-
	IPN20-D,T,S,R	5.25	WMRM	1300MB	83ms	XT/AT	-	-
	IPS10-M	5.25	WMRM	650MB	83ms	MCA	-	-
	IPS20-D,T,S,R	5.25	WMRM	1300MB	83ms	MCA	-	-

Optical Drive List (Continued)

Manufacturer	Model Number	Form Factor	Type	Capacity	Access Time	Interface	Media	Audio
Alphatronix (Con't)	ISS10-M	5.25	WMRM	592MB	83ms	SCSI(S)	-	-
	ISS20-D,T,S,T	5.25	WMRM	1184MB	83ms	SCSI(S)	-	-
APT Odessa	ROS-3250EIS	5.25	WMRM	560MB	107ms	SCSI	-	-
Apple Computer	CD SC	5.25 FH	-	550MB	600ms	SCSI-M	Disk	Yes
Arix Computer	RO-5030E	5.25	WMRM	652MB	67ms	SCSI	-	-
ASC	MO-55	5.25	WMRM	596MB	49ms	SCSI	-	-
CD Technology	T3201 Portadriv	5.25 FH	-	-	350ms	SCSI-M	Disk	Yes
Chinon	CDA-431	5.25 HH	-	550MB	350ms	SCSI-M	-	Yes
	CDS-431	5.25 HH	-	550MB	350ms	SCSI	-	Yes
	CDX-431	5.25 HH	-	550MB	350ms	SCSI	-	Yes
Concurrent	R/W Optical	5.25	WMRM	1000MB	49ms	SCSI	-	-
Consan,Inc	RS600/N	5.25	WMRM	596MB	67ms	SCSI	-	-
Corel Systems	650-MO	5.25	WMRM	650MB	95ms	SCSI	Cart	-
Deltaic Systems	OptiServer 600	5.25	WMRM	595MB	67ms	SCSI	-	-
	OptiServer 600P	5.25	WMRM	595MB	67ms	SCSI	-	-
Denon	DRD-253	5.25 HH	RO	-	400ms	SCSI	-	Yes
Dolphin System	Sonar-600S	5.25	WMRM	600MB	95ms	SCSI	-	-
Dynatek Systems	DROS600	5.25	WMRM	1200MB	50ms	SCSI	-	-
	MOS1600	5.25	WMRM	600MB	50ms	SCSI	-	-
	MOS2600	5.25	WMRM	600MB	50ms	SCSI	-	-
	MOS3600	5.25	WMRM	600MB	50ms	SCSI	-	-

Optical Drive List (Continued)

Manufacturer	Model Number	Form Factor	Type	Capacity	Access Time	Interface	Media	Audio
Dynatek Systems (Con't)	ROS600	5.25	WMRM	600MB	50ms	SCSI	-	-
Exsys Storage	Laser RA-2M	5.25	WMRM	934MB	35ms	SDI	-	-
	Laser RA-2S	5.25	WMRM	574MB	95ms	SDI	-	-
	Laser RA-4M	5.25	WMRM	1868MB	35ms	SDI	-	-
	Laser RA-4S	5.25	WMRM	1188MB	95ms	SDI	-	-
	Laser RA-7M	5.25	WMRM	3269MB	35ms	SDI	-	-
	Laser RA-7S	5.25	WMRM	2079MB	95ms	SDI	-	-
FWB	Hammerdisk 1000	5.25	WMRM	1000MB	35ms	SCSI	-	-
	Hammerdisk 600S	5.25	WMRM	574MB	107ms	SCSI	-	-
General Micro	MO/D 220	5.25	WMRM	924MB	35ms	SCSI(S)	-	-
Genstar	2000	5.25	RO	650MB	450ms	Prop.		
Herstal	50652A	5.25	WMRM	652MB	44ms	SCSI	-	-
	51000A	5.25	WMRM	1000MB	35ms	SCSI	-	-
Hewlett-Packard	50720A	5.25 HH	RO	-	500ms	PRO	-	-
	C1711A	5.25	WMRM	650MB	107ms	SCSI	-	-
Hitachi	CDR-1700S	5.25	RO	600MB	350ms	SCSI	Disk	-
	CDR-1750S	5.25	RO	600MB	320ms	SCSI	-	-
	OD-112-1	5.25	WMRM	644MB	75ms	SCSI	-	-
IBM	3510-001	5.25	RO	600MB	380ms	SCSI	-	yes
	0162	3.50	WMRM	-	-	SCSI	-	-
Laser Magnetics	CM-201	5.25 HH	RO	600MB	500ms	IDE	Cart	Digital
	CM-212	5.25 HH	RO	600MB	400ms	SCSI	Cart	Digital

Optical Drive List (Continued)

Manufacturer	Model Number	Form Factor	Type	Capacity	Access Time	Interface	Media	Audio
Laser Magnetics (Con't)	CM-221	5.25 HH	RO	600MB	500ms	IDE	Cart	Analog
	CM-231	5.25 HH	RO	600MB	400ms	SCSI	Cart	Analog
	LM-510	5.25 FH	WORM	654MB	61ms	SCSI	Cart	-
	LM-520	5.25 FH	WMRM	654MB	70ms	SCSI	Cart	-
	LD-4100	Rack	WMRM	5.6GB	80ms	SCSI	Cart	-
	LF-4500	Rack	WMRM	28.0GB	80ms	SCSI	Cart	-
M.O.S.T.	RMD-5100-S	3.50 HH	WMRM	128MB	35ms	SCSI	-	-
Macsetra	Genesis 6000i	5.25	WMRM	600MB	95ms	SCSI	-	-
Maxcess	M-600L	5.25	WMRM	600MB	95ms	SCSI	-	-
Maxoptix	RXT-800HS	5.25 HH	WORM	786MB	108ms	SCSI	Cart	-
	Tahiti	5.25 FH	WMRM	1GB	35ms	SCSI	Cart	-
Meridian	100T Network	5.25 HH	RO	-	250ms	-	Disk	N/A
Micro Design	Laserbank 600CD	5.25 HH	RO	600MB	350ms	SCSI	Disk	Yes
	Laserbank 600R	5.25	WMRM	650MB	65ms	SCSI	-	-
Micronet	SB-SMO/DOS	5.25	WMRM	586MB	107ms	SCSI	-	-
Mirror Technology	CDR-10	5.25	RO	600MB	350ms	SCSI	Disk	Yes
	RM600	5.25	WMRM	594MB	61ms	SCSI	-	-
Mitsubishi	MW-5D1	5.25 FH	-	300MB	63ms	ESDI	-	-
	MW-5U1	5.25 FH	WORM	300MB	68ms	SCSI	-	-

Optical Drive List (Continued)

Manufacturer	Model Number	Form Factor	Type	Capacity	Access Time	Interface	Media	Audio
NEC	CDR-73	5.25 HH	RO	600MB	300ms	SCSI	-	Yes
N/Hance Systems	R6501mce-DOS, LAN, OS2	5.25	WMRM	650MB	95ms	SCSI	-	-
	R6501sce-DOS, LAN, MAC	5.25	WMRM	650MB	95ms	SCSI	-	-
	R6501sci-DOS	5.25	WMRM	650MB	95ms	SCSI	-	-
	W6501	5.25	WMRM	594MB	107ms	SCSI	-	-
Ocean	Tidalwave 650	5.25	WMRM	564MB	107ms	SCSI	-	-
Online Products	OPC-OSU-202	5.25 HH	RO	600MB	350ms	SCSI,P	Disk	N/A
Optima	Concorde	5.25	WMRM	564MB	107ms	SCSI	-	-
Panasonic	LF-5010	5.25 FH	WORM	940MB	90ms	SCSI-2	Cart	-
	LF-7010	5.25 HH	WMRM	1000MB	90ms	SCSI-2	Cart	-
Pinnacle Microsystems	REO-130	5.25 HH	RO	128MB	28ms	SCSI,M	Disk	Opt
	REO-1300	5.25 FH	WMRM	1300MB	65ms	SCSI,M	Disk	Opt
	REO-650	5.25 FH	WMRM	650MB	65ms	SCSI,M	Disk	Opt
	REO-6500	5.25 FH	RO	6500MB	65ms	SCSI,M	Disk	Opt
	REO-36000	5.25 FH	RO	36000MB	65ms	SCSI,M	Disk	Opt
Pioneer	DD-U5001	5.25 FH	-	654MB	60ms	SCSI	Cart	-
	DE-S7001	5.25	WMRM	654MB	53ms	SCSI	Cart	-

Optical Drive List (Continued)

Manufacturer	Model Number	Form Factor	Type	Capacity	Access Time	Interface	Media	Audio
Pioneer (Con't)	DE-U7001	5.25 FH	WMRM	654MB	53ms	SCSI	Cart	-
	DRM-600	5.25 FH	RO	6x540MB	600ms	SCSI	Disk	Yes
	DD-8001	8.00 FH	WMRM	1500MB	250ms	SCSI	Cart	-
	DJ-1	8.00	WMRM	1500MB	250ms	SCSI	Cart	-
PLI Peripherals	Infinity Optical	5.25 FH	WMRM	562MB	107ms	SCSI	Cart	-
	CD-ROM	5.25	RO	600MB	380ms	SCSI	-	-
Procom Technology	MCDRom-650	5.25 HH	RO	-	350ms	SCSI,M	Disk	Yes
	MEOD650/E	5.25	WMRM	568MB	107ms	SCSI	-	-
Reference Technology	500AT Dual SCSI	5.25 HH	RO	-	500ms	SCSI	Disk	Optical
	500AT External	5.25 HH	RO	-	500ms	PRO	Disk	Optical
	500AT Ext.SCSI	5.25 HH	RO	-	500ms	SCSI	Disk	Optical
	500AT Internal	5.25 HH	RO	-	500ms	PRO	Disk	Optical
	500AT Int. SCSI	5.25 HH	RO	-	500ms	SCSI	Disk	Optical
	500PS2 Ext.	5.25 HH	RO	-	500ms	PRO	Disk	Optical
	500PS2EXT. SCSI	5.25 HH	RO	-	500ms	SCSI	Disk	Optical
Relax Tech.	25-2160	5.25	WMRM	570MB	65ms	SCSI	-	-
Ricoh	RO-5030E II	5.25 FH	WMRM	652MB	67ms	SCSI	Cart	-
	RA-9100H	5.25 HH	WORM	800MB	168ms	SCSI	Cart	-

Optical Drive List (Continued)

Manufacturer	Model Number	Form Factor	Type	Capacity	Access Time	Interface	Media	Audio
Ricoh (Con't)	RS-9200E II	5.25 FH	WMRM	652MB	67ms	SCSI	Cart	-
Sony	CDU-7205	5.25	RO	600MB	340ms	IDE	-	-
	CDU-7211	5.25	RO	600MB	380ms	SCSI	-	-
	SMO-D501 C501	5.25	WMRM	650MB	95ms	SCSI	-	-
	SMO-S501	5.25	WMRM	650MB	95ms	SCSI	-	-
SST Storage	STAK II	5.25	WMRM	650MB	67ms	SCSI	-	-
Storage Dimensions	Erasable Optical	5.25	WMRM	562MB	107ms	SCSI	-	-
	LNE1-1000AT	5.25	WMRM	900MB	49ms	SCSI	-	-
	LSE1-1000AT	5.25	WMRM	900MB	49ms	SCSI	-	-
	MCE880-HC1	5.25	WMRM	900MB	49ms	SCSI	-	-
Summus Comp.	SO-600	5.25	WMRM	594MB	90md	SCSI	-	-
Sumo Systems	RSSM600-C (PC)	5.25	WMRM	594MB	50ms	SCSI	Cart	-
	RSSM600 DEC	5.25	WMRM	594MB	50ms	SCSI	Cart	-
	RSSM600 S(SUN)	5.25	WMRM	594MB	50ms	SCSI(S)	Cart	-
Sun Moon Star	CDR-3600U	-	-	-	-	-	-	-
	Syst. 286-12 CD	-	-	-	-	-	-	-
Tandy	CDR-1000	5.25	RO	600MB	1000ms	Prop.	-	-
Tecmar	Laservault	5.25	WMRM	1000MB	107ms	SCSI	-	-
Texel	DM-5021	5.25	RO	600MB	340ms	SCSI	-	-
Todd	TCDR-6000	5.25	RO	600MB	340MS	Prop.	-	-
Toshiba	TXM-3301-E1	5.25	RO	600MB	325ms	SCSI	-	-

Optical Drive List (Continued)

Manufacturer	Model Number	Form Factor	Type	Capacity	Access Time	Interface	Media	Audio
Toshiba (Con't)	WM-070	5.25	WORM	900MB	90ms	SCSI	-	-
	XM-3201A1 MAC	5.25 HH	RO	600MB	350ms	SCSI(M)	-	Yes
	XM-3201A1 PC	5.25 HH	RO	600MB	350ms	SCSI	-	Yes
	XM-3201-PS2	5.25 HH	RO	600MB	350ms	SCSI	-	Yes
	XM-3201B	5.25 HH	RO	683MB	350ms	SCSI	Cart	Yes
	XM-5100A MAC	5.25 HH	RO	683MB	380ms	SCSI(M)	Cart	Yes
	XM-5100A PCF	5.25 HH	RO	683MB	380ms	SCSI	Cart	Yes
	XM-5100A PS2	5.25 HH	RO	683MB	380ms	SCSI	Cart	Yes
	WM-500	-	WORM	5000MB	160ms	SCSI	Cart	Yes
Trimarchi	LaserAce	5.25	WMRM	600MB	45ms	SCSI	-	-
Tristar	PE3600-1D	5.25	WMRM	600MB	61ms	SCSI	-	-
	PE3660-1DQ	5.25	WMRM	600MB	61ms	Q-Bus	-	-
	PE3660-1R	5.25	WMRM	600MB	61ms	SCSI	-	-
	PE3660-2R	5.25	WMRM	1200MB	61ms	SCSI	-	-
U.S. Design	QD1000-Q	5.25	WMRM	1000MB	35ms	Q-Bus	-	-
	QD1000-S	5.25	WMRM	1000MB	35ms	SCSI(S)	-	-
	QD1000-U	5.25	WMRM	1000MB	35ms	Unibus	-	-
	QT1000-Q	5.25	WMRM	1000MB	35ms	Q-Bus	-	-
	QT1000-S	5.25	WMRM	1000MB	35ms	SCSI(S)	-	-
	QT1000-U	5.25	WMRM	1000MB	35ms	Unibus	-	-
Xyxis	XY600RW	5.25	WMRM	574MB	61ms	SCSI	-	-
Zetaco	SKR-600	5.25	WMRM	650MB	95ms	SCSI	-	-

Tape Drives

Tape Drive Interfaces

Listed below are the most common tape drive interfaces.

Floppy Tape

The Floppy Tape interface is simply an SA-400 floppy drive pinout. Floppy tape drives can be connected just like a floppy drive and usually do not require a separate interface card. There is a performance penalty paid for this convenience though: most floppy tape drives can not transfer data faster than 500Kbits/sec.

Pertec

The Pertec standard interface dates back to the mainframe tape drives of the early 70's. Nearly all 9 track reel to reel tape drives use the Pertec interface.

QIC-02

QIC-02 is a hardware interface and software command set standard. QIC-02 drives have an imbedded microprocessor which controls them and uses standard commands to read and write blocks of data and control the tape (similar to the SCSI interface). A QIC-02 style command set is also used by most QIC-36 controllers.

QIC-36

QIC-36 is a low level hardware interface used by most all DC600 style tape drives. This interface offers no "intelligence"; it connects directly the drive motors and heads. An intelligent controller is required to use the QIC-36 interface.

SCSI

The SCSI interface is now used on all of the newer DAT and most of the DC600 style tape drives. Many companies offer "bridge controllers" which connect QIC-02 and QIC-36 drives to the SCSI bus.

Data Compression and Honest Capacity

Since digital tape drives have inherently slow access times, they are used primarily for backup and archival storage and large capacity information transfer. Since most backup and archival processes benefit greatly from data compression, many manufacturers include data compression software with their tape drives. Many also advertise the capacity of the tape drive AFTER DATA COMPRESSION.

This advertising is deceptive because the actual storage capacity of the tape will vary depending on how much the incoming data can be compressed before it is recorded. Most data compression schemes will compress typical data to a maximum 2:1 ratio. The actual compression ratio you get will depend on the type of files you are compressing. Most graphics and text files can be easily compressed, while programs generally do not compress well.

Choosing a Tape Drive

To choose a tape drive, first determine the maximum capacity you need. Beware of deceptive advertising when selecting a drive based on capacity. Colorado Memories sells the Colorado Jumbo as a 250 Megabyte floppy tape drive. The actual uncompressed storage capacity of this drive using standard length tapes is 80MB. Extended length tapes boost capacity to 120MB. If data can be compressed 2:1 using the included Colorado data compression software, the capacity could be as high as 250MB. The actual storage capacity you get will probably be much less.

Another main consideration in selecting a tape drive is data transfer rate. Floppy Tape drives are generally the slowest and QIC-36 and SCSI drives are generally the fastest available. Using data compression generally slows data transfer . The table below lists the backup times and transfer rates of some typical drives tested at CSC. The actual transfer rate and backup time you achieve will depend on several factors including: bus speed, hard drive speed, and controller setup, but this chart provides a relative reference.

Tape Drive Performance Comparison

Colorado Jumbo "250MB"

Interface:	Floppy Tape
Controller:	AT Floppy
Rated Capacity:	250MB
Honest Capacity:	120MB
Transfer Rate:	1.3MB/minute
Time to write 40MB:	31 minutes

Caliper CP-150B

Interface:	QIC-36
Controller:	Wangtec (DMA mode)
Rated Capacity:	250MB
Honest Capacity:	250MB
Transfer Rate:	6.1MB/minute
Time to write 40MB:	6.5 minutes

JVC 4MM SCSI DAT

Interface:	SCSI
Controller:	CSC FastCache 64 Controller
Rated Capacity:	800MB
Honest Capacity:	800MB
Transfer Rate:	7.5MB/minute
Time to write 40MB:	5.4 minutes

PerSci 9 Track 6250BPI reel-reel

Interface:	Pertec
Controller:	MicroTech
Capacity with 9" tape:	80MB
Transfer Rate:	5MB/minute
Time to write 40MB:	8 minutes

The above performance tests were made in a typical 25MHz 486 clone with a SCSI hard drive. It's interesting to note that the QIC-36 drives offer a transfer rate similar to the DAT drives. The speed of the floppy tape drive was close to most floppy disk backup programs.

Extended Length Tapes

The maximum capacity of a tape drive can also be increased using an extended length tape. To increase the length of a tape cartridge, the tape material must be made thinner than normal. Thin tapes tend to tear under heavy use. If you do not need the extra capacity that extended length tapes provide, or if you use your tapes frequently, a standard length tape will prove more reliable. Thin tapes usually have an XL added to the tape part number. The following chart lists the standard capacities of most common standard and extra length tape cartridges.

STANDARD TAPE CAPACITY

Tape Cartridge	Length (feet)	Tracks	Capacity (no compression)
DC 100	185	16	10MB
DC 1000	185	16	10MB
DC 1000 Alphamat	185	24	20MB
DC 2000	200	24	40MB
DC 2000XL	200	24	60MB
DC 615	150	09	15MB
DC 600	600	09	60MB
DC 600A	600	09	60MB
DC 600XTD	600	15	125MB
DC 600XL	960	15	200MB
1/2" Cartridge	1000	36	200MB
4MM DAT DDS-1 60M	180	Helical Scan	1300MB
4MM DAT DDS-1 90M	270	Helical Scan	2000MB
4MM DAT DDS-2 90M	270	Helical Scan	4000MB
8MM EXABYTE 8200 60M	180	Helical Scan	2200MB
8MM EXABYTE 8500 60M	180	Helical Scan	5000MB
Reel-to-Reel Tapes	**Length**	**Tracks**	**Capacity**
9 Track 1400BPI	1000'	9	17MB
9 Track 6250BPI	1000'	9	75MB

Standard Tape Capacity

Manufacturers Phone List

Although these numbers are believed to be correct to the best of our knowledge at the time of printing, CSC cannot assume liability for their use.

3COM	(800)876-3266
Accton Technology	(408)452-8900
Acculogic	(714)454-2441
Ace Technologies, Inc	(408)428-9722
	(800)825-9977
Acer America	(800)848-2237
Adaptec	(408)945-2550
	(800)959-7274
Adtron Corporation	(602)926-7274
Allegro MicroSystems, Inc	(508)853-5000
ALR	(714)581-6770
AMD	(408)749-2385
	(800)538-8450
Amdek	(800)722-6335
America Megatrends	(404)263-8181
AMI ASIS Division	(208)234-6661
AMP	(717)564-0100
	(800)522-6752
Ampex	(800)262-6739
Amphenol Corporation	(203)281-3200
AMS	(305)784-0900
AMT International Industries	(714)375-0306
Angia Communications	(801)371-0488
Apex Data	(800)841-2739
Artisoft	(602)670-7000
Aspen Peripherals	(818)787-1111
AST	(905)822-2626
	(800)727-1278
ATI Technologies	(416)882-2600
AT&T Microelectronics	(800)372-2447
AT&T Paradyne	(800)482-3333
Atmel Corporation	(408)441-0311
Aura Associates	(408)252-2872
Austin Computer Systems	(800)483-9938
Award Software	(415)968-4433
B.A.S.F.	(800)669-2273
	(800)225-4350
B&C Microsystems, Inc	(408)730-5511
Berg Electronics	(919)248-5098
Boca Research	(407)241-8088
Borland	(800)841-8180
Calcomp	(800)541-7877
Calluna Technology	(408)453-4735
Canon	(800)423-2366
Capstone Technology	(510)438-3500
Cardwell International Corp	(916)985-1880
Catalyst Semiconductor, Inc	(408)748-7700
CDC (Imprimis)	(800)852-3475
Celestica	(800)461-2913
Centennial, Inc	(508)670-0646
C Centennial	(508)532-5908
	(800)535-3668
Central Point	(503)690-8080
Century Microelectronics	(408)748-7788
Chaplet Peripherals	(408)732-7950
Chips & Technology	(408)434-0600
CIM Engineering, Inc.(USA)	(415)578-9998
Cirrus Logic	(510)623-8300
CMS Enhancements	(714)222-6000
Cogito	(408)942-8262
Colorado Memory	(303)635-1501
Commstar, Inc	(612)473-4284
Compaq	(800)345-1518
Complus	(510)623-1000
Computer Boards	(508)261-1123
Computer Peripherals	(805)499-5751
ComTree USA	(301)670-6166
Conner Peripherals	(408)433-3340
	(408)456-3200
Core International	(407)997-6055
	(800)688-9910
Corporate Systems Center	**(408)734-3475**
CPI	(805)499-6021
Creative Labs	(405)742-6622
Curtis Inc	(612)631-9512
Cyrix	(800)462-9749
Data I/O	(206)881-6444
	(800)332-1536
Data 1, Inc	(800)642-1536
Databook	(716)889-4204
Datalight	(206)435-8086

Data Race, Inc................................(210)558-1900
(800)749-3703
Data Shield....................................(312)329-1601
Data Trek Corporation....................(219)522-8000
Diamond Systems...........................(904)241-4550
Digital Equipment Corp.................(800)722-9332
Disk Technologies..........................(800)553-0337
D Link..(714)455-1688
Dr. Neuhaus Engineering...............(408)685-0928
DuPont Connector Systems...........(800)237-4357
Elco...(814)643-0700
(800)653-3526
Emulex Corporation.......................(800)368-5393
Enhance Memory Products............(800)343-0100
E Tech Research, Inc......................(408)730-1388
Epson America..............................(310)7825341
(800)922-8911
Everex..(510)498-4411
EXP Computer..............................(516)496-3703
EXP Memory.................................(714)453-1020
FarPoint Communications.............(805)726-4420
FDK America, Inc..........................(408)432-8331
Flexstar Technology.......................(510)440-0170
Focus Microsystems.......................(408)436-2336
Foxconn Internatinal, Inc...............(408)749-1228
Fuji...(408)428-9100
Fujitsu America.............................(800)626-4686
Fujitsu ICL....................................(800)345-0845
Fujitsu Microelectronics..................(408)922-9202
Future Domain...............................(714)253-0400
(800)879-7599
Gateway 2000...............................(605)232-2000
(800)846-2000
Gateway Communications............(714)553-1555
(800)367-6555
Genoa...(408)432-9090
Goldstar Technology......................(800)777-1192
Globe Manufacturing Sales, Inc.....(908)232-7301
(800)227-3258
Greystone Peripherals....................(408)866-4739
GVC..(201)579-3630
Hayes Microcomputer Products.....(404)441-1617
Hewlett-Packard............................(208)323-2551
(800)752-0900
Hirose Electric, Inc........................(805)522-7958
Hitachi America, Ltd......................(415)589-8320
(800)369-0422
Houston Instruments......................(800)444-3425

IBM...(416)448-4299
(800)426-3333
IBM/Lexmark.................................(606)232-3000
IBM Microelectronics....................(802)769-6774
IBM Personal Computer Co...........(800)772-2227
IBM Toronto..................................(416)448-5555
(800)461-2913
Integral Peripherals........................(303)449-8009
Intel Corporation............................(503)629-7000
(800)879-4683
Iomega..(800)456-5522
IMP...(408)432-9100
Irma DCA......................................(404)740-0300
Irwin Magnetics..............................(801)778-3000
JAE Electronics, Inc.......................(714)753-2600
J.S.T. Corporation..........................(708)803-3300
(800)947-1110
Kalok Corporation(JTS).................(408)734-4258
Kensington Microware..................(800)535-4242
Keytronic......................................(800)262-6006
Kingston Technology Corp............(714)435-2699
Kodak Diconix...............................(800)344-0006
Kurta...(800)445-8782
Kyocera...(619)576-2600
Laser Tools....................................(800)767-8005
Linksys..(714)261-1288
Logic Modeling..............................(503)690-6900
(800)344-0004
Logitech..(510)795-0801
Lonetek Electronics Technology....(408)737-7600
Lotus Development........................(800)223-0303
LSI Logic Corporation...................(408)433-8000
M Systems.....................................(516)424-4545
MagicRAM, Inc.............................(213)413-9999
Mag Innovision.............................(800)827-3998
Magnavox & Philips......................(615)475-0317
Maxell Corporation of America.....(201)794-8382
Maxim Integrated Products............(408)737-7600
Maxtor Corporation........................(408)432-1700
(800)262-9867
Megadrive Systems.........................(800)322-4744
Megahertz Corporation..................(801) 272-6000
(800)527-8677
Memorex Computer Supplies.........(408)957-0104
Memorex Corporation....................(408)957-1000
Memory Card Associates...............(408)732-2550
Methode Electronics, Inc...............(708)867-9600
(800)323-6858
Micrel Semiconductor....................(408)245-2500

Micro Memory	(818)998-0070
Micronics	(510)651-2300
Micropolis	(818)709-3300
Microsoft Corporation	(206)454-2030
Miniscribe (Now Maxtor Colorado)	(303)651-6000
	(800)262-9867
Ministor Peripherals Corp	(408)943-0165
Mitsubishi	(800)843-2515
	(800)344-6352
Mitsubishi Electronics America	(408)746-0911
Molex, Inc	(708)969-4550
Motorola NewsCard	(407)364-3160
	(800)542-7882
Motorola UDS	(205)430-8000
	(800)451-2369
Mountain Network Solutions	(800)458-0300
MSD3	(408)778-7267
Multitech Design & Test, Inc	(408)970-8700
Multitech Systems	(612)785-3500
	(800)328-9717
Nanao USA Corporation	(800)800-5202
National Instruments	(512)794-0100
National Semiconductor	(800)272-9959
NCL	(408)737-2496
NCR	(316)636-8000
NDC Communications, Inc	(408)428-9108
NEC Technologies	(708)860-0335
	(800)388-8888
Newbury Data	(310)372-3775
New Media Corporation	(714)453-0550
	(800)453-0550
Novacor, Inc	(408)441-6500
Novell	(800)453-1267
Okidata	(609)235-2600
	(800)634-0089
Oki Semiconductor	(408)737-6372
Olivetti	(908)526-8200
Olson Computer Products	(210)379-7000
Omron	(408)727-1444
Ontrack	(612)937-2121
OPTI	(408)980-8178
Optima Technology	(714)476-0515
Orchid Technology	(510)683-0300
Otari Corporation	(415)341-5900
Pacific Data Products	(619)597-3444
Pacific Magtron	(408)733-1188
Pacific Rim Systems, Inc	(510)782-1013
Panasonic	(408)262-2200
	(800)222-0584
Panasonic Industrial Co	(201)348-5272
	(800)848-3979
ParadiseSystems	(415)960-3360
	(800)832-4778
PCS Computer Products	(408)441-6174
Pen National, Inc	(801)973-6090
Phoenix Technologies, Inc	(617)551-4000
Piiceon	(408)432-8030
	(800)366-2983
Practical Peripherals	(805)496-7707
Precision Plastics	(415)588-4450
Pre Max Electronics	(714)851-8242
Prima International	(408)727-2600
Procom Technology	(714)549-9449
	(800)800-8600
Proteon	(508)898-3100
Proxim	(415)960-1630
Pure Data	(800)661-8210
Quantum	(408)894-4000
R&D Micro, Inc	(714)830-1387
Robinson Nugent	(812)945-0564
Rockwell Internaitonal	(714)833-6849
Rohm Corporation	(615)641-2020
Samsung Electronics Co., Ltd	(408)954-7000
	(800)423-7364
Seagate Technology	(408)438-6550
	(800)468-3472
Sharp Electronics	(201)529-9457
Shugart	(714)770-1100
Siemens	(714)979-2240
Sierra Semiconductor	(408)263-9300
Silicon Storage Technology	(408)735-9110
Silicon Systems	(714)573-6200
Siliconix	(408)988-8000
	(800)554-5565
Simple Technology, Inc	(714)558-1120
	(800)367-7330
Smart Modular Technologies	(510)623-1231
SMC	(800)992-4762
	(800)638-5323
SMS/OMTI	(408)954-1633
Socket Communications	(510)670-0300
Solectek	(800)437-1518
Sony	(408)432-0190
Stocko Connectors	(201)93304452
Storage Dimensions	(408)954-0710
Summagraphics	(800)729-7866
Summit Memory	(408)438-2660
SunDisk Corporation	(408)562-0500

Supra Corporation	(503)967-2410
	(800)727-8772
Synova Systems	(408)436-2336
Syquest	(510)226-4000
	(800)245-2278
SystemSoft Corporation	(508)651-0088
Tandy	(817)390-3011
TDK Systems Devel. Center	(916)265-5395
Teac Incorporated	(213)726-0303
Teka Interconnection Systems	(401)785-4110
Telecomputer, Inc	(714)894-8954
Telenetics	(714)455-4000
Texas Instruments	(817)771-5856
Texel	(800)886-3935
Toddco General, Inc	(619)549-9229
Toshiba	(714)455-0407
	(800)999-4273
Toshiba Electronic Components	(714)455-2000
Trantor	(408)945-8600
TRENDware International, Inc	(310)328-7795
Tripplite	(312)329-1601
Tulin	(408)432-9025
US Robotics	(800)982-5151
Vadem	(408)943-9301
Ventura Micro, Inc	(805)486-6686
VLSI Technology, Inc	(408)434-3100
Western Digital	(714)932-4900
	(800)832-4778
Windsoft	(201)586-4400
Wireless Access	(408)383-1900
Word Perfect	(800)541-5096
Wyse	(408)435-2770
Xircom	(818)878-7600
	(800)874-7875
XXCAL, Inc	(310)477-2902
Zenith	(708)808-4300
	(800)553-0331
Zeos	(800)554-7172
ZIA	(800)722-2447
Zilog	(408)370-8000

Bulletin Board Services

Many manufacturers of hard drives and other related computer products maintain computer bulletin boards to provide technical support for their customers. Listed below are bulletin boards that we know about. The ones that we have called all use 8,N, 1, modem parameters. Many of them support modem speeds up to 14.4K baud.

Although these numbers are believed to be correct to the best of our knowledgeat the time of printing, CSC cannot assume liability for their use.

Accton Technology	(408)452-8828
Adaptec	(408)945-7727
Always Technology	(818)597-0275
Areal Technology	(408)954-0360
APCU(Assoc of PC Groups)	(408)439-9367
ATI Technologies	(905)764-9404
	(416)764-9404
Award (BIOS)	(415)968-0249
Borland	(408)439-9096
Central Point Software	(503) 690-6650
Chips & Technology	(408)456-0721
Computer Peripherals Inc	(805)499-9646
Conner Peripherals	(408)456-4415
Core International	(407)241-2929
CDC	(408)438-8771
CSC Tech Support	**(408)541-8455**
Data Technology Corp	(408)942-4197
Disk Technologies	(407)671-6099
DPT (Dist Process Tech)	(407)831-6432
Emulex Corporation	(714)662-1445
Fifth Generation Systems	(504)295-3344
Future Domain	(714)253-0432
Gateway Communications	(714)863-7097
Genoa	(408)943-1231
Gibson Research	(714)362-8848
GVC	(201)579-2380
Hayes Microcomputer Products	(404)446-6336
	(800)874-2937
Headland Technology	(510)656-0503
Hercules Computer Tech	(510)540-0621
IBM Microelctronics	(919)517-0001
IBM PC Users Group	(404)988-2790
Intel Support	(503)645-6275
JTS Corporation(Kalok)	(408)734-4258
LAN (Magazine)	(415)267-7640
Logitech	(510)795-0408
Mace, Paul Software	(714)240-7459
Maxtor	(303)678-2222
McAffee Association	(408)988-4004
Micronics	(510)651-6837
Micropolis Corporation	(818)709-3310
Miniscribe	(303)678-2222
Mouse Systems	(510)683-0617
Multitech Systems	(612)785-9875
National Semiconductor	(408)245-0671
New Media Corporation	(714)453-0214
Norton/Symantec	(408)973-9598
Novell(2400)	(408)649-3443
(9600)	(408)649-3696
Ontrack Computer Systems	(612)937-0860
OPTI	(408)980-9774
Optima Technology	(714)476-0626
Orchid Technology	(510) 683-0327
Panasonic Comm. Systems	(201)863-7845
PKWare (PKZip)	(414)354-8670
Proxim	(415)960-2419
Quantum	(408)894-3214
Quarterdeck Office Systems	(310)396-3904
Samsung Info. Systems	(408)434-5684
Seagate Technology USA	(408)438-8771
Seagate Technology UK	44-628-478011
Seagate Technology Germany	49-89-140-9331
Seagate Technology Singapore	65-227-2217
Silicon Valley Computers	(415)967-8081
Storage Dimension	(408)944-1220
SunDisk Corporation	(408)986-1186
Syquest	(510)656-0473
Tech Data	(813)538-7090
Telix Support	(919)481-9399
Toshiba America	(714)837-4408
U.S.Robotics	(708)982-5092
Western Digital	(714)753-1234
WordPerfect Corporation	(801)225-4414
Wyse Technology	(408)922-4400

Directory

The following is a list of the addresses and phone numbers of many manufacturers of storage devices and related products. The code shown at the end of the listing indicates the primary products for that manufacturer.

Code: M = Macintosh, PC = IBM PC or compatibles, MTD = Macintosh Tape Drives, PCTD = PC Tape Drives, MCD = Macintosh CD-ROM, PCCD = PC CD-ROM, MRW = Macintosh Read/Write Optical, PCRW = PC Read/Write Optical.

Accton Technology
1962 Zanker Road
San Jose, CA 95112
(408) 452-8900
(408) 452-8988 Fax

Ace Technologies, Inc.
2880 Zanker Road, #103
San Jose, CA 95134
(408) 428-9722
(800) 825-9977
(408) 428-9721 Fax

Acer America
2641 Orchard Parkway
San Jose, CA 95134
(800) 848-ACER
(408) 922-2953 Fax

Acma Computers, Inc.
47988 Fremont Blvd.
Fremont, CA 94538
(510) 249-0560

Adaptec, Inc.
691 South Milpitas Blvd.
Milpitas, CA 95035
(800) 422-7274

Adtron Corporation
3050 S Country Club Dr.
Suite 24
Mesa, AZ 84210
(602) 926-9324
(602) 926-9359 Fax

Advanced Digital
Information Corporation
14737 N.E. 87th St.
Redmond WA 88073-2996
(800) 336-1233
(206) 881-8004
PC MTD PCTD PCRW

Advanced Gravis
Computer Tech, Ltd.
1602 Carolina St. Ste D-12
Bellingham, WA 98226
(604) 434-7274
M PC

Allegro MicroSystems, Inc
115 Northeast Cutoff
Box 15036
Worchester, MA 01615
(508) 853-5000

Alphatronix, Inc.
2300 Englert Dr. Ste. C
P.O. Box 13687
Research Triangle Pk NC
27709-3687
(919) 544-0001
MRW PCRW

AMD
901 Thompson Place
Sunnyvale, CA 94088
(408) 749-2385
(800) 538-8450

American Megatrends
6145F Northbelt Pky
Norcross, GA 30071
(404) 263-8181
(404) 263-9381 Fax

American Micro Research
13505A Yorba Ave.
Chino, CA 91710
(714) 590-3900
M

AMI ASIS Division
200 South Main Street
Pocatello, ID 83204
(208) 234-6661
(208) 234-6695 Fax

AMP
P.O. Box 3608
Harrisburg, PA 17105
(717) 564-0100
(800) 522-6752
(717) 986-7575 Fax

AMS
1460 SW 3rd St. Suite B-8
Pompono Beach, FL 33069
(305) 784-0900
(305) 784-5872 Fax

AMT Int'l Industries
16571 Gemini Lane
Huntington Beach CA
92647
(714) 375-0306
(714) 375-0317 Fax

Angia Communications
441 East Bay Blvd.
P.O.Box 50540
Provo, UT 84605-0540
(801) 371-0488
(801) 373-9847 Fax

Apex Data
6670 Amador Plaza Rd.
#200
Dublin, CA 94568
(800) 841-APEX
(510) 803-9388 Fax

Apple Computer, Inc.
20525 Mariani Avenue
Cupertino, CA 95014
(408) 996-1010
M MCD

Applied Engineering
3210 Beltline Rd. #154
Dallas, TX 75234
(214) 241-6060
M

Areal Technology, Inc.
2075 Zanker Road
San Jose, CA 95131
(408) 436-6800
(408) 436-6844 Fax
PC

Aspen Peripherals
7247 Hayvenhurst Ave A5
Van Nuys, CA 91406
(818) 787-1111
(818) 779-2866 Fax

AST Research, Inc.
16215 Alton Pkwy
P.O. Box 19658
Irvine, CA 92718
(800) 876-4278
(714) 727-4141
PC PCTD

AT&T Microelctronics
Two Oak Way
Berkeley Heights, NJ
07922
(800) 372-2447
(215) 439-5923 Fax

AT&T Paradyne
8545 126th Avenue N
Largo, FL 34649
(800) 482-3333
(813) 530-2103 Fax

Atmel Corporation
2125 O'Nel Drive
San Jose, CA 95131
(408) 441-0311
(408) 436-4300 Fax

Aura Associates
2605 S Winchester Blvd.
Campbell, FA 95008
(408)252-2872
(408)252-2876 Fax

Auspex Engineering
9051 Pelican Avenue
Fountain Valley, CA
92708
(714) 964-6405
(714) 965-9935 Fax

Austin Computer Systems
10300 Metric Blvd.
Austin, TX 78758
(800)483-9938
(512)454-1357 Fax

Award Software Int'l.
777 E Middlefield Road
Mt. View, CA 94043
(415) 968-4433
(415) 968-0274 FAx

Axonix
1214 Wilmington Ave.
Salt Lake City, UT 84106
(800) 866-9797
(801) 466-9797
PC

B & C Microsystems, Inc.
750 North Patoria Avenue
Sunnyvale, CA 94086
(408) 730-5511
(408) 730-5521 Fax

Berg-Electronics
Barley Mill Plaza
Wilmington,DE 19898
(919) 248-5098
(919) 248-5341 Fax

Blackhole Tech. Corp.
225 East St.
Winchester, MA 01890
(800) 227-1688
(617) 721-7690
MTD

Boca Raton Technical Serv
1000 NW 51st Street
Roca Raton, FL 33429
(407) 443-8350
(800) 426-2622
(407) 982-4288 Fax

Boca Research, Inc.
6413 Congress Avenue
Boca Raton, FL 33487
(407)997-6227
(407)997-0918

Boca Technology Group
21346 St Andrews Blvd
#219
Roca Raton, FL 33433
(407) 750-1528
(407) 750-8873 Fax

Brand Technology, Inc.
9559 Irwindale
Chatsworth, CA 91311
(818) 407-4040
PC

Calluna Technology
1792 Technology Drive
#241
San Jose, CA 95110
(408)453-4735
(408)453-0427 Fax

Canon U.S.A. Inc.
1 Canon Plaza
LakeSuccess, NY 11042
(516) 488-6700
PCRW

Cardwell Int'l. Corp.
110 Blue Ravine Road
Suite 156
Folsom, CA 95630
(916)985-1880
(916)985-1899 Fax

Catalyst Semiconductor
2231 Calle De Luna
Santa Clara, CA 95054
(408)748-7700
(408)980-8209 Fax

CBIS, Inc.
5875 Peachtree Industrial
Blvd #160
Norcross, GA 30092
(404) 446-1332
MCD PCCD

CD Technology, Inc.
780 Montaque Expwy
#407
San Jose, CA 95131
(408) 432-8698
MCD PCCD

Centennial, Inc.
37 Manning Rd, Suite 1
Billerica, MA 01821
(508)670-0646
(508)670-9025 Fax

C Centennial
2 Centennial Drive
Peabody, MA 01960
(508)532-5908
(800)535-3668
(508)532-6275 Fax

Century Microelectronics
4800 Great America Pky
Santa Clara, CA 95054
(408)748-7788
(408)748-8688 Fax

Chaplet Peripherals
252 North Wolfe Road
Sunnyvale, CA 94086
(408)732-7950
(408)732-6050 Fax

Chinon America, Inc.
660 Maple Ave.
Torrance, CA 90503
(800) 441-0222
(310) 533-0274
MCD PCCD

Chinook Technology
601 Main St. #635
Longmont, CO 80501
(800) 999-7034
(303) 678-5544

CIM Engineering (USA)
1291 E Hillsdale Blvd.
Foster City, CA 94404
(415)578-9998
(415)578-0259 Fax

Cipher Data Products, Inc
10101 Old Grove Road
San Diego, CA 92138
(800) 424-7437
(619) 578-9100
MTD PCTD UTD

Cirrus Logic
3100 W Warren Avenue
Fremont, CA 94538
(510) 623-8300
(510) 226-2180 Fax

CMS Enhancements, Inc.
2722 Michelson
Irvine, CA 92715
(714) 222-6000
M PC MTD MWR

Colorado Memory Sys.
800 S. Taft Ave.
Loveland, CO 80537
(303) 669-8000
PCTD

Commstar, Inc.
6440 Flying Floud Drive
Eden Prairie, MN 55344
(612)473-4284
(612)473-4284 Fax

Complus
4151 Business Center Dr.
Fremont, CA 94538
(510)623-1000
(510)623-1004 Fax

Computer Age Inc.
9433 Georgia Avenue
Silverspring, MD 20910
(800)622-3384
(301)588-6565
M

Computer Boards
125 High Street
Mansfield, MA 02048
(508)261-1123
(508)261-1094 Fax

Computer Peripherals
667 Rancho Conejo Blvd.
Newbury Park, CA 91320
(805) 499-5751
(800) 854-7600

ComTree USA
211 Perry Parkway #5
Gaitherburg, MD 20877
(301) 670-6166
(301) 670-6167 Fax

Conner Peripherals
3081 Zanker Rd.
San Jose, CA 95134-2128
(408) 456-4500
(408) 456-4501 Fax
M PC

Core International, Inc.
3605 Long Beach Blvd.
#233
Long Beach, CA 92646
(407) 997-6055
M PC PCTD

Corporate Systems Center (CSC)
1294 Hammerwood Ave.
Sunnyvale, CA 94089
(408) 734-3475
(408) 745-1816 Fax
M PC PCTD

Curtis, Inc.
418 W County Road D
Saint Paul, MN 55112
(612) 631-9512
(612) 631-9508 Fax

Cutting Edge
P.O. Box 1259
Evanston, WY 82930
(307) 789-0582
(307) 789-8519 Fax
M

Data I/O
10525 Willows Road NE
P.O.Box 97046
Redmond, WA 98073-9746
(206) 881-6444
(800) 332-8246

Data 1, Inc.
2739 US North, Suite 213
Holiday, FL 34691
(800) 632-1536

Databook, Inc.
112 Prospect Street
Babcock Hall
Ithaca, NY 14850
(716) 889-4204
(716) 889-2593 Fax

Datalight
307 N Olympic Avenue
Suite 201
Arlington, WA 98223
(206) 435-8086
(206) 435-0253 Fax

Data Race, Inc.
11550 1H 10 West
Suite 395
San Antonio, TX 78230
(210) 558-1900
(800) 749-7223
(210) 558-1929 Fax

DataTrek Corporation
4505 Wyland Drive
Elkhart, IN 46516
(219) 522-8000
(219) 522-0822 Fax
(800) PCMCIA7

Deltaic Systems
1701 Junction Ct. #302B
San Jose, CA 95112
(800) 745-1240
(408) 441-1240
M PC MTD PCTD MWR
PCRW

Denon America, Inc.
222 New Road
Parsippany, NJ 07054
(201) 575-7810
MCD PCCD

Digital Equipment Corp.
40 Old Bolton Road
Stow, MA 01775
(800) 722-9332

Disk Technologies, Inc.
904 Railroad Ave.
Winter Park, FL 32789
(800) 553-0337
(407) 645-0001
M PC

DMA Technologies, Inc.
601 Pine Ave.
Goleta, CA 93117
(800) 223-9443
(805) 964-0733
M PC MRW PCRW

Dr. Neuhaus Engineering
1145 Pinehurst Drive
Aptos, CA 95003
(408) 685-0928
(408) 685-0928 Fax

DTC (see Qume)

DuPont Connector Sys.
Barley Mill Plaza
P.O.Box 80019
Wilmington, DE 19880
(800) 237-4357

Ehman, Inc.
97 S. Red Willow Road
Evanston, WY 82930
(800) 257-1666
(307) 789-3830
M

Enhance Memory Products
18720 Oxnard Street
Tarzana, CA 91356
(818) 343-3066
(800) 343-0100
(818) 343-1436 Fax

Elco
Huntington Industrial Park
Huntington, PA 16652
(814) 643-0700
(800) 653-ELCO
(814) 643-0426 Fax

EMAC Division of Everex
48431 Milmont Dr.
Fremont, CA 94538
(800) 811-0806
(510) 683-2382
MTD PCTD

EMC Corporation
171 South St.
Hopkinton MA 01748-9103
(800) 222-3622
(508) 435-1000
PC

Epson America, Inc.
20770 Madrona Avenue
Torrance, CA 90503
(310) 782-5341
(800) 289-3776
(310) 782-5320 Fax

Espert Co. Ltd
1630 Oakland Road, A109
San Jose, CA 95131
(408) 452-5771
PC

E Tech Research, Inc.
3525 Ryder Street
Santa Clara, CA 95051
(408) 730-1388
(408) 730-2488 Fax

EXP Computer
223 Michael Drive
Stosser, NY 11791
(516) 496-3703
(516) 496-2914 Fax

EXP Memory
12C Mauchly
Irvine, CA 92718
(714) 453-1020
(714) 453-1319 Fax

FarPoint Communications
104 East Avenue K4,
Suite F
Lancaster, CA 93535
(805) 726-4420
(805) 726-4438 Fax

FDK America, Inc.
3099 North First Street
San Jose, CA 95134
(408) 432-8331
(408) 435-7478 Fax

Flexstar Technology
213 Hammond Avenue
Fremont, CA 94539
(510) 440-0170
(510) 440-0177 Fax

Focus Microsystems
1735 North First Street
Suite 307
San Jose, CA 95112
(408) 436-2336
(408) 436-2348 Fax

Foxconn International
930 W Maude Avenue
Sunnyvale, CA 94086
(408) 749-1228
(408) 749-1266 Fax

Fujitsu America, Inc.
3055 Orchard Dr.
San Jose, CA 95134
(800) 626-4686
(408) 432-1300
M PC

Fujitsu Microelectronics
3545 North First Street
San Jose, CA 95134-1804
(408) 922-9202
(408) 432-9030 Fax

Fuji Electric Co.
2610B North 1st. Street
San Jose, CA 95134
(408) 428-9100
PC

Future Domain
2801 McGaw Avenue
Irvine, CA 92714
(714) 253-0400

FWB, Inc.
2040 Polk St. #215
San Francisco, CA 94109
(415) 474-8055
M PC MTD MRW

Gateway 2000
610 Gateway Drive
North Sioux City, SD
57049
(605) 232-2000
(800) 846-2000
(605) 232-2023 Fax

Gateway Communications
2941 Alton Avenue
Irvine, CA 92714
(714) 553-1555
(800) 367-6555
(714) 553-1616 Fax

Globe Manufacturing, Inc.
1159 US Route 22
Mountainside, NJ 07092
(908) 232-7301
(800) 227-3258
(908) 232-4729 Fax

Greystone Peripherals
130-A Knowles Drive
Los Gatos, CA 95030
(408) 866-4739
(408) 866-8238 Fax

GVC
376 Lafayette Road
Sparta, NJ 07871
(201) 579-3630
(201) 579-2702 Fax

Hayes Microcomputer
Products
P.O.Box 105203
Atlanta, GA 30348
(404) 441-1617
(404) 441-1213 Fax

HCo. Computer Products
17922 Skypark Circle
Suite F
Irvine, CA 92714
(714) 833-3222
(800) 726-2477
(714) 833-3389 Fax

Hewlett-Packard Co.
Disk Memory Division
P. O. Box 39
Boise, ID 83707-0039
(208) 323-2332
(208) 323-3991 Fax
PC

Hirose Electric, Inc.
2688 Westhill Court
Simi Valley, CA 93065
(805) 522-7958
(805) 522-3217 Fax

Hitachi America
2000 Sierra Point Pkwy
Research Triangle Park,
NC 27709
(916) 543-0297
(196) 543-0159

IBM Microelectronics
1000 River Street
Essex Junction, VT 05452
(802) 769-6774

IBM Personal Computer Co
Route 100
Somers, NY 10589
(800) 772-2227
(800) 426-4329 Fax

Integral Peripherals
5775 Flatiron Pkwy
Boulder, CO 80301
(303) 449-8009
(303) 449-8089 Fax

Intel Corporation
1900 Prairie City Road
Folsom, CA 95630
(916) 356-2746
(800) 879-4683
(916) 356-5033 Fax

Iomega Corp.
1821 W. 4000 South
Roy, UT 84067
(800) 234-0408
(801) 778-3398
M PC MRW PCRW

JAE Electroniccs, Inc.
142 Technology Drive
Building 100
Irvine, CA 92718-2401
(714) 753-2600
(714) 753-26999 Fax

Jasmine Technologies Inc.
1225 Elko Drive
Sunnyvale, CA 94089
(800) 347-3228
(408) 752-2900
M

Kingston Technology
17600 Newhope Street
Fountain Valley CA 92708
(714) 435-2699
(714) 534-2699 Fax

Kyocera Unison, Inc.
1321 Harbor Bay Pkwy.
Alameda, CA 94501
(800) 367-7437
(510) 748-6680
PC

La Cie, Ltd
19552 S.W. 90th Ct.
Tualatin, OR 97062
(800) 999-0143
(503) 646-3424

Laser Magnetic Storage
Int'l
4425 Arrows W. Dr.
Colorado Springs, CO
80907
(800) 777-5674
(719) 593-7900
MCD PCCD MRW PCRW

Liberty Systems
160 Saratoga Ave. #38
Santa Clara, CA 95051
(408) 983-1127
M PC MTD PCTD MRW
PCRW

Linksys
16811A Millikan Avenue
Irvine, CA 92714
(714) 261-1288
(714) 261-8868 Fax

Literal Corporation
2180 Executive Circle
Colorado Springs, CO
80906
(719) 540-7883
MRW PCRW

Logic Modeling
19500 NW Gibbs Drive
P.O.Box 310
Beaverton, OR 97075
(503) 690-6900
(800) 344-0004
(503) 690-6906 Fax

LSI Logic Corporation
Milpitas, CA
(408) 433-8000
(408) 434-6457 Fax

M Systems
200 Broadhollow Road
Suite 207
Melville, NY 11747
(516) 424-4545
(516) 424-4546

MagicRAM, Inc.
1850 Beverly Blvd.
Los Angeles, CA 90057
(213) 413-9999
(213) 413-0828 Fax

Mass Microsystems
810 W. Maude Ave.
Sunnyvale, CA 94086
(800) 522-7979
(408) 522-1200
MTD MRW

Maxell Corp of America
22-08 Route 208
Fair Lawn, NJ 07410
(201) 794-8382
(201) 794-3274 Fax

Maxim Integrated Products
120 San Grabriel Drive
Sunnyvale, CA 94086
(408) 737-7600

Maxtor Corporation
211 River Oaks Pkwy
San Jose, CA 95134
(408) 432-1700
(800) 2-MAXTOR
(408) 432-4510 Fax
M PC

MDB Systems, Inc.
1110 W. Taft Ave.
P.O. Box 5508
Orange, CA 92613-5508
(800) 556-0222
(714) 998-6900
M PC MTD PCTD

Mega Drive Systems
1900 Ave of the Stars 2870
Los Angeles, CA 90067
(800) 322-4744
(310) 556-1663
M PC

Megahertz Corporation
4505 S Wasatch Blvd
Salt Lake City, UT 84124
(801) 272-6000
(801) 272-6077 Fax

Memorex Computer Supplies
1200 Memorex Drive
Santa Clara, CA 95050
(408) 957-0104
(408) 957-1145 Fax

Memory Card Assoc.
1600 Wyatt Drive, Suite 9
Santa Clara, CA 95054
(408) 732-2550
(408) 970-8422 Fax

Methode Electronics, Inc.
6446 W Wilson Avenue
Chicago, IL 60656
(708) 867-9600
(800) 323-6858
(708) 867-0435 Fax

Micrel Semiconductor
560 Oakmead Parkway
Sunnyvale, CA 94086
(408) 245-2500
(408) 245-4175 Fax

Microscience Int'l Corp.
90 Headquarters Drive
San Jose, CA 95134
(408) 433-9898
(408) 954-0989
PC

Ministor Peripherals Corp
2801 Orchard Parkway
San Jose, CA 95134
(408) 943-0165
(408) 434- 0784 Fax

Mitsubishi Electronics
1050 E Arques Avenue
Sunnyvale, CA 94086
(408) 746-0911
(408) 746-0915 Fax

Molex, Inc.
2222 Wellington Court
Lisle, IL 60521
(708) 969-4550
(708) 969-1352 Fax

Morton Management, Inc.
12079 Tech Road
Silver Spring, MD 20904
(800) 548-5744
(301) 622-5600
PC PCTD PCCD PCRW

Motorola NewsCard
1500 NW 22nd Avenue
Boynton Beach, FL 33426
(407) 364-3160
(800) 542-7882

Motorola UDS
5000 Bradford Drive
Huntsville, AL 35805-1993
(205) 430-8000
(800) 451-2369
(205) 830-5657 Fac

MSD3
365 Woodview Avenue
Suite 700
Morgan Hill, CA 95037
(408) 778-7267
(408) 778-7267 Fax

Mountain Network Solutions
240 E. Hacienda Ave.
Campbell, CA 95008
(800) 458-0300
(408) 379-4300
PCTD

Multimedia Systems division of Hitachi
401 W. Artesia Blvd.
Compton, CA 90220
(800) 369-0422
(310) 537-8383
MCD PCCD

Multitech Design & Test
3171 Jay Street
Santa Clara, CA 95054
(408) 970-8700
(408) 980-0451 Fax

Multitech Systems
2205 Woodale Drive
Mounds View, MN 55112
(612) 785-3500
(800) 328-9717
(612) 785-9874 Fax

National Instruments
6504 Bridge Point Pkwy
Austin, TX 78730-5039
(512) 794-0100
(512) 794-8411

National Semiconductor
2900 Semiconductor Drive
P.O.Box 58090
Santa Clara, CA 95052
(800) 272-9959
(800) 428-0065 Fax

NDC Communications
2180 Bering Drive
San Jose, CA 95131
(408) 428-9108
(408) 428-9109 Fax

NEC Profession Systems Div.
1255 Michael Dr.
Wood Dale, IL 60191
(800) 366-3632
(708) 860-9500
MCD PCCD

NEC Technologies
1414 Machachusetts Ave
Boxborough, MA 01719
(800) 388-8888

New Media Corporation
15375 Barranca B101
Irvine, CA 92718
(714) 453-0550
(800) 453-0550
(714) 453- 0114 Fax

Novacor, Inc.
1841 Zanker Road
San Jose, CA 95112
(408) 441-6500
(408) 441-6811 Fax

Ocean Microsystems, Inc.
246 E. Hacienda Ave.
Campbell, CA 95008
(408) 374-8300
M PC MRW PCRW

Oki Semiconductor
785 North Mary Avenue
Sunnyvale, CA 94086
(408) 737-6372
(408) 720-1918 Fax

Olson Computer Products
1903 North Austin Street
Seguin, TX 78155
(210) 379-7000
(210) 379-4921 Fax

Optima Technology Corp.
17526 Van Karman
Irvine, CA 92714
(714) 476-0515
(714) 476-0613 FAX
M PC MTD PCTD MRW PCRW

Orca Technology, Corp.
1751 Fox Drive
San Jose, CA 95131
(408) 441-1111
(408) 441-1102 Fax

Pacific Magtron, Inc.
568-8 Weddell Dr.
Sunnyvale, CA 94089
(800) 828-2822
(408) 744-1188
M PC

Panasonic Industrial Co.
2 Panasonic Way, B7C7
Secaucus, NJ 07094
(201) 348-5272
(800) 848-3979
(201) 392-6361 Fax

PCs Computer Products
1350 Ridder Park Drive
San Jose, CA 95131
(408) 441-6174
(408) 453-7667 Fax

Pen National, Inc.
2351 South 2300 West
Salt Lake City, UT 84119
(801) 973-6090
(800) 8PCMCIA
(801) 973-4550 Fax

Personal Computer Peripherals Corp. (PCPC)
4710 Eisenhower Blvd.
Bldg. A-4
Tampa, FL 33634
(800) 622-2888
(813) 884-3092
MTD

Phonix Technologies
846 University Avenue
Norwood, MA 02062
(617) 551-4000
(617) 551-3750 Fax

Piceon
1996 Lundy Avenue
San Jose, CA 95131
(408) 432-8030
(800) 366-2983
(408) 943-1309 Fax

Pioneer Communications of America, Inc.
600E. Crescent Ave.
Upper Saddle River, NJ 07458
(201) 327-6400
MCD PCCD

Practical Peripherals
375 Conejo Ridge Avenue
Thousands Oaks, CA 91361
(805) 497-4774
(805) 374-7200 Fax

Precision Plastics
340 Roebling Road
South San Francisco, CA 94080
(415) 588-4450
(415) 5888-5336 Fax

PreMax Electronics
17702 Mitchell North, Suite 100
Irvine, CA 92714
(714) 851-8242
(714) 851-8249 Fax

Prima International
3350 Scott Blvd., Bldg. 7
Santa Clara, CA 95054
(408z0 727-2600
(408) 727-2435 Fax

Procom Technology, Inc.
200 McCormick Ave.
Costa Mesa, CA 92626
(714) 549-9449
M PC MTD PCTD MCD PCCD MRW PCRW

Proxim
295 N Bernardo Avenue
Mountain View, CA 94043
(415) 960-1630
(415) 964-5181 Fax

Q Logic
3545 Harbor Blvd.
Costa Mesa, CA 92626
(800) TOP-SCSI

Qume/DTC
500 Yosemite Drive
Milpitas, CA 05035
(408) 262-7700
PCC

R & D Micro, Inc.
23392-A Madero Road
Mission Viejo, CA 92691
(714) 830-1387
(714) 951-5422 Fax

Robinson Nugent
P.O.Box 1208
New Albany IN 48151
(812) 945-0564
(812) 845-0804 Fax

Rockwell International
4311 Jamboree Road
Newport Beach, CA 92658
(714) 833-6849
(714) 833-6375 Fax

Rodime Systems
7700 W. Camino Real
Boca Raton, FL 33433
(407) 994-5585
M PC

Rohm Corporation
3034 Owen Drive
Antioch, TN 37013
(615) 641-2020
(615) 641-2022 Fax

Samsung Electronics, Ltd.
3725 North First Street
San Jose, CA 95134
(408) 954-7000
(800) 423- 7364
(408) 954-7870 Fax

Seagate Technology
920 Disc Drive
Scotts Valley, CA 95066
(408) 438-655(408) 438-6356 Fax
M PC

Sharp Electronics
Sharp Plaza
Mahwah, NJ 07430
(201) 529-9457
(201) 529-9117 Fax

Sierra Semiconductor
2075 N Capitol Avenue
San Jose, CA 95132
(408)263-9300

Silicon Storage Technology
1208 Apollo Way Suite 502
Sunnyvale, CA 94086
(408) 735-9110
(408) 735-9036 Fax

Silicon Systems
14351 Myford Road
Tustin, CA 92680
(714) 573-6200
(714) 573-6906 Fax

Siliconix
2201 Laurelwood Road
P.O.Box 54951
Santa Clara, CA 95056
(408) 988-8000
(800) 554-5565
(408) 727-5414 Fax

Simple Technology, Inc.
1801 E Edinger Ave #255
Santa Ana, CA 92705
(714) 558-1120
(800) 367-7330
(714) 558-0997 Fax

Socket Communications
2501 Technology Drive
Hayward, CA 94545
(510) 670-0300
(510) 670-0333 Fax

Solectek
6370 Nancy Ridge Drive
San Diego, CA 92121
(800) 437-1518

Sony Computer
Peripheral Products Co.
655 River Oaks Pkwy.
San Jose, CA 95134
(800) 222-0878
(408) 432-0190
MCD

Sony Corporation
2 Van Riper Road
Montvale, NJ 07645
(201) 476-8199
(201) 476-8155 Fax

STB Systems, Inc.
1651N. Glenville, #210
Richardson, TX 75081
(214) 234-8750
PCTD

Stocko Connectors
P.O.Box 187
495 Industrial "Road
Carlstadt, NJ 07072
(201) 933-4452
(201) 933-4522 Fax

Storage Plus Inc.
dba Sumo Systems
1580 Old Oakland Rd.
Suite. C103
San Jose, CA 95131
(408) 453-5744
MCD

SunDisk Corporation
3270 Jay Street
Santa Clara, CA 95054
(408) 562-0500
(408) 980-8607 Fax

Supra Corporation
P.O.Box 7101
Albany, OR 97321-8000
(503) 967-2410
(800) 727-8772
(503) 967-2401 Fax

SyDOS, Div. of SyQuest
6501 Park of Commerce
Blvd.
Suite 110
Boca Raton, FL 33487
(407) 998-5400
PCTD

Synova Systems
1735 N First St., Suite 307
San Jose, CA 95112
(408) 436-2336
(408) 436-2348 Fax

SyQuest Technology, Inc.
47071 Bayside Pkwy.
Fremont, CA 94538
(510) 226-4000
(800) 245-2278
(510) 226-4102 Fax
MTD

SystemSoft Corporation
313 Speen Street
Natick, MA 01760
(508) 651-0088
(508) 651-8188 Fax

TDK Systems Dev Center
117 New Mohawk Road
Nevada City, CA 95959
(916) 265-5395
(916) 478-8390 Fax

Teac America, Inc.
7733 Telegraph Road
Montebello, CA 90640
(213) 726-0303
PC PCTD

Tecmar, Inc.
6225 Cochran Rd.
Solon, OH 44139
(800) 624-8560
(216) 349-0600
MTD PCTD MRW PCRW

Teka Interconnection Sys.
45 Salem Street
Providence, RI 02907-2888
(401) 785-4110
(401) 461-2310 Fax

Telecomputer, Inc.
15026 Moran Street
Westminister, CA 92683
(714) 894-8954
(714) 891-8364 Fax

Telenetics
26772 Vista Terrace Drive
Lake Forest, CA 92630
(714) 455-4000

Texas Instruments
12203 SW Freeway
Staffold, TX 77477
(713) 274-3361

Toddco General, Inc.
7888 Silverton Avenue
Suite A
San Diego, CA 92126
(619) 549-9229
(619) 549-2162 Fax

Toshiba America
Information Systems, Inc.
9740 Irvine Blvd.
Irvine, CA 92718
(800) 456-3475
(714) 583-3000
MCD PCCD

TRENDware International
2421 W 205th St., D-102
Torrance, CA 90501
(310) 328-7795
(310) 328-7798 Fax

Tulin Corporation
2156H O'Toole Ave.
San Jose, CA 95131
(408) 432-9025
(408) 943-0782 FAX
M PC

US Robotics
8100 N McCormick Blvd.
Skokie, IL 60076-2999
(800) DIAL-USR
(708) 982-5235 Fax

Vadem
1885 Lundy Avenue #201
San Jose, CA 95131
(408) 943-9301
(408) 943-9735 Fax

Ventura Micro, Inc.
200 South A Street Ste 208
Oxnard, CA 93030-5717
(805) 486-6686
(805) 486-3343 Fax

VLSI Technology, Inc.
1109 McKay Drive
San Jose, CA 95131
(408) 434-3100

Western Digital
8105 Irvine Center Drive
Irvine, CA 92718
(714) 932-5000
(800) 847-6181
(714) 863-1656 Fax
PC

WindSoft, Inc. 66 Ford
Road
Denville, NJ 07834
(201) 586-4400
(201) 586-9045 Fax

Xircom
26025 Mureau Road
Calabasas, CA 91302
(818) 878-7600
(818) 878-7630 Fax

XXCAL, Inc.
11500 W Olympic Blvd
#325
Los Angeles, CA 90064
(310) 477-2902
(310) 477-7127 Fax

Xyxis Corporation
1821 W. 4000 South
Roy, UT 84067
(800) 234-0408
(801) 778-3398

Zenith Data Systems
2150 E Lake Cook Road
Buffalo Grove, IL 60089
(708) 808-5000
(800) 553-0331
(708) 808-4434 Fax

ZIA
2830 N First Street
San Jose, CA 95134
(800) 722- CHIP

Zeos International
1301 Industrial Blvd.
Minneapolis, MN 55413
(800) 554-7172

Zilog
210 E Hacienda Avenue
Campbell, CA 95008-6600
(408) 370-8000
(408) 370-8056 Fax

Software

The software included with the Hard Drive Bible is a collection of utilities that we have found useful. This software is copyrighted by the various authors of the programs and provided through the courtesy of the authors. Some of these programs are referred to as Shareware, which is a means of distributing programs for evaluation before paying for them. All of the programs have their own documentation and indicate whether a fee is required after an evaluation period. These programs are installed on the diskettes in "Zipped" format. This is a process which compresses the data so that more files can be placed on the diskette. Before using the files they must be Unzipped or decompressed. To unzip the files, use the PKUNZIP program provided on the disk. PKUNZIP.EXE is provided by PKWare, Inc. and is used by typing the following:

PKUNZIP <filename>

Note: The zipped files are compressed as much as 75%. There must be enough room on the diskette or hard drive directory to accommodate the unzipped files. The best way to accomplish this is to copy the zipped file and PKUNZIP.EXE to a directory or a blank diskette before unzipping it.

DISCLAIMER

CSC, DTC, Maxtor Corporation and Seagate Technology expressly disclaim any liability which may arise from the use of the software included with the Hard Drive Bible. To the best of our knowledge, this software is workable and free of major bugs, but no guarantee of performance or fitness for any particular application is made. This software is provided free of charge, but may not be duplicated without consent as listed below.

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System Notes

Use the following pages to enter data pertaining to your system This information may be required if you need to call a dealer for technical assistance or you have a system failure.

Computer

Make: ____________________
Model: ____________________
Serial No.: ____________________

Monitor

Make: ____________________
Model: ____________________
Serial No.: ____________________

System BIOS

Make: ____________________
Version: ____________________

Motherboard

Make: ____________________
Model: ____________________
Serial No.: ____________________
Bus Speed: ____________________
Wait States: ____________________
Memory Installed: ____________________

Floppy Drive A

Make: ____________________
Model: ____________________
Capacity: ____________________
Serial No.: ____________________

Floppy Drive B

Make: ____________________
Model: ____________________
Capacity: ____________________
Serial No.: ____________________

Extended Floppy #1

Make: ____________________
Model: ____________________
Capacity: ____________________
Serial No.: ____________________

Extended Floppy #2

Make: ____________________
Model: ____________________
Capacity: ____________________
Serial No.: ____________________

Hard Drive #1

Make: ____________________
Model: ____________________
Capacity: ____________________
Serial No.: ____________________
Heads: ____________________
Cylinders: ____________________
Sectors per Track: ____________________

Hard Drive #2

Make: ____________________
Model: ____________________
Capacity: ____________________
Serial No.: ____________________
Heads: ____________________
Cylinders: ____________________
Sectors per Track: ____________________

Tape Backup

Make: ____________________
Model: ____________________
Capacity: ____________________
Serial No.: ____________________

You may use the spaces below to paste a printout of your AUTOEXEC.BAT and CONFIG.SYS files.

AUTOEXEC.BAT

CONFIG.SYS

Software

Program: ____________________ Program: ____________________
Version: ____________________ Version: ____________________
Serial No.: ____________________ Serial No.: ____________________

Program: ____________________ Program: ____________________
Version: ____________________ Version: ____________________
Serial No.: ____________________ Serial No.: ____________________

Program: ____________________ Program: ____________________
Version: ____________________ Version: ____________________
Serial No.: ____________________ Serial No.: ____________________

Program: ____________________ Program: ____________________
Version: ____________________ Version: ____________________
Serial No.: ____________________ Serial No.: ____________________

Glossary

ACCESS
The process of obtaining data from, or transferring data to a storage device, register, or RAM. (i.e. accessing a memory location).

ACCESS TIME
Time required to perform an ACCESS. Usages, i.e.: 1) seek to location on a disk, 2) amount of time to read or write to a memory location , 3) the time to position to the correct location in a disk drive. Access time is often defined as the time from the leading edge of the first step pulse received to SEEK COMPLETE (including settling). The additional time required before a read or write is referred to as "latency". A more realistic definition of total access time is the sum of SEEK, LATENCY, and SETTLING times.

ACTUATOR
See also HEAD POSITIONER

The two basic types of actuators are steppers and voice coils. Open-loop steppers are obsolete, except in floppy disks because they cannot achieve positioning accuracy and speed as high as closed-loop voice coil systems. For more information on actuators, see the Basic Drive Operation section.

ADDRESS (physical)
A specific location in memory where a byte, or other unit of data like a disk sector is stored. Each area on a disk is given a unique address consisting of three components: cylinder number, sector number, and head number. CYLINDER ADDRESSING is accomplished by assigning numbers to the disk's surface concentric circles (cylinders). The cylinder number specifies the radial address component of the data area. SECTOR ADDRESSING is accomplished by numbering the data records (sectors) from an index that defines the reference angular position of the disks. Index records are then counted by reading their ADDRESS MARKS. HEAD ADDRESSING is accomplished by vertically numbering the disk surfaces, usually starting with the bottom-most disk data surface. For example, the controller might send the binary equivalent of the decimal number 610150 to instruct the drive to access data at cylinder 610, sector 15, and head 0.

ADDRESS MARK
Two byte address at the beginning of both the ID field and the data field of the track format. The first byte is the "A1" data pattern, the second byte is used to specify either an ID field or a data field.

ADJUSTABLE INTERLEAVE
Interleaving permits access to more than one memory module, i.e., if one memory module contains odd-numbered address and another even-numbered address, they can both be accessed simultaneously for storage. If the interleave is adjustable, the user may select which ranges or areas are to be accessed each time.

ANSI
American National Standards Institute

APPLICATION PROGRAM
A sequence of programmed instructions that tell the computer how to perform an end use task (i.e. accounting, word processing or other work for the computer system user). To use a program, it must first be loaded into MAIN MEMORY from a floppy diskette or hard disk.

AREAL DENSITY
Bit density (bits per inch, or BPI) multiplied by track density (tracks per inch, or TPI), or bits per square inch of the disk surface. Bit density is measured around a track (circumference around on the disk), and track density is radially measured.

ASCII
American Standard for Coded Information Interchange.

ASME
American Society of Mechanical Engineers

ASYNCHRONOUS DATA
Data sent usually in parallel mode without a clock pulse. Time intervals between transmitted bits may be of unequal lengths.

AT INTERFACE
Disk drive interface on the IBM PC-AT computer and compatibles, sometimes called the IDE (Integrated Drive Electronics interface.

AUTOMATIC BACK UP OF FILES
This gives a user the security to make changes to a file without worrying about accidentally destroying it; there is always another copy. One weakness of this method is that files take up twice the room on a disk.

AUXILIARY MEMORY
Memory other than main memory; generally a mass storage subsystem, it can include disk drives, backup tape drives, controllers and buffer memory. Typically, AUXILIARY MEMORY is non-volatile.

AUXILIARY STORAGE DEVICE

Devices, generally magnetic tape and magnetic disk, on which data can be stored for use by computer programs. Also known as secondary storage.

AVERAGE ACCESS TIME

The average track access time, calculated from the end of the CONTROLLER commands to access a drive, to drive Seek complete time averaged over all possible track locations at the start of ACCESS, and over all possible data track ADDRESSES. Typically, the minimum average access time including carriage settling for open loop actuators is less than 85 ms and for voice coil disk drives is less than 40 ms. As technology improves these times will continue to decrease.

AZIMUTH

The angular distance in the horizontal plane, usually measured as an angle from true track location.

BACKUP DEVICE

Disc or tape drive used with a fixed Winchester disk drive to make copies of files or other data for off line storage, distribution or protection against accidental data deletion from the Winchester drive, or against drive failure.

BACKUP FILE

File copies made on another removable media device (disk, tape or sometimes a remote hard disk system) and kept to ensure recovery of data lost due to equipment failure, human errors, updates, disasters and the like.

BAUD RATE

A variable unit of data transmission speed equal to one bit per second.

BCAI

Byte Count After Index. Used in defect mapping to indicate the position of defects with relation to index.

BDOS

The Basic Disk Operating System (BDOS) controls the organization of data on a disk. BDOS is usually pronounced "B-DOS".

BI-DIRECTIONAL BUS

A bus that may carry information in either direction but not in both simultaneously i.e. the SCSI data bus.

BINARY

A number system like the decimal numbers, but using 2 as its base and having only the two digits 0 (zero) and 1 (one). It is used in computers because digital logic can only determine one of two states - "OFF" and "ON." Digital data is equivalent to a binary number.

BIOS (Basic Input Output System)

A collection of information (firmware) that controls communication between the Central Processor and its peripherals.

BIT

The smallest unit of data. Consists of a single binary digit that can take the value of 0 or 1.

BIT CELL LENGTH

Physical dimension of the bit cell in direction of recording along the disk circumference of a track.

BIT CELL TIME

The time required to pass one bit of information between the controller and the drive. Cell time is the inverse of the drive's data rate; nominally 200 nsec for 5 Mhz drives.

BIT DENSITY

Expressed as "BPI" (for bits per inch), bit density defines how many bits can be written onto one inch of a track on a disk surface. It is usually specified for "worst case", which is the inner track. Data is the densest in the inner tracks where track circumferences are the smallest.

BIT JITTER

The time difference between the leading edge of read and the center of the data window. A source of errors in hard disks. Bit Jitter is caused by spindle speed variations, electrical noise, and mechanical vibrations.

BIT SHIFT

A data recording effect, which results when adjacent 1's written on magnetic disks repel each other. The "worst case" is at the inner cylinder where bits are closest together. BIT SHIFT is also called pulse crowding.

BLOCK

A group of BYTES handled, stored and accessed as a logical data unit, such as an individual file record. Typically, one block of data is stored as one physical sector of data on a disk drive. Normally a 512 byte sector in most SCSI devices.

BOOT

(Short for bootstrap). Transfer of a disk operating system program from storage on diskette or hard disk drive to computer's working memory.

BUFFER

A temporary data storage area that compensates for a difference in data transfer rates and/or data processing rates between sender and receiver.

BUFFERED SEEK

A feature of the ST412 INTERFACE. In buffered mode head motion is postponed until a string of step pulses can be sent to the drive. These pulses represent the number of tracks that the head is to be stepped over and are sent much faster than the heads can move. The pulses are saved or buffered then the optimum head movement to the correct track is performed.

BUS

A length of parallel conductors that forms a major interconnection route between the computer system CPU and its peripheral subsystems. Depending on its design, a bus may carry data to and from peripheral's addresses, power, and other related signals.

BYTE

A sequence of adjacent BINARY digits or BITS considered as a unit, 8 bits in length. One byte is sufficient to define all the alphanumeric characters. There are 8 BITS in 1 BYTE. The storage capacity of a disk drive is commonly measured in MEGABYTES, which is the total number of bits storable, divided by eight million.

CACHE MEMORY

Cache Memory allows the system to load bytes of frequently used data from the hard disk to memory. The system may then refer to memory for information instead of going back to the hard disk, thereby increasing the processing speed.

CAPACITY

Amount of memory (measured in megabytes) which can be stored in a disk drive. Usually given as formatted (see FORMAT OPERATION).

CARRIAGE ASSEMBLY

Assembly which holds read/write heads and roller bearings. It is used to position the heads radially by the actuator, in order to access a track of data.

CENTRAL PROCESSOR UNIT (CPU)

The heart of the computer system that executes programmed instructions. It includes the arithmetic logic unit (ALU) for performing all math and logic operations, a control section for interpreting and executing instructions, fast main memory for temporary (VOLATILE) storage of an application program and its data.

CHARACTER

An information symbol used to denote a number, letter, symbol or punctuation mark stored by a computer. In a computer a character can be represented in one (1) byte or eight (8) bits of data. There are 256 different one-byte binary numbers, sufficient for 26 lower case alphas, 26 upper case alphas, 10 decimal digits, control codes and error checks.

CHIP

An integrated circuit fabricated on a chip of silicon or other semiconductor material, typically an integrated circuit, a microprocessor, memory device, or a digital logic device.

CLOCK RATE

The rate at which bits or words are transferred between internal elements of a computer or to another computer.

CLOSED LOOP

A control system consisting of one or more feedback control loops in which functions of the controlled signals are combined with functions of the command to maintain prescribed relationships between the commands and the controlled signals. This control technique allows the head actuator system to detect and correct off-track errors. The actual head position is monitored and compared to the ideal track position, by reference information either recorded on a dedicated servo surface, or embedded in the inter-sector gaps. A position error is used to produce a correction signal (FEEDBACK) to the actuator to correct the error. See TRACK FOLLOWING SERVO.

CLUSTER SIZE

An operating system term describing the number of sectors that the operating system allocates each time disk space is needed. A cluster is the standard group of data which is accessed by the operating system. DOS cluster sizes increase with drive capacity.

CODE

A set of rules specifying the way which digital data is represented as magnetized bits, on a disk drive. The main objectives of coding are to pack the maximum number of binary bits in the smallest space on the disk. MFM and RLL are coding techniques.

COERCIVITY

A measurement in units of orsteads of the minimum amount of magnetic energy required to cause a reversal in the magnetic dipole moments of a recording media.

COMMAND

1) An instruction sent by the central processor unit (CPU) to a controller for execution. 2) English-like commands entered by users to select computer programs or functions. 3) A CPU command, which is a single instruction such as "add two binary numbers" or "output a byte to the display screen."

CONSOLE (also called CRT or Terminal)

A device from which a computer can be operated; often includes a monitor and keyboard.

CONTROLLER

A controller is a printed circuit board required to interpret data access commands from host computer (via a BUS), and send track seeking, read/write, and other control signals to a disk drive. The computer is free to perform other tasks until the controller signals DATA READY for transfer via the CPU BUS.

CORE

Originally a computer's main memory was made of ferrite rings (CORES) that could be magnetized to contain one or two bits of data each. CORE MEMORY is synonymous with

MAIN MEMORY. Main memory today is fabricated from CHIPS, usually DRAM.

CRASH

A malfunction in the computer hardware or software, usually causing loss of data.

CYCLIC-REDUNDANCY-CHECK (CRC)

Used to verify data block integrity. In a typical scheme, Two CRC bytes are added to each user data block. The two bytes are computed from the user data, by digital logical chips. The mathematical model is polynomials with binary coefficients. When reading back data, the CRC bytes are read and compared to new CRC bytes computed from the read back block to detect a read error. The read back error check process is mathematically equivalent to dividing the read block, including its CRC, by a binomial polynomial. If the division remainder is zero, the data is error free.

CYLINDER

The cylindrical surface formed by identical track numbers on vertically stacked disks. In a drive with dedicated servo, at any location of the head positioning arm, all tracks under all heads are the cylinder. Cylinder number is one of the three address components required to find a specific ADDRESS, the other two being head number and sector number.

DAISY CHAIN

A way of connecting multiple drives to one controller. The controller drive select signal is routed serially through the drives, and is intercepted by the drive whose number matches. The disk drives have switches or jumpers on them which allow the user to select the drive number desired.

DATA

Information processed by a computer, stored in memory, or fed into a computer.

DATA ACCESS

When the controller has specified all three components of the sector address to the drive, the ID field of the sector brought under the head by the drive is read and compared with the address of the target sector. A match enables access to the data field of the sector.

DATA ADDRESS

To return to the same area on the disk, each area is given a unique address consisting of the three components: cylinder, head and sector numbers. HORIZONTAL: accomplished by assigning numbers to the concentric circles (cylinders) mapped out by the heads as the positioning arm is stepped radially across the surface, starting with 0 for the outermost circle. By specifying the cylinder number the controller specifies a horizontal or radial address component of the data area. ROTATIONAL: once a head and cylinder have been addressed, the desired sector around the selected track of the selected surface is found by counting address marks from the index pulse of the track. Remember that each track starts with an index pulse and each sector starts with an address mark. VERTICAL: assume a disk pack with six surfaces, each with its own read/write head, vertical addressing is accomplished by assigning the numbers 00 through XX to the heads, in consecutive order. By specifying the head number, the controller specifies the vertical address component of the data area.

DATA BASE

An organized collection of data stored in DISK FILES, often shared by multiple users., i.e., the Official Airline Guide, which contains up-to-date schedules for all airlines.

DATA BASE MANAGEMENT SYSTEM (DBMS)

Application program used to manage, access and update files in a data base.

DATA ENCODING

To use a code such as GCR, MFM, RLL, NZR, etc. to represent characters for memory storage.

DATA FIELD

The portion of a sector used to store the user's DIGITAL data. Other fields in each sector include ID, SYNC and CRC which are used to locate the correct data field.

DATA SEPARATOR

Controller circuitry takes the CODED playback pulses and uses the timing information added by the CODE during the write process to reconstruct the original user data record. See NRZ, MFM, and RLL.

DATA TRACK

Any of the circular tracks magnetized by the recording head during data storage.

DATA TRANSFER RATE (DTR)

Speed at which bits are sent: In a disk storage system, the communication is between CPU and controller, plus controller and the disk drive. Typical units are bits per second (BPS), or bytes per second, i.e., ST506/412 INTERFACE allows 5 Mbits/sec. transfer rate, and WIDE SCSI supports a 20MByte/sec (160Mbit/sec) transfer rate.

DECREASE THE FLYING HEIGHT

Since the head core is closer to the media surface, the lines of flux magnetize a smaller area. Thus, more bits can be recorded in a given distance, and higher BPI (bits per inch) is achievable.

DEDICATED SERVO SYSTEM

A complete disk surface is dedicated for servo data. This technique offers quicker access times, but less accuracy as it does not provide a method to compensate for thermal warpage of the head stack assembly.

DEFAULT
A particular value of a variable which is used by a computer unless specifically changed, usually via an entry made through a software program.

DENSITY
Generally, bit recording density. SEE AREAL, BIT and STORAGE DENSITY.

DIGITAL
Any system that processes digital binary signals having only the values of a 1 or 0. An example of a non-digital signal is an analog signal which continuously varies, i.e., TV or audio.

DIGITAL MAGNETIC RECORDING
See MAGNETIC RECORDING

DIRECT ACCESS
Generally refers to an AUXILIARY MEMORY device, having all data on-line. I.E., a tape drive without a tape mounted is not direct access, but a WINCHESTER DRIVE is direct access.

DIRECTORY
A special disk storage area (usually cylinder zero) that is read by a computer operating system to determine the ADDRESSES of the data records that form a DISK FILE.

DISK FILE
A file of user data, i.e. the company employee list, with all names and information. The data in the file is stored in a set of disk SECTORS (records).

DISK OPERATING SYSTEM (DOS)
A computer program which continuously runs and mediates between the computer user and the APPLICATION PROGRAM, and allows access to disk data by DISK FILE names.

DISK PACK
A number of metal disks packaged in a canister for removal from the disk drive. WINCHESTER DRIVES do not have disk packs.

DISK PLATTER
For rigid disks, a flat, circular aluminum disk substrate, coated on both sides with a magnetic substance (iron oxide or thin film metal media) for non-VOLATILE data storage. The substrate may consist of metal, plastic, or even glass. Surfaces of disks are usually lubricated to minimize wear during drive start-up or power down.

DISK STORAGE
Auxiliary memory system containing disk drives.

DISKETTE
A floppy disk. A plastic (mylar) substrate, coated with magnetic iron oxide, enclosed in a protective jacket.

DOS (Disc Operating System)
A computer program which runs continuously and mediates between the computer user and the application program and allows access to the disk data by disk file names.

DRIVE
A computer memory device with moving storage MEDIA (disk or tape).

DRIVE SELECT
An ADDRESS component that selects among a string of drives attached to a disk controller. In the ST 506/412 interface standard, a drive's select code is physically set in the drive to a value between 0 and 3. When the controller activates one of the four drive select code lines in the J1 cable, the selected drive is enabled to respond to access commands from the controller.

DRIVE TYPE
A number representing a standard configuration of physical parameters (cylinders, heads, and sectors) of a particular type of disk drive. Each AT system BIOS contains a list of drive types that the system considers "Standard Types". These types are not necessarily the same from one BIOS to the next. That is, drive type 25 on one BIOS may represent a drive that has 615 cylinders, 4 data heads, and 17 sectors per track, while type 25 on another BIOS could be totally different.

DROP-IN/DROP-OUT
Types of disk media defects usually caused by a pin-hole in the disk coating. If the coating is interrupted, the magnetic flux between medium and head is zero. A large interruption will induce two extraneous pulses, one at the beginning and one at the end of the pin-hole (2 DROP-INs). A small coating interruption will result in no playback from a recorded bit (a DROP-OUT).

DRUM
An early form of rotating magnetic storage, utilizing a rotating cylindrical drum and a multiplicity of heads (one per track). Discs stack more compactly than drums.

ECC (Error Correction Code)
The ECC hardware in the controller used to interface the drive to the system can typically correct a single burst error of 11 bits or less. This maximum error burst correction length is function of the controller. With some controllers the user is allowed to the select this length. The most common selection is 11.

ELECTRO-STATIC DISCHARGE (ESD)
An integrated circuit (CHIP) failure mechanism. Since the circuitry of CHIPs are microscopic in size, they can be damaged or destroyed by small static discharges. People handling electronic equipment should always ground themselves before touching the equipment. Electronic equipment should always be handled by the chassis or frame. Components, printed circuit board edge connectors should never be touched.

EMBEDDED SERVO SYSTEM

Servo data is embedded or superimposed along with data on every cylinder.

ERASE

To remove previously recorded data from magnetic storage media.

ERROR

See HARD ERROR and SOFT ERROR.

ESDI (Enhanced Small Device Interface)

A set of specifications for the drives. See also SCSI.

EXECUTE

To perform a data processing operation described by an instruction or a program in a computer.

FCI (Flux Changes per Inch)

Synonymous with FRPI (flux reversals per inch). In MFM recording 1 FCI equals 1 BPI (bit per inch). In RLL encoding schemes, 1 FCI generally equals 1.5 BPI.

FEEDBACK

A closed-loop control system, using the head-to-track positioning signal (from the servo head) to modify the HEAD POSITIONER signal (to correctly position the head on the track).

FETCH

A CPU read operation from MAIN MEMORY and its related data transfer operations.

FIELDS

Storage units grouped together to make a record are considered to be a field; i.e., a record might be a company's address; a field in the record might be the company's ZIP code.

FILE (See DISK FILE)

A file consists of a group of logically related records that, in turn, are made up of groups of logically related fields.

FILE ALLOCATION TABLE (FAT)

What the operating systems uses to keep track of which clusters are allocated to which files and which are available for use. FAT is usually stored on Track-0.

FILE NAME

Each file has a name, just like the name on the tab of a file folder. When you want DOS to find a file, you give DOS the file name.

FIRMWARE

A computer program written into a storage medium which cannot be accidentally erased, i.e., ROM. It can also refer to devices containing such programs.

FIXED DISK

A disk drive with disks that cannot be removed from the drive by the user, i.e., WINCHESTER DISK DRIVE.

FLOPPY DISK

A flexible plastic disk coated with magnetic media and packaged in a stiff envelope. Comes in 8-inch, 5-1/4-inch, and various sub-4 inch sizes. FLOPPY DISKS generally exhibit slow ACCESS TIME and smaller CAPACITY compared to WINCHESTER DRIVES, but feature removable diskettes.

FLUX CHANGE

Location on the data track, where the direction of magnetization reverses in order to define a 1 or 0 bit.

FLUX CHANGES PER INCH (FCI)

Linear recording density defined as the number of flux changes per inch of data track.

FM

Frequency modulation CODE scheme, superseded by MFM, which is being superseded by RLL.

FORMAT

The purpose of a format is to record "header" data that organize the tracks into sequential sectors on the disk surfaces. This information is never altered during normal read/write operations. Header information identifies the sector number and also contains the head and cylinder ADDRESS in order to detect an ADDRESS ACCESS error.

FORMATTED CAPACITY

Actual capacity available to store user data. The formatted capacity is the gross capacity, less the capacity taken up by the overhead data used in formatting the disks. While the unformatted size may be 24 M bytes, only 20 M bytes of storage may actually be available to the user after formatting.

FPI (flux changes per inch), also FRPI

The number of Flux Reversals per inch.

FRICTION

Resistance to relative motion between two bodies in contact; i.e., there is sliding friction between head and disk during drive power up/down.

FULL HEIGHT DRIVE

Winchester 5-1/4" drive which fits in the same space as full height mini-floppy drive (called the full-height form factor).

G

A G is a unit of force applied to a body at rest equal to the force exerted on it by gravity. Hard disk drive shock specifications are usually called out in Gs. A shock specification of 40 Gs non-operating means that a drive will not suffer any permanent damage if subjected to a 40 G shock. This is roughly equivalent to a drop of the drive to a hard surface from a distance of 1 inch.

GAP

1. FORMAT: Part of the disk format. Allows mechanical compensations (i.e. spindle motor rotational speed variations) without the last sector on a track overwriting the first sector. 2. HEAD: An interruption in the permeable head material, usually a glass bonding material with high permeability, allowing the flux fields to exit the head structure to write / read data bits in the form of flux changes on the recording media.

GAP LENGTH

Narrowing the head gap length achieves higher bit density because the lines of force magnetize a smaller area where writing data in the form of flux changes on the recording media.

GAP WIDTH

The narrower the gap width, the closer the tracks can be placed. Closer track placement results in higher TPI.

GCR (Group Code Encoding)

Data encoding method. See the encoding section in "DIsk Drive Operation"

GUARD BAND

1. Non-recorded band between adjacent data tracks, 2. For closed loop servo drives, extra servo tracks outside the data band preventing the Carriage Assembly from running into the crash stop.

HALF HEIGHT DRIVE

A Winchester drive which fits in one half of the space of a full height mini-floppy drive

HARD DISK DRIVE

Commonly called rigid disk drives, or Winchester disk drives. An electromechanical device that can read rigid disks. Though similar to floppy disk drives, the hard disks have higher bit density and multiple read/write surfaces.

HARD ERROR

An error that occurs repeatedly at the same location on a disk surface. Hard errors are caused by imperfections in the disk surface, called media defects. When formatting hard disk drives, hard error locations, if known, should be spared out so that data is not written to these locations. Most drives come with a hard error map listing the locations of any hard errors by head, cylinder and BFI (bytes from index - or how many bytes from the beginning of the cylinder).

HARD ERROR MAP

Also called defect map, bad spot map, media map. Media defects are avoided by deleting the defective sectors from system use, or assigning an alternative track (accomplished during format operation). The defects are found during formatting, and their locations are stored on a special DOS file on the disk, usually on cylinder 0.

HARD SECTOR MODE

A hardware controlled convention defining a fixed number of sectors per track in any specified zone.

HARDWARE

Computer equipment (as opposed to the computer programs and software).

HDA (Head/Disk Assembly)

A sealed Winchester assembly including disks, heads, filter and actuator assembly.

HEAD

An electromagnetic device that can write (record), read (playback), or erase data on magnetic media. There are three types:

Head Type	BPI	TPI	Areal density
Monolithic	8000	900	10 to 6th
Composite	12000	2000	10 to 8th
Thin-film	25000	3000	10 to 9th

HEAD CRASH

A head landing occurs when the disk drive is turned on or off. This function normally does not damage the disk as the disk has a very thin lubricant on it. A head crash occurs when the head and disk damage each other during landing, handling or because a contaminant particle gets between them. Head crash is a catastrophic failure condition and causes permanent damage and loss of data.

HEAD LANDING AND TAKEOFF

In Winchester drives, the head is in contact with the platter when the drive is not powered. During the power up cycle, the disk begins rotation and an "air bearing" is established as the disk spins up to full RPM (rotations per minute). This air bearing prevents any mechanical contact between head and disk.

HEAD LANDING ZONE

An area of the disk set aside for takeoff and landing of the Winchester heads when the drive is turned on and off.

HEAD POSITIONER

Also known as the ACTUATOR, a mechanism that moves the CARRIAGE ASSEMBLY to the cylinder being accessed.

HEAD SLAP

Similar to a head crash but occurs while the drive is turned off. It usually occurs during mishandling or shipping. Head slap can cause permanent damage to a hard disk drive. See HEAD CRASH.

HEXADECIMAL (HEX)

A number system based on sixteen, using digits 0 through 9 and letters A through F to represent each digit of the number. (A = 10, B = 11, C = 12, D = 13, E = 14, F = 15).

ID FIELD

The address portion of a sector. The ID field is written during the Format operation. It includes the cylinder, head, and sector number of the current sector. This address information is compared by the disk controller with the desired head, cylinder, and sector number before a read or write operation is allowed.

IDE (Imbedded Drive Electronics)

A popular electronic interface standard for hard drives used in IBM XT and AT compatible computers. IDE drives use an embedded microprocessor to control both the drive and bus control logic. Using one microprocessor for both functions saves costs and eliminates the need for an intelligent controller card.

IMAGE-BACKUP MODE

Used with streaming tape, image-backup mode records an exact copy of the disk, including unused sectors and bad tracks.

INDEX (PULSE)

The Index Pulse is the starting point for each disk track. The index pulse provides initial synchronization for sector addressing on each individual track.

INDEX TIME

The time interval between similar edges of the index pulse, which measures the time for the disk to make one revolution. This information is used by a disk drive to verify correct rotational speed of the media.

INPUT

1. Data entered into the computer to be processed.
2. User commands or queries.

INPUT/OUTPUT

The process of entering data into or removing data from a computer system.

INTELLIGENT PERIPHERAL

A peripheral device that contains a processor or microprocessor to enable it to interpret and execute commands, thus relieving the computer for other tasks.

INTERFACE

The protocol data transmitters, data receivers, logic and wiring that link one piece of computer equipment to another, such as a disk drive to a controller or a controller to a system bus. Protocol means a set of rules for operating the physical interface, i.e., don't read or write before SEEK COMPLETE is true.

INTERFACE STANDARD

The interface specifications agreed to by various manufacturers to promote industry-wide interchange ability of products such as disk drives and controllers. An interface standard generally reduces product costs, allows buyers to purchase from more than one source, and allows faster market acceptance of new products. (See ST-506/412, SCSI, ESDI)

INTERLEAVE FACTOR

The ratio of physical disk sectors skipped for every sector actually written.

INTERLEAVING

The interleave value tells the controller where the next logical sector is located in relation to the current sector. For example, an interleave value of one (1) specifies that the next logical sector is physically the next sector on the track. Interleave of two (2) specifies every other physical sector, three (3) every third sector and so on. Interleaving is used to improve the system throughout based on overhead time of the host software, the disk drive and the controller; i.e., if an APPLICATION PROGRAM is processing sequential logical records of a DISK FILE in a CPU time of more than one second but less than two, then an interleave factor of 3 will prevent wasting an entire disk revolution between ACCESSES.

INTERRUPT

A signal, usually from a peripheral device to a CPU, to signify that a commanded operation has been completed or cannot be completed.

I/O PROCESSOR

Intelligent processor or controller that handles the input/output operations of a computer.

KILOBYTE (KBYTE)

1) 1024 bytes (two to the tenth power, this is the normal definition); 2) 1000 bytes; (this definition is used by disk drive companies to bolster the specified capacity of their drives.

LAN

Local Area Network

LANDING ZONE

The landing zone is where the read/write head sits when it is not active. If the system features a dedicated landing zone, the head will rest on the same track each time.

LATENCY (ROTATIONAL)

The time for the disk to rotate the accessed sector under the head for read or write. Average latency is usually slightly more than the time for half of a disk revolution.

LOGIC

Electronic circuitry that switches on and off ("1" and "0") to perform digital operations.

LOOKUP
The action of obtaining and displaying data in a file.

LOW LEVEL FORMAT
The first step in preparing a drive to store information after physical installation is complete. The process sets up the "handshake" between the drive and the controller. In an XT system, the low level format is usually done using DOS's debug utility. In an AT system, AT advanced diagnostics is typically used. Other third-party software may also be used to do low level format on both XTs and ATs.

LUN
Logical Unit Number

MAGNETIC MEDIA
A disk or tape with a surface layer containing particles of metal, or metallic oxides that can be magnetized in different directions to represent bits of data, sounds or other information.

MAGNETIC RECORDING
The use of a head, recording head, recording media (tape or disk), and associated electronic circuitry for storing data or sound or video.

MAINFRAME COMPUTER
A large computer generally found in data processing centers. See MINICOMPUTER AND MICROCOMPUTER. MAIN MEMORY Random-access memory used by the CPU for storing program instructions and data currently being processed by those instructions. See RANDOM-ACCESS MEMORY.

MEAN TIME BEFORE FAILURE (MTBF)
The average time before a failure will occur. This is not a warranty measurement. MTBF is a calculation taking into consideration the MTBF of each component in a system and is the statistical average operation time between the start of a unit's lifetime and its time of a failure. After a product has been in the field for a few years, the MTBF can become a field proven statistic.

MEAN TIME TO REPAIR (MTTR)
The average time to repair a given unit. Limited to a qualified technician with proper equipment.

MEDIA
The magnetic layers of a disk or tape. See DISK/PLATTER.

MEDIA DEFECT
A media defect can cause a considerable reduction of the read signal (missing pulse or DROP-OUT), or create an extra pulse (DROP-IN). See HARD ERROR MAP.

MEGABIT (Abbreviated Mb)
One million bits. Not to be confused with megabyte (MB) see below. There are usually 8 bits in a byte.

MEGABYTE (Abbreviated MB)
1. 2 to the 20th power (1024K) This is the industry standard definition. 2. One million bytes (exactly 1,000,000 bytes). This definition is used by disk drive companies.

MEMORY
Any device or storage system capable of storing and retrieving information. See also STORAGE DEFINITIONS.

MICROCOMPUTER
A computer whose central processor unit (CPU) is manufactured as a chip or a small number of chips. Personal computers are examples of microcomputers.

MICROINCH (uin)
One-millionth of an inch.

MICROSECOND (us)
One-millionth of a second.

MILLISECOND (Msec)
One-thousandth of a second.

MINICOMPUTER
A computer midway in size and processing power between a MICROCOMPUTER and a MAINFRAME COMPUTER.

MINI-SLIDER HEADS
Manganese/Zinc Ferrite Winchester heads. Smaller, lighter heads with stiffer load arms than standard Winchester heads. They allow smaller flying heights, and therefore higher bit and track density, if they are made with smaller and narrower gaps.

MINI WINCHESTER
A Winchester disk drive with 5-1/4 or 3-1/2 inch diameter disks.

MNEUMONIC
A shortened abbreviation for a series of codes.

MODIFIED FREQUENCY MODULATION (MFM)
A method of recording digital data, using a particular CODE to get the flux reversal times from the data pattern. MFM recording is self-clocking because the CODE guarantees timing information for the playback process. The controller is thus able to synchronize directly from the data. This method has a maximum of one bit of data with each flux reversal. (See NRZ, RLL).

MULTIPROCESSOR
A computer containing two or more processors.

MULTITASKING
The ability of a computer system to execute more than one program or program task at a time.

MULTIUSER
The ability of a computer system to execute programs for more than one user at a time.

NOISE
Extraneous electronic signals that interfere with information signals (similar to radio static or TV interference). Sources of noise in computers can be power supplies, ground loops, radio interference, cable routing, etc.

NRZ (Non-Return to Zero)
1) User digital data bits; 2) A method of magnetic recording of digital data in which a flux reversal denotes a one bit, and no flux reversal a zero bit, NRZ recording requires an accompanying synchronization clock to define each cell time unlike MFM or RLL recording).

OFF LINE
Processing or peripheral operations performed while not connected to the system CPU via the system BUS.

OPEN COLLECTOR
A type of output structure found in certain bipolar logic families. The device has an NPN transistor with grounded emitter that enables it to output to a low voltage level only. When the device is inactive, an external resistor holds the device output at a high voltage level.

OPERATING SYSTEM
An operating system is a program which acts as an interface between the user of a computer and the computer hardware. The purpose of the operating system is to provide an environment in which a user may run programs. The goal of the operating system is to enable the user to conveniently use the computer's resources such as the CPU, memory, storage devices and printers.

OUTPUT
Processing data being transferred out of the computer system to peripherals (i.e. disk, printer, etc.). This includes responses to user commands or queries.

PARITY
A computer data checking method using an extra bit in which the total number of binary 1's (or 0's) in a byte is always odd or always even; thus, in an odd parity scheme, every byte has eight bits of data and one parity bit. If using odd parity and the number of 1 bits comprising the byte of data is not odd, the 9th or parity bit is set to 1 to create the odd parity. In this way, a byte of data can be checked for accurate transmission by simply counting the bits for an odd parity indication. If the count is ever even, an error is indicated.

PARKING
Parking the disk drive heads means the recording heads are moved so that they are not over the platter's data area. Many drives have an auto-park feature where the heads are automatically parked when power to the drive is shut off. Other drives require the user to run some kind of parking software to park the heads.

PARTITIONING
Method for dividing an area on disk drive for use by more than one disk operating system or for dividing large disk drives into areas which the File Allocation Table (FAT) can deal with when in use. The current IBM DOS maximum partition size is 2000MB.

PATH
The DOS term "path" has three definitions and each definition involves directories. A PATH may be defined as: 1) the names of the chain of directories leading to a file; 2) the complete file or directory name; 3) a DOS command.

PERIPHERAL EQUIPMENT
Auxiliary memory, displays, printers, disk drives, and other equipment usually attached to computer systems' CPU by controllers and cables (they are often packaged together in a desktop computer).

PLATED THIN FILM DISKS
Magnetic disk memory media having its surface plated with a thin coating of a metallic alloy instead of being coated with oxide.

PLATTER
The round magnetic disk surfaces used for read/write operations in a hard disk system.

POLLING
A technique that discerns which of several devices on a connection is trying to get the processor's attention.

PRECOMPENSATION
Applied to write data by the controller in order to partially alleviate bit shift which causes adjacent 1's written on magnetic media physically to move apart. When adjacent 1's are sensed by the controller, precompensation is used to write them closer together on the disk, thus fighting the repelling effect caused by the recording. Precompensation is only required on some oxide media drives.

PREVENTIVE MAINTENANCE
A method of doing a scheduled routine observation or exchanging a part, prior to a breakdown of a piece of equipment.

PRINTED CIRCUIT BOARD (PCB)
A circuit board IC and other components, like the one attached to a drive.

PROCESSING (DATA PROCESSING)

The process of computer handling, manipulating, and modifying data such as arithmetic calculation, file lookup and updating, or word processing.

PROGRAM

A sequence of instructions stored in memory and executed by a processor or microprocessor. See also APPLICATIONS PROGRAMS.

PROTOCOL

A set of conventions governing the format of messages to be exchanged within a communications system.

RADIAL

A way of connecting multiple drives to one controller. In radial operation, all output signals are active even if the drive is not selected. Also see DAISY CHAIN.

RAM DISK

A system where part of the computer's random access memory is used to simulate a disk drive. The RAM disk and its contents will disappear if power is lost or the system is restarted. RAM is far faster (microseconds ACCESS TIME) than disks (milliseconds), so APPLICATIONS PROGRAMS which access the disk run faster.

RANDOM ACCESS MEMORY (RAM)

Memory where any location can be read from or written to in a random order. Random access memory usually refers to volatile memory where the contents are lost when power is removed. The user addressable memory of a computer is random access memory.

READ

To access a storage location and obtain previously recorded data.

RECALIBRATE

Return to Track Zero. A common disk drive function in which the heads are returned to track 0 (outermost track).

RECORD

A single unit made up of logically related fields.

REDUCED WRITE CURRENT

A signal input (to some older drives) which decreases the amplitude of the write current at the actual drive head. Normally this signal is specified to be used during inner track write operations to lessen the effect of adjacent bit "crowding." Most drives today provide this internally and do not require controller intervention.

REDUCED WRITE CURRENT

To minimize the effects of peak shift, on some drives, the magnitude of the write current is reduced on some of the innermost tracks. When installing a drive in a system, the number requested is the first track number to begin the area of reduced write current, that track and all subsequent tracks will be written with reduced write current.

RESOLUTION

With regards to magnetic recording, the band width (or frequency response) of the recording heads.

RLL (RUN LENGTH LIMITED CODE)

1) A method of recording digital data, whereby the combinations of flux reversals are coded/decoded to allow greater than one (1) bit of information per flux reversal. This compression of information increases data capacity by approximately 50 percent; 2) a scheme of encoding designed to operate with the ST412 interface at a dial transfer rate of 7.5 megabit/sec. The technical name of this specific RLL CODE used is "two, seven".

ROM (READ ONLY MEMORY)

A chip that can be programmed once with bits of information. This chip retains this information even if the power is turned off. When this information is programmed into the ROM, it is called burning the ROM.

ROTATIONAL SPEED

The speed at which the media spins. On 5-1/4 or 3-1/2" Winchester drives it is usually 3600 rpm.

SCSI

Small Computer Systems Interface. The current "high end" CPU-to-drive interface.

SCSI-II, SCSI-III

Refer to recent attempts by ANSI to standardize SCSI software and hardware improvements.

SECTOR

A sector is a section of a track whose size is determined by formatting. When used as an address component, sector and location refer to the sequence number of the sector around the track. Typically, one sector stores one user record of data. Drives typically are formatted from 17 to 26 sectors per track. Determining how many sectors per track to use depends on the system type, the controller capabilities and the drive encoding method and interface.

SECTOR-SLIP

Sector-slip allows any sector with a defect to be mapped and bypassed. The next contiguous sector is given that sector address.

SEEK

The radial movement of the heads to a specified track address.

SEEK COMPLETE

An ST506 interface signal from drive to controller which indicates that read/write heads have settled on the desired track and completed the seek.

SEQUENTIAL ACCESS

Writing or reading data in a sequential order, such as reading data blocks stored one after the other on magnetic tape (the opposite of random access).

SERVO TRACK

A prerecorded reference track on the dedicated servo surface of a closed-loop disk drive. All data track positions are compared to their corresponding servo track to determine "off-track/on-track" position.

Information written on the servo surface that the electronics of the drive uses to position the heads over the correct data track. This information is written on the drive by the servo track writer.

SETUP

Program used by AT type computers to store configuration in CMOS. This program is sometimes found in the system BIOS and can be accessed from the keyboard. On other systems, the program is on a diskette.

SILICON

Semiconductor substrate material generally used to manufacture microprocessors and other integrated circuit chips.

SKEWING

Some low-level formatting routines may ask for a Head and/or Cylinder Skew value. The value will represent the number of sectors being skewed to compensate for head switching time of the drive and/or track-to-track seek time allowing continuous read/write operation without losing disk revolutions.

SMD (Storage Module Device)

An 8" mainframe and minicomputer disk drive interface standard.

SMD (Surface Mounted Device)

A CHIP in a smaller integrated surface package, without connection leads.

SOFT ERROR

A bit error during playback which can be corrected by repeated attempts to read.

SOFT SECTOR MODE

A convention, defined by software, of setting a variable number of sectors per track in direct relationship to the drive's FCI rating in regards to the area of media that passes beneath the head. This scheme takes advantage of the fact that, in actual surface area, the outermost tracks are longer than the innermost.

SOFTWARE APPLICATION PROGRAMS

The Disc Operating System and other programs (as opposed to HARDWARE). The instructions or programs, usually stored on floppy or hard disks, which are used to direct the operations of a computer, or other hardware.

SOFTWARE PATCH

Software modification which allows or adds functions not otherwise available using the standard software program.

SPINDLE

The rotating hub structure to which the disks are attached.

SPINDLE MOTOR

The spindle motor is the electro-mechanical part of the disk drive that rotates the platters.

ST-506/ST-412 INTERFACE

An early industry standard interfaces between a hard disk and hard disk controller. In the ST-506/ST-412 interface, the "intellegence" is on the controller rather than the drive. See INTERFACE STANDARD, ESDI and SCSI.

STEP

An increment or decrement of the head positioning arm to move the heads in or out, respectively, one track from their current position. In buffered mode (open loop drives), the head motion is postponed until the last of a string of step pulses has been received.

STEPPER MOTOR

The stepper motor is the electro-mechanical part of the disk drive that positions the heads by step pulse on the tracks of the disk to read and write data.

STEP PULSE

The trigger pulse sent from the controller to the stepper motor on the step interface signal line to initiate a step operation.

STEP TIME

The time required by the drive to step the heads from the current cylinder position to a target cylinder.

STICTION

A slang term used in the drive industry to describe the condition when Winchester heads become "stuck" to a disk. This occurs when the disk lubricant hardens under the head.

STORAGE CAPACITY

Amount of data that can be stored in a memory, usually specified in kilobytes (KB) for main memory and floppy disk drives and megabytes (MB) for hard disk and tape drives.

STORAGE DENSITY

Usually refers to recording density (BPI, TPI, or their product, AREAL DENSITY).

STORAGE LOCATION

A memory location, identified by an ADDRESS, where information is to be read or written.

STORAGE MODULE DRIVE (SMD)

Storage module drive interface. An interface, used in larger disk drives, i.e. 8" & 14" drives.

SYNCHRONOUS DATA

Data sent, usually in serial mode, with a clock pulse.

TAPE DRIVE

A sequential access memory device whose magnetic media is tape in a cassette, reel or continuous loop.

THIN FILM HEADS

A read/write head whose read/write element is deposited using integrated circuit techniques rather than being manually fabricated by grinding ferrite and hand winding coils.

TPI

Tracks per inch.

TRACK

The radial position of the heads over the disk surface. A track is the circular ring traced over the disk surface by a head as the disk rotates under the heads.

TRACK ACCESS TIME

See AVERAGE ACCESS TIME.

TRACK DENSITY

See TPI.

TRACK FOLLOWING SERVO

A closed-loop positioner control system that continuously corrects the position of the disk drive's heads by utilizing a reference track and a feedback loop in the head positioning system. See also CLOSED LOOP.

TRACK PITCH

Distance from centerline to centerline of adjacent tracks (TPI divided into 1.0). New drives have track pitches approaching 3000 TPI.

TRACKS PER INCH

Track density, number of tracks per inch.

TRACK WIDTH

Width of data track. Also called core width of Read/ Write Head.

TRACK ZERO

Track zero is the outermost data track on a disk drive. In the ST 506 INTERFACE, the interface signal denotes that the heads are positioned at the outermost cylinder.

TRACK ZERO DETECTOR

An obsolete technology that RECALIBRATES by sensing when infrared beams between a LED and infrared sensitive photo-transistor are blocked by the track zero interrupter (TZI). In newer drives, the track position is encoded in the servo signals.

TUNNEL ERASE

An erase scheme where both sides of the recorded data are erased when writing data to eliminate track to track interference. This is primarily used on floppy disk drives.

UNFORMATTED (Capacity)

Drive byte capacity before formatting. Maximum capacity of a disk drive before formatting = (bits per track) x number of heads x # of cylinders. See MEGABYTE.

UPGRADE PATH

Generally, with disk products, a family having multiple products with varying capacities such that the system storage capacity can increase with changing application requirements simply using a different disk drive within the product family.

VERIFICATION

This feature lets the computer go back and read what it just wrote to disk to ensure the data was written correctly.

VOICE COIL MOTOR

An electro-magnetic positioning motor in the rigid disk drive similar to that used in audio speakers. A wire coil is placed in a stationary magnetic field. When current is passed through the coil, the resultant flux causes the coil to move. In a disk drive, the CARRIAGE ASSEMBLY is attached to the voice coil motor. Either a straight line (linear) or circular (rotary) design may be employed to position the heads on the disk's surface.

VOLATILE MEMORY

Memory that will be erased if power is lost. Typically, MAIN MEMORY is volatile, and AUXILIARY MEMORY is non-volatile and can be used for permanent (but changeable at will) storage of programs and data.

WAN

Acronym for Wide Area Network

WEDGE SERVO SYSTEM

A certain part of each TRACK contains servo positioning data. Gaps between each sector contain servo data to maintain head stack position on that cylinder. Identical to "EMBEDDED SERVO"

WINCHESTER DRIVE

A disk drive with a Winchester style (floats on air) heads and non-removable (fixed) disks sealed in a contaminant-free housing.

WORD

Number of bits processed in parallel (in a single operation) by a CPU. Standard word lengths are 8, 16, 32, and 64 (1, 2, 4 or 8 bytes).

WORM

Acronym for Write Once, Read Many. A non-erasable optical disk drive that operates by melting (ablating) a thin layer of media.

WRITE

To access a storage location and store data on the magnetic surface.

WRITE CURRENT

The amount of electrical current used to drive a magnetic recording head. The amount of write current necessary to saturate the magnetic media in different cell location will vary.

WRITE FAULT

Disc drive interface signal to the controller used to inhibit further writing when a condition exists in the drive which, if not detected, would cause improper writing on the disk. A "Write Fault Error" may occur if an operating system detects this bit is set or is unable to verify data written to disk.

XSMD

Extended storage module drive interface. A popular electrical interface for 8" drives used in minicomputer and mainframe applications.

ZBR (Zone Bit Recording) or ZONED RECORDING

A media optimization technique where the number of sectors per track is dependent upon the cylinder circumference. I.E. tracks on the outside cylinders have more sectors per track than the inside cylinders. ZBR is a Trademark of Seagate Technology. Zoned Recording is used to maximize the capacity of all modern hard disk drives.

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