CORPORATE SYSTEMS CENTER

HARD DRIVE BIBLE

EDITION VIII

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TABLE OF CONTENTS

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TABLE OF CONTENTS

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TABLE OF CONTENTS

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TABLE OF CONTENTS

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TABLE OF CONTENTS

TABLE OF CONTENTS

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TABLE OF CONTENTS

TABLE OF CONTENTS

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TABLE OF CONTENTS

TABLE OF CONTENTS

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TABLE OF CONTENTS

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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 that 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 that 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 mes-

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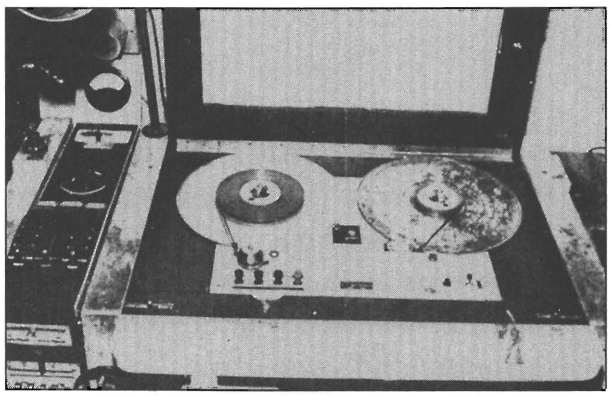
sages. By World War II the Germans had perfected the recording technology and manufactured high quality reel-to-reel tape recorders called Magnetophons. These tape recorders were nearly identical to today's high quality audio tape recorders.

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 in Redwood City 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. The 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, video and digital tape drives.



Magnetophon Recorder

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 (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 25 to 80Mbits per second data rates typical today! The popular name for this huge stack of disks at IBM was the "baloney slicer".

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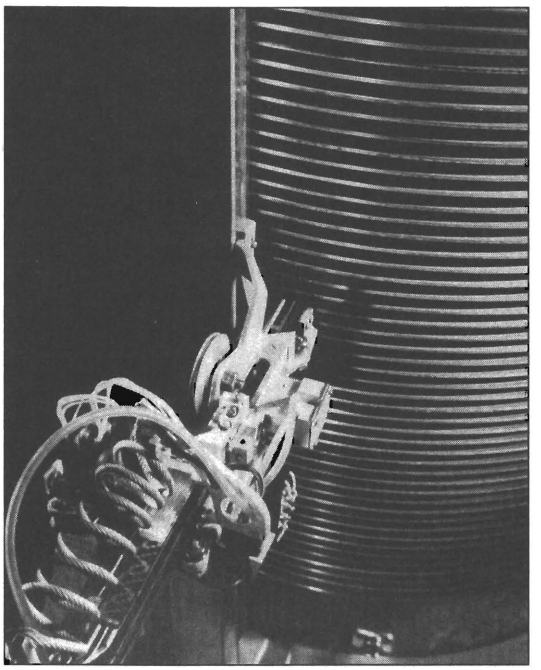
In 1955, realizing that magnetic recording density was severely limited by the number of linear stripes (tracks) on the tape, two brilliant engineers at Ampex Corporation, Charles Ginsburg and Ray Dolby, developed the helical scan recording system. Their ingenious scanning system uses a tiny spinning 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.



The Baloney Slicer!

In 1961, IBM pushed disk data storage ahead by announcing the 1301 Disk Storage unit that used aerodynamically shaped recording heads that "flew" above the surfaces of the spinning disks. This enabled 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.

During 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 Corporate Systems Center (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 to store and ship microcode. In

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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.

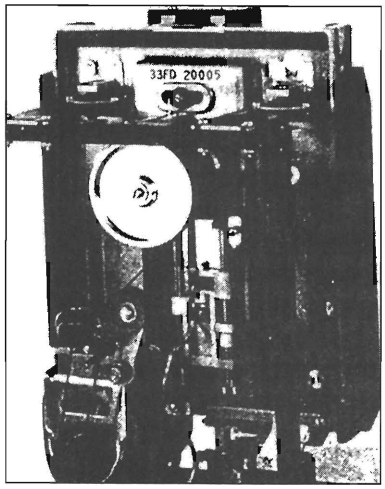
In 1970, IBM announced the 3330 Disk Storage Facility which was the first disk storage product to use an electrical feedback system called a "track-following servo" to control a "voice coil" motor that could quickly position recording heads at desired positions over the disk. This combination provided 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 that the US could never overcome.

In 1973, the first read-write floppy disk, the Igar (IBM 33FD), which stored an incredible (for it's time) 242,944 bytes - started shipping to customers. The original code 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. This term became an industry standard to



IBM 33FD Floppy Drive

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identify this "floating head" design.

In 1975, IBM announced the 3350 Direct Access Storage Device, which 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, that 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 50 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. Alan 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 that 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!

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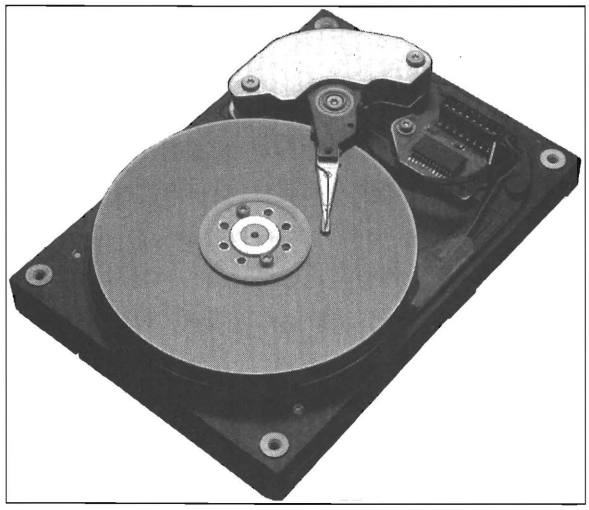
As sales of Apple Computer's Macintosh line of personal computers began to grow, the industry was introduced to the idea of using the Small Computer Systems Interface (SCSI) as a standard port for desktop PC peripherals. SCSI at this point was basically a glorified 8 bit parallel port. But SCSI would 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 created and made popular both the IDE interface and the 3.5" hard drive form factor. An enormous volume market for IDE drives grew in the next few years as IBM compatible desktop systems grew in popularity.

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.



Early Conner IDE Drive

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 created 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 boosted the capacity of standard diskettes to 2.88MB and "ZIP" diskettes to 100MB. 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 1994 with over 8GB of formatted capacity.

As we write the update to the Hard Drive Bible, it is now 1996. It's

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hard to predict the future, but I'll be glad to share a few thoughts on the data storage industry.

Compaq will soon ship Floptical drives with 120 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-R drives revolutionizing software distribution.

The hard disk industry, on the other hand, is moving faster than ever. Volumes are huge while only a few manufacturing companies are staying profitable because of the 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 hope Flash will kill hard drives. But our friends in Japan working on DVD optical disk drives feel that optical drives will win out in the long run. My opinion is unchanged. For the last ten years, I've had people tell me that something better will replace hard drives. Every time there's a technical advance in Flash or optical drive, there's a corresponding advance in magnetic 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 several more years at least.

In 1996, a major disk drive merger took place between Seagate and Conner Peripherals. 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 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.

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Some feel that magnetic recording technology has 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 selected 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 that 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, but hard drives will remain the best choice for non-removable applications.

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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 that usually also 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, operating in reverse to read data. 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, head carriage, 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

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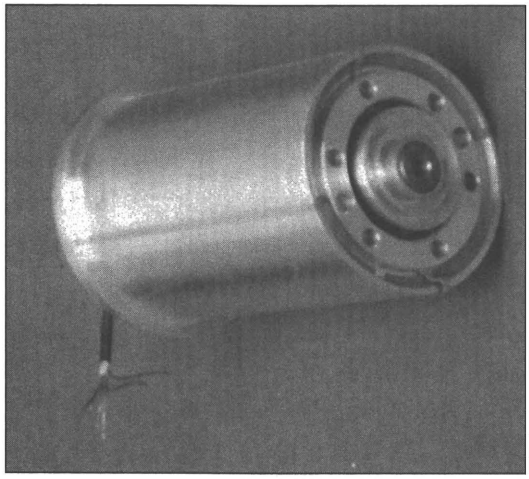
as the heat dissipation inside the drive. A motor with a high start-up torque is necessary since the extremely flat heads and disks used in modern drives tend to stick together when power is removed and the heads land on the disk. At the same time, the spindle motor must operate efficiently with a minimum 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 that uses pulse width modulation to minimize power consumption once the drive reaches operating speed.



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 that 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 that locked to the 60 Hz AC line frequency. Some newer designs now offer "fast spin" speeds of up to 8000 RPM. At these higher spin speeds, improved spindle motor bearing quality and balancing is essential. Faster response 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

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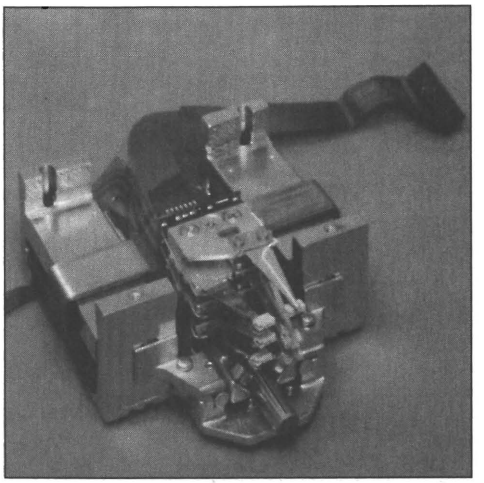
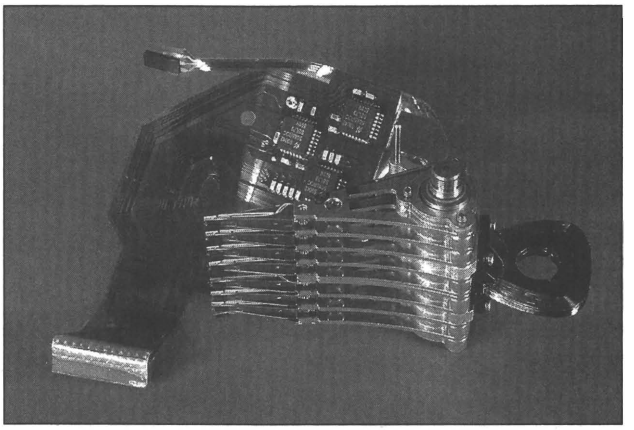
hold the heads firmly and rigidly using existing bearing and actuator technology. And management wants it for free! The head carriage must have the lowest moving mass possible, enabling it to be moved hundreds of time a second.



Head carriage with linear actuator

The head carriage pictured 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.

The head carriage to the right 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.



Head carriage with rotary 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 are made of annealed aluminum that is sputtered and plated with magnetic coatings, then polished and 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

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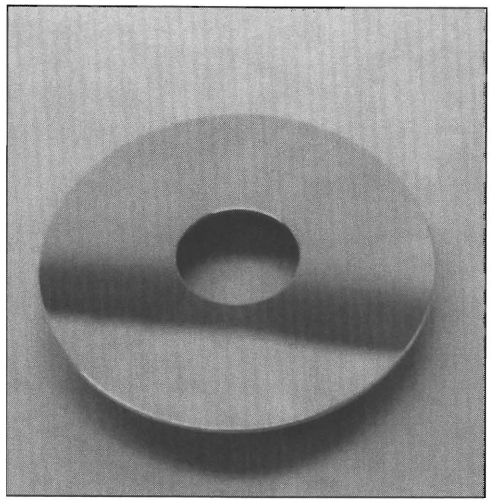
accordingly. New heads must handle higher write currents and be more sensitive when reading. Head gap sizes are constantly shrinking. Due to this, the drive industry is moving toward the thin film and magneto-resistive heads of the future and away from monolithic heads of yesterday. Head flying heights are now just a few millionths of an inch to enable efficient magnetic coupling with miniscule gap widths.



5.25" Plated media

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 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 inside the stepper motor must be moved along with the head carriage.

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 a limitation 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 system, 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

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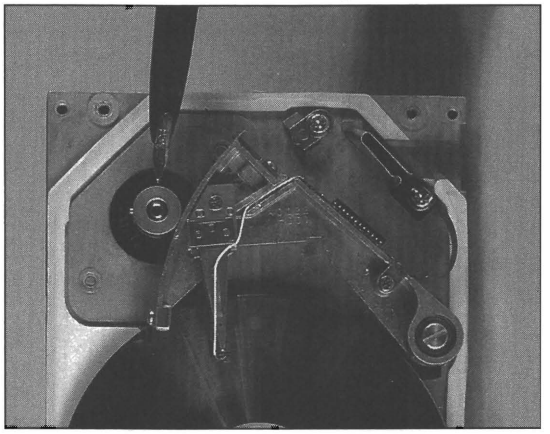
an inch in less than 1/100th of a second and come to a complete stop within 0.0001" of its target. Modern voice coil actuators are capable of doing this over 1,000,000,000 times. The voice coil servo system is the key component in all newer high performance disk drives. A voice coil actuator is simply a coil of copper wire attached to the head carriage. This coil is surrounded by high energy permanent magnets that are attached to the HDA base 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 that 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.



Stepper Motor Server

Many drives use an ASIC control chip in the voice coil servo system that contains a D/A converter. The output of the D/A converter usually drives a MOSFET power amplifier that provides the current required by the voice coil. The circuitry that moves the head from track to track is simple compared to the circuitry that 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. When you see a drive in the drive 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 has difficulty compensating for thermal warpage of the head

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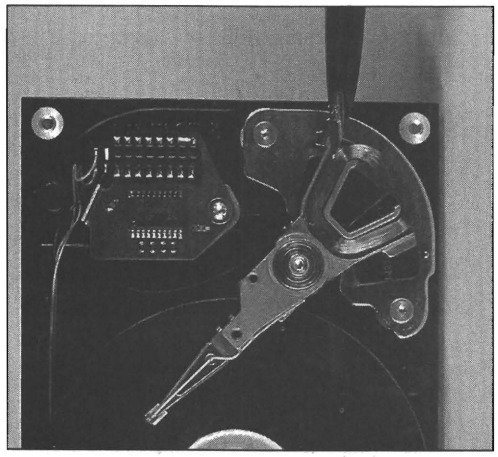
stack assembly.



Voice Coil Servo

A more popular voice coil servo feedback system is called an "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. The 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.

Some drives employ a "hybrid" servo system that 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.

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

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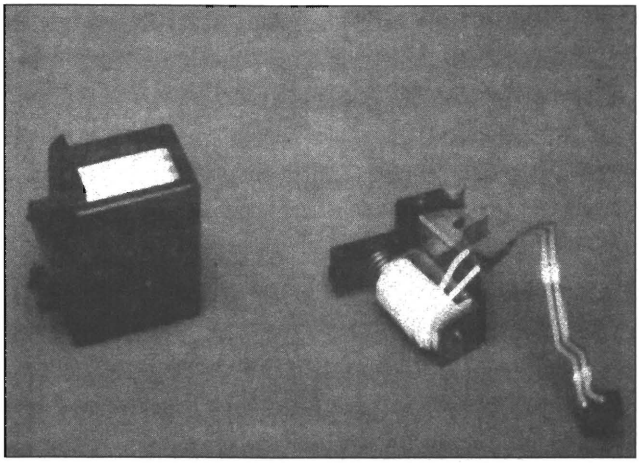
circulating air system that catches these particles in a filter.

Most disk drives have filtered vents that 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 vents.



Drive Filter and Latch Components

Data Encoding and Decoding

Data encoding is the technique used to convert a stream of binary data into a varying current that drives a magnetic head. The varying current in 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 that stores the data. The magnetic head has a maximum frequency limitation that 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 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 then becomes one of 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 an "ENDEC".

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Encoding and Decoding Codes

The following encoding and decoding codes are 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 reliable and 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 used in disk drives.

MFM (Modified Frequency Modulation)

MFM is by far the easiest modern coding technique to implement. This encoding is used in all modern floppy drives and many small capacity hard drives. MFM doubles the data capacity of FM encoding without increasing the recording bandwidth (MFM floppy drives are called Double Density). It works by eliminating the clock pulses in FM encoding and replacing them with data bits. Clock pulses are still used,

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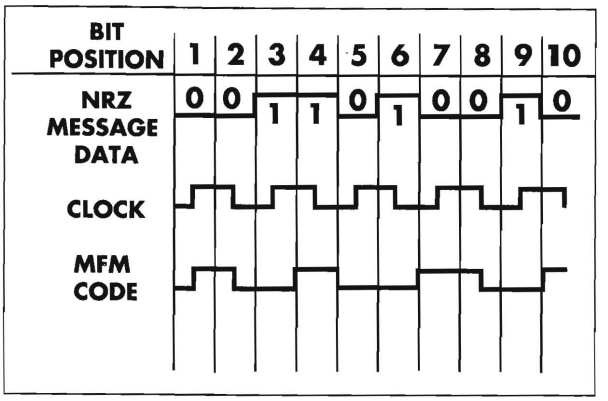
but they are written only when a one (1) data bit is not present in both the preceding and the current data cell.



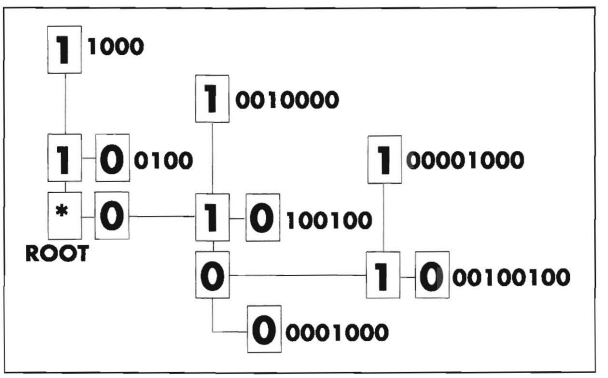
MFM Encodingz

To decode MFM data, a data separator must generate a clock signal based on several flux transitions. In 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. An electronic compensating circuit called a Phase Locked Loop (or PLL) is used to lessen the effects of spindle speed variations.

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 to examine the encoding tree below. 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 2,7 Encoding Tree

RLL encoding has two main disadvantages. The first is that RLL requires significantly more complex encoding and decoding circuitry than MFM. This has been overcome in part by single ENDEC chips from companies like SSI, VTC 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 and retry algorithms 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 that 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 is causing a gradual shift away from RLL.

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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

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Shugart Associates

Pioneer in floppy disk drives

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 integrated 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 older 8-bit IDE interface were originally called "XT Interface" drives, while 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) can be eliminated.

Older "XT Interface" drives used a BIOS ROM on the paddleboard and could not 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 AT compatible 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

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most new disk drives use zoned recording techniques to increase drive capacity, all of these drives must use imbedded controllers. The only practical interface alternatives for imbedded controllers on small disks are IDE or SCSI.

One disadvantage of the original IDE interface was the 528MB limitiation. This limitation has been overcome with the industry standard "EIDE" or Enhanced IDE interface. See the Enhanced IDE chapter for more information on how the EIDE interface will continue to be improved in the future.

Another minor problem with the IDE interface is hardware incompatibility. Some IDE drives may be incompatible with each other. This is generally due to different buffering or decoding. See the Enhanced IDE Chapter 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 that 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 that depends on the bits that 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 that stores 1000MB of data at 5Mbit/sec MFM data rate can be made to store 1500MB of data using RLL encoding. The data transfer rate increases by 50% using RLL 2,7, while the recording bandwidth stays

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the same.

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. Modern IDE and SCSI drives use RLL encoding. For a more detailed description of how RLL data is coded and decoded, see the previous 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.

ESDI Interface

The Enhanced Small Device Interface (ESDI) was 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 improved compatibility and made 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 were manufactured with rates up to 28 Mbits/sec.

ESDI is not particularly well suited to zoned recording, and is really only useful for fixed disks. ESDI was once 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 and EIDE/ATAPI.

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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 fifteen 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 15 devices using a daisy-chained cable. Unfortunately though, most manufacturers of SCSI peripherals adhere to the basic ANSI hardware specifications; while the level of SCSI software compatibility varies from manufacturer to manufacturer. A newer ANSI standard, SCSI-II was announced in an attempt to standardize the SCSI software interface. The ANSI SCSI-II specification added 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 at www.corpsys.com. The SCSI-III specification is now under development.

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 4-5MB/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.

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FAST SCSI

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

Ultra SCSI

The "Ultra SCSI" industry standard is an attempt to accelerate SCSI peripherals by changing SCSI timing and handshake specifications. To keep up with the more critical and noise sensitive requirements of Ultra SCSI, cable lengths must be reduced and termination becomes more critical. In most systems, Wide SCSI provides a more practical performance boost than Ultra SCSI.

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 and SCSI 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 dri-

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ves are popular in PC applications due to their low cost. Drives are now available with up to 400MB (800MB compressed) capacities and data transfer rates up to 2Mbit/sec.

QIC-36 Interface

This now obsolete 50-pin tape drive interface standard was pioneered by companies like Wangtec and Archive. The pinout is listed in the Pinout Section. If you run across a QIC-36 drive, you'll need a controller card which is QIC-02 software compatible to make it work.

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 it 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 EIDE (or ATAPI) 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. As SCSI software standards evolve, and the costs of SCSI drives and controllers drop, much of the EIDE 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.

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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, first 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 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 (using an error checking code), 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

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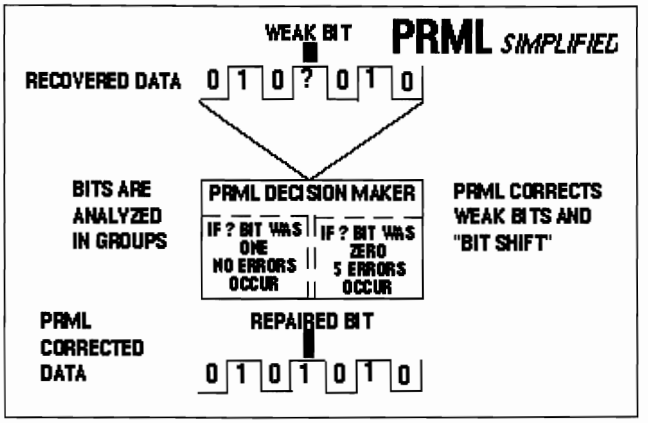
of available hard drives? Sooner than you might expect. Mid range drives will be the first to take advantage of the new technology. Cirrus Logic and VTC are currently shipping silicon that fully implements PRML. IBM, Quantum and others have PRML drives in production. The current bottleneck seems to be 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

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ENHANCED IDE

The Enhanced IDE standard originally 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 original IDE interface had a total drive capacity limitation of 528MB. This constraint came from the original IBM MFM controller design that 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 (that 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, original IDE was limited to a 528MB maximum capacity.

ORIGINAL (NON-ENHANCED) 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 - 528 MB with 512 byte sectors

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To bypass this limitation, the new 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.

IBM AT COMPATIBLE BIOS LIMITATIONS

Heads - 256 Maximum (Numbered 0 though 255)
Sectors - 63 Maximum (Numbered 1 through 63)
Cylinders - 1024 Maximum (Numbered 0 through 1023)
Total Blocks - 16,515,072
Maximum Capicity - 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 was also limited in terms of performance. This was mainly due to the speed of 16 bit programmed (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.

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 its design is suspiciously similar to SCSI.

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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.

Enhanced IDE hard drives are now available from several manufacturers in capacities over 2GB. ATAPI CD-ROM drives have become low cost, standard units.

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SCSI COMMAND REFERENCE

When we asked CSC customers what they wanted added to the Sixth Edition 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 details 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.

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Format Unit - Op Code 04_H

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

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

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

Inquiry - Op Code 12_H

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 - Op Code 15_H

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

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Mode Sense - Op Code $1A_H$

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 - Op Code 08_H

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.

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

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.

Read Capacity - Op Code 25_H

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	Operation 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

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Read Extended - Op Code 12_H

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

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 - Op Code $3E_H$

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 will 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 - Op Code 07_H

The REASSIGN BLOCKS command requests the drive to reassign the defective logical blocks to an area on the drive's media reserved

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for this purpose

The initiator transfers a defect list that contains the logical block addresses to be reassigned. The drive will reassign the physical media 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.

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

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

DEFECT DESCRIPTOR(S)	
BYTE	
0	Defect Logical Block Address (MSB)
1	Defect Logical Block Address
2	Defect Logical Block Address
3	Defect Logical Block Address (LSB)

If the drive has insufficient 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.

Release - Op Code 17_H

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

Request Sense - Op Code 03_H

The REQUEST 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 is 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

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Rezero Unit - Op Code 01_H

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 - Op Code $0B_H$

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 - Op Code $2B_H$

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

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Send Diagnostic - Op Code $1D_H$

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		SlfTest	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 - Op Code $1B_H$

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 1BH							
1	LUN			Reserved				Immed
2	Reserved							
3	Reserved							
4	Reserved							Start
5	VU		Reserved				Flag	Link

Test Unit Ready - Op Code 00_H

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 00H							
1	LUN			Reserved				
2	Reserved							
3	Reserved							
4	Reserved							
5	VU		Reserved				Flag	Link

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Verify - Op Code $2F_H$

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

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

Write - Op Code $0A_H$

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

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

Write Extended - Op Code $2A_H$

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

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

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Write Long - Op Code $3F_H$

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

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WHAT IS SCSI-III?

SCSI Buzzwords

The American National Standards Institute (abbreviated ANSI) organizes committees of industry representatives who work together and form standards for computer interfaces. These standards are designed so that peripheral products from different manufacturers will operate together with little or no custom configuration.

The ultimate goal of ANSI SCSI committees is the creation of true "plug and play" interface standards. They want SCSI to support *ALL* of the drives in your system: HARD, CD-ROM, TAPE, OPTICAL and even printers! They're making progress, but the standards are constantly changing. Here's a brief explanation of the more popular terms:

SCSI-III

SCSI-III is the popular name for the newest standard document that is currently being completed by ANSI. The SCSI-III document will include several new interface standards, including "fiber channel" which uses an optical fiber to transmit data at increased speeds. You can download more information and SCSI specifications from the CSC BBS at (408) 541-8455.

We will be adding the SCSI spec documents to our Web site at: WWW.CORPSYS.COM soon.

The current SCSI-II standard document is the only SCSI document that has been completed and accepted by the industry at the time of this writing. The SCSI-II specification includes the following connector standards that are now in widespread use throughout the hard disk drive industry.

FAST SCSI - How it all started

The original SCSI-I standard dates back to 1986. ANSI named the specification "ANSI X3.31-1986", and a standard was born. The first SCSI products transferred data at rates from 1.5 to 5MB/sec over a stan-

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dard 50 pin connector. As more devices began to share the bus, and as hard disk performance increased, the 5MB/sec maximum transfer specification became a bottleneck. "Fast SCSI" came to the rescue. Timing specifications were adjusted as synchronous transfers were added so that 10 MB/sec could be transferred over the 8 bit interface.

Narrow SCSI

The term "Narrow SCSI" is now used to refer to SCSI devices that transfer data over a "narrow" 8 bit 50 pin connector up to 10MB/sec. Most currently manufactured SCSI-II devices support "fast SCSI" and transfer data up to 10 MB/sec. Several manufacturers are working on variations of narrow SCSI that increase transfer rates over 10 MB/sec. One proposed standard is "Ultra SCSI", which uses the 50 pin narrow SCSI interface but makes changes to timing and handshaking to increase burst transfer performance up to 20MB/sec. For "Ultra SCSI" to work, both the controller and drive must fully support the faster timing and handshaking. "Ultra SCSI" drives are more susceptible to termination and noise problems, and require shorter cables than standard 10 MB/sec SCSI-II drives.

WIDE SCSI

The term "SCSI-III" is often used to refer to WIDE SCSI. This isn't exactly correct. WIDE SCSI is the correct name of the popular 16-bit wide interface that doubles data transfer rates to 20MB/sec. Wide SCSI drives use 68 pin and separate power connectors. Wide SCSI provides a reliable performance boost for workstations and file servers. The difference between narrow (50 pin) and wide (68 pin) SCSI performance is particularly noticeable when using multitasking operating systems like Novell or Windows NT. Proposed standards exist to increase the transfer rates up to 40MB/sec using a 32-bit cable. Wide SCSI drives are reliable and robust. The only disadvantage to using WIDE is the added bulk and expense of the cables.

SCA

Another popular SCSI drive interface is "SCA", which stands for Single Connector Assembly. SCA connectors carry both the SCSI data and power to the drive in a single connector. SCA is used in newer file servers, disk arrays, and workstations. 80 pin, 16 bit Wide SCSI is the most common SCA, but narrow connectors are also available. SCA connectors are rugged and designed for "hot plug" operation.

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Fiber Channel - The future of SCSI?

Fiber channel is an optical interface proposed but not finalized in the new SCSI-III standard. Current fiber channel technology operates at 12.5-25MB/sec data transfer rates. Much higher transfer rates are possible as the technology develops. Fiber channel cables are unaffected by termination, electrical noise, length, and other limitations that make conventional SCSI cabling difficult.

Note: 1MB/sec = 8-10 Mbit/sec

Both Sun Microsystems and Silicon Graphics use fiber channel interfaces to their disk arrays. In early 1996, list prices for fiber channel disk arrays started around $16,000. Inside the disk arrays, standard SCA or Wide SCSI cables are used to interface with the drives. Disk drives with optical fiber interfaces have not yet become affordable or available in quantity. Fiber channel will certainly have an effect on the SCSI industry, but it will be years before it's in widespread use.

Another potential alternative is Apple Computer's proposed "Fire Wire" standard. "Fire Wire" offers fiber channel data transfer rates over lower cost, easy to connect 6 pin cables. Time will tell if Apple's idea will catch on.

Downward Compatibility?

Can SCSI-II and SCSI-III devices share the same controller? How about narrow and wide drives? The answer is yes - sometimes. To properly share narrow and wide drives on a PC, you'll want a controller card that has both connectors - narrow 50 pin and wide 68 pin.

If you're using a workstation with a 68 pin wide connector, you'll need a 50 pin to 68 pin adaptor cable to use both wide and narrow drives simultaneously. Adapter cables can cause termination problems for reasons that we won't discuss here. Use them only as a last resort.

The ideal solution is a controller with three connectors (2 wide and one narrow) and automatic termination. CSC manufactures a three connector PCI card that's supported by Win '95 and NT.

What SCSI flavor should I buy?

All standards are subject to change until the industry approves and accepts them. Whatever you choose, make sure it's upgradable for future expansion. A card with FLASH ROM or removable EPROM like CSC's PCI cards will let you add software features as SCSI standards advance.

For file servers and workstations, your best performance choice today is Wide SCSI. In the PC environment, we recommend SCSI over IDE for performance, flexibility, and the ability to add high performance peripherals.

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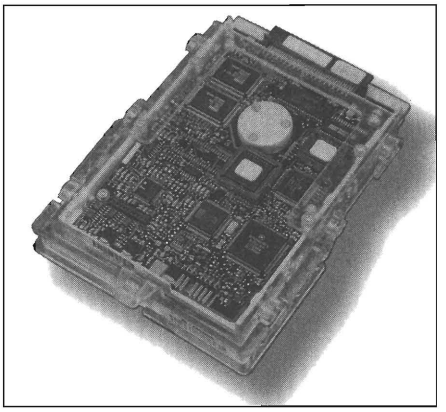
SCA HOT PLUG

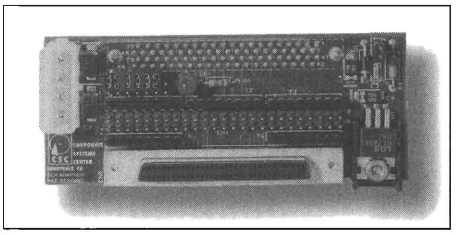
Technically, SCA isn't a separate interface. It's really just another way to use SCSI. SCA stands for "Single Connector Assembly", and SCA drives use a single 8 pin connector which carries both power and data. SCA was originally desinged for use in disk arrays, but it's finding its way into workstations and high end PC environments.

SCA drives are often mounted in a carrier which permits them to be easily removed for service, replacement, or to exchange data. Military and Government institutions with strong data security requirements like the removability of SCA. Since hard drives are relatively fragile devices, we don't recommend you remove your drive for transport in your briefcase. But if you're running a mission critical network system, SCA provides great serviceability along with Wide SCSI performance.



SCA drive in carrier (as used in SUN workstations)

Since an SCA drive includes everything a SCSI drive contains, simple adapters are available to connect thes drives to either Narrow or Wide systems. A SCA adaptor from CSC is pictured to the right.



SCA Adapter (available from CSC)

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PCI INTERFACE

The PCI bus has rapidly overtaken older industry standards like EISA, and VESA. PCI uses a solid hardware and sofware specification to ensure compatability with different cards *and* different CPU chips. PCI stands for "Peripheral Computer Interface", and is used with processors ranging from Intel's Pentium Pro to DEC's fast Alpha Chip. Apple loves how it accelerates the Motorola Power PC processors.

PCI offers two main advantages. First, it's fast. Real fast. A true 133MB/sec transfer rate is realistic. This transfer feeds data faster than most microprocessors and memory systems can digest. There's no disk drive that can sustain transfer rates anywhere near what the PCI bus can handle.

The second advantage of PCI is "plug and play". PCI boards install easily without setting jumpers or switches. Automatic configuration of interrupts, memory and I/O address space are performed by the host processor when the system first starts up. There's almost no potential for an interrupt or address conflict.

PCI self configuration is made possible by a hardware resource switching system that operates under software control. On power up, the host processor first checks to see what hardware requirements each adaptor card will have. These requirements may include memory address space, I/O address space, hardware interrupts, and even DMA transfer capability. The processor then starts assigning resources to each PCI slot. To be "PCI compatible", the adapter card and its driver software must support any address, interrupt, or I/O location that is assigned to it. So the processor forces each card to take a "place in line" by assigning hardware resources in sequence.

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Unfortunately, "Plug and Play" sometimes becomes "Plug and Pray". When a PCI card won't work in your system, you don't have any options to reconfigure it. You might end up wishing your card had switches and jumpers after all. Don't abandon hope. Most newer motherboards (we like the Intel manufactured boards) have PCI configuration options in CMOS setup to help you. Try changing the "PCI Bus Mastering" option for network or SCSI controller card problems. Switch the PCI system interrupt number if your card works but the software drivers won't load.

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CHOOSING A HARD DRIVE & CONTROLLER

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 your choices by eliminating drive interfaces or controllers that are not compatible with your application. For example, an IDE drive might not offer sufficient performance for your network software, or an older machine might not be compatible with Enhanced IDE. In general PC applications, 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 Win 95, OS/2 and Windows NT require software drivers for full performance and support of SCSI controllers. Determine 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 7to 15 different devices, including SCSI hard drives, CD-ROMs, erasable optical drives, DAT and other SCSI peripherals from the same controller.

Most interfaces other than SCSI and IDE are now obsolete. Use them only if you are upgrading an older system that already has them installed. ESDI, RLL, and MFM drives are still available. They may not be the fastest or most economical choice, but they may be a good choice for upgrading an older system.

If you are building a new IBM compatible system, you also have a choice of motherboard bus/controller card configurations. The most popular choices are ISA and PCI. Each bus has it advantages and limitations.

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ISA refers to the original 16-bit bus that IBM designed into the first 80286 based AT computers. The IBM ISA specifications 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 band width for acceptable video performance.

To solve the AT-Bus performance 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 that 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 that can be used decreases. For example, most 50MHz VESA motherboards will support only one or (maybe) two cards. Due to these limitiations, the VESA VL-BUS standard has lost popularity and is now found only in older systems.

A new standard, the Peripheral Connection Interface (or PCI) bus has now taken front stage. The PCI bus offers high performance (up to 133MB/sec in burst mode) and easy installation. PCI doesn't suffer from a limited number of supported slots as VESA does. PCI boards are also autoconfiguring (an advantage over VESA and ISA). As more PCI peripherals become available and prices drop, the price/performance ratio of PCI will make it the only practical bus for SCSI drive interface cards. Insist on both PCI and ISA if you are building up a new system.

Once you've selected a motherboard, it's time to make sure the controller board is really 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. The VESA bus is famous for compatibility problems between video and controller cards. PCI cards are generally all compatible, but inserting one low performance PCI card in your system will lower the performance of all the other cards.

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With standard IDE controllers, bus speed is normally not an issue. With memory or I/O mapped SCSI controllers, you will need an available interrupt and rsufficient address space in the base 640K memory to support the footprint of the controller BIOS. ISA 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 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, an EIDE drive will offer the most for the money. Weigh your storage and speed requirements. For Network server applications, go with the fastest wide SCSI 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 EIDE drive with an imbedded controller. For maximum software compatibility in sizes below 2GB standard EIDE 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.

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CONTROLLER SETUP & JUMPERING

In PC applications, controller jumpering is often the first step in installing a new drive and controller. You will need the controller board manual, to correctly jumper the controller, as well as documentation on the other boards installed in the system. Settings for some common 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 addresses used are 1F0-1F7H and 3F6-3F7H. At the time of this printing, MS-DOS 6.4 did not support the use of more than one IDE controller at an alternate (secondary) address. Windows '95 and IBM's OS/2, however, do support a secondary IDE controller.

If you are designing an I/O mapped controller card that 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.

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ISA Bus Base BIOS Address

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

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 ROM address conflicts 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.

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 can 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

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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:xx = 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.

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.

Recommended C & T, OPTI, Intel, and ETQ Wait States.

SYSCLOCK 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

NOTE: SYSCLOCK is the CPU clock frequency of your motherboard. Use extended setup to chose betweembetween

SYSCLOCK, SYSCLOCK or SYSCLOCK

3 4

5,6 etc.

to adjust your bus clock frequency.

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

SYSCLOCK

5

will provide a bus clock speed of

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

Most Floppy Controllers will work at bus speeds up to about 10MHz. Many Hard Drive Controllers do 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 that 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.

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DRIVE SETUP & 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.

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

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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 that 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

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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).

MFM, RLL, and ESDI Drive Jumpering

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

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 that 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 that 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 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 PCI SCSI-III board will scan the SCSI bus each time the system is powered up, adding support for the extended drives at that time.

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DRIVE CABLING

IDE Drive Cabling

IDE (Imbedded Drive Electronics) interface disk drives use a 40-pin interface cable. This cable connects the drive logic board (with imbedded controller) to a bus adapter card or to a motherboard IDE connector. IDE adapters are usually called "paddle boards". 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.

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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 older 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.

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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.

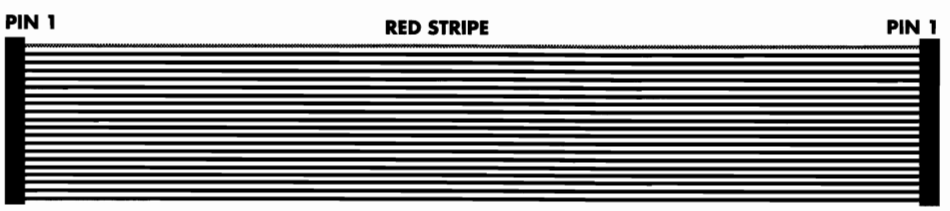
A flat cable is required for applications with more than two ESDI drives. If only two drives will be installed, ESDI drives may also be cabled with a twisted 34-pin cable in a manner identical to MFM cabling.

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.

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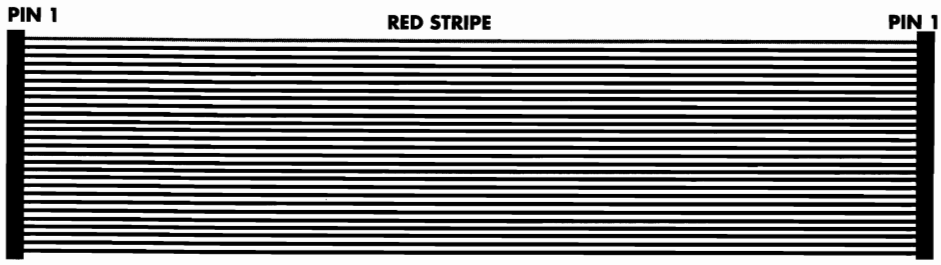
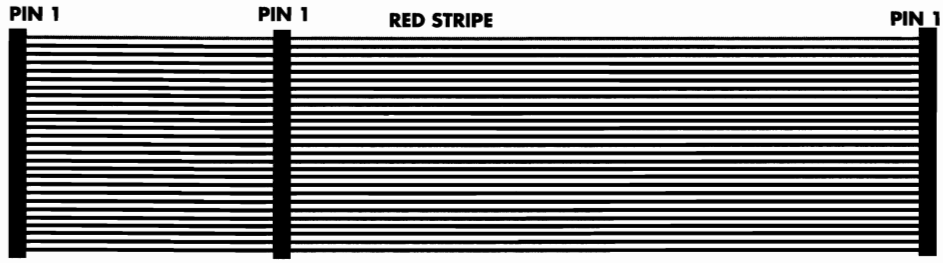
34-Pin Control Cable. Used for single drive MFM, RLL or ESDI systems.



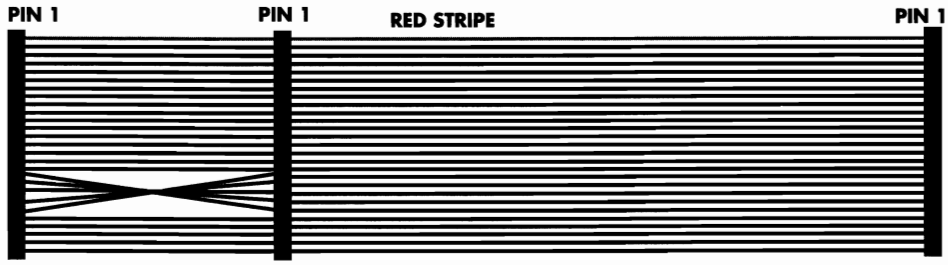
C:DRIVE

Dual Drive straight 34-Pin Control Cable. Used for MFM, RLL, and 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).

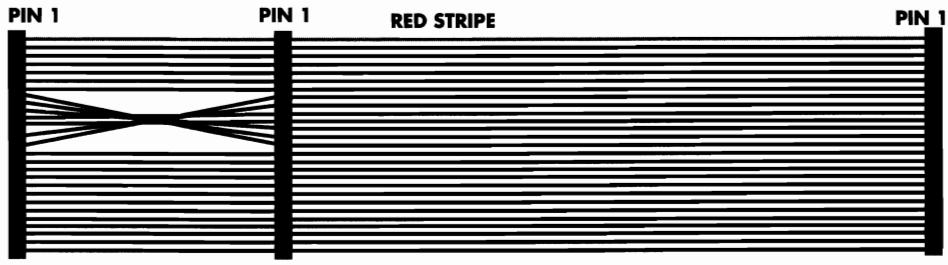
Dual Hard Drive twisted (5 wires) 34-Pin Control Cable. Used for MFM, RLL, and ESDI drives



DRIVE C DRIVE D

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



DRIVE A DRIVE B

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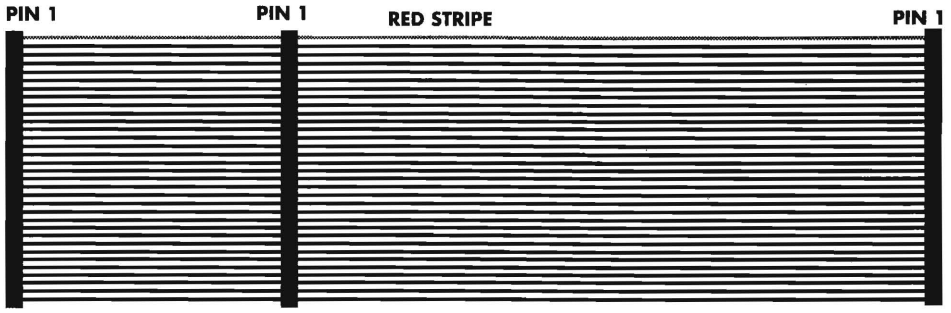
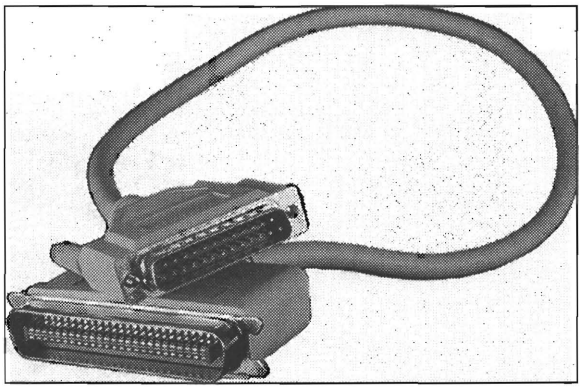
Note: Both floppy drives should be set to Drive Select 1.



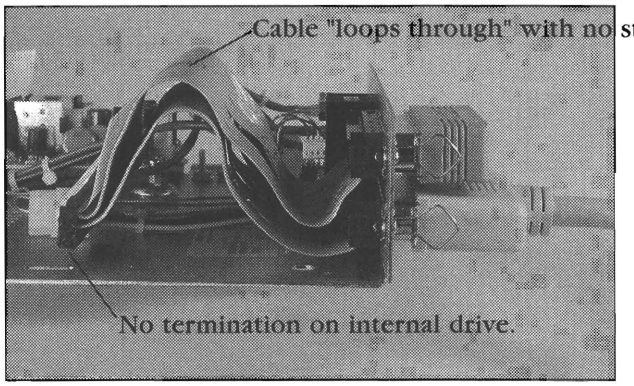
40-Pin IDE cable for one or two hard drives

DRIVE C DRIVE D

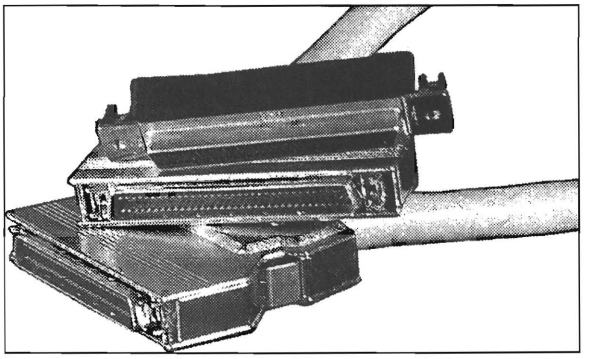
SCSI CABLE IDENTIFICATION



MAC Style DB-25 to Centronics Cable



Correct Enclosure Cabling for External Drives



Wide SCSI Cable and Mating Connector

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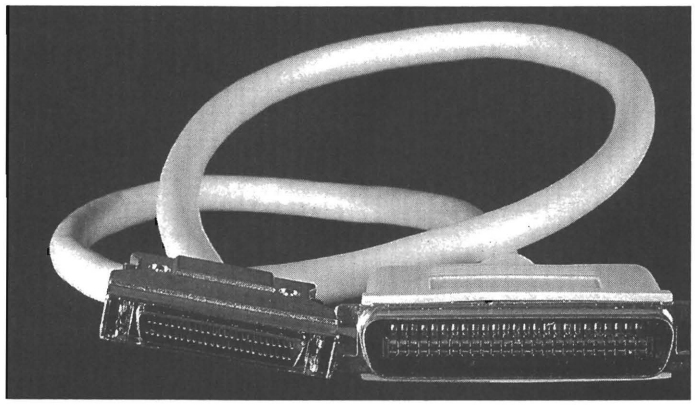
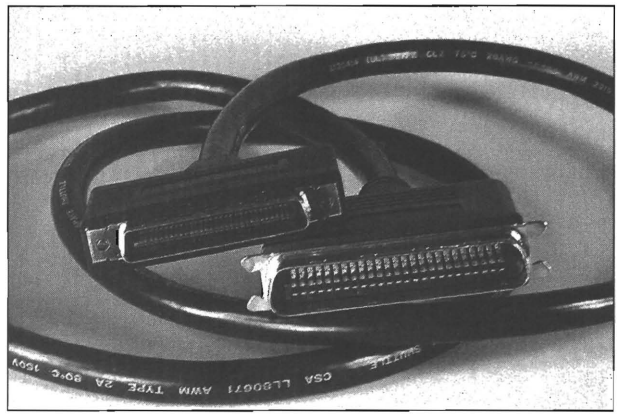
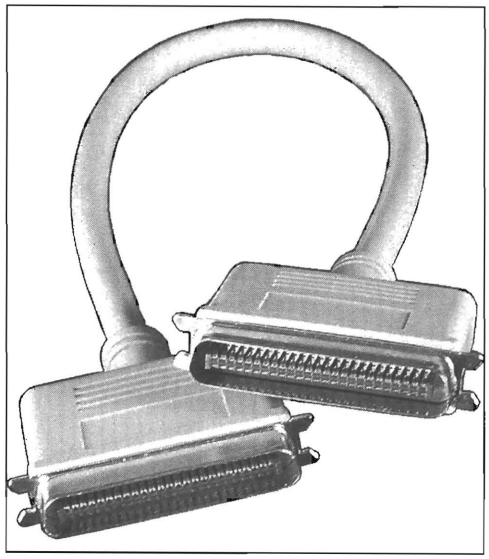


SCSI-II Amp Style to Centronics Cable



PS/2 to Centronics SCSI Cable



Centronics to Centronics SCSI Cable

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LOW-LEVEL FORMATTING

Unlike floppy disks that are low-level formatted at the same time as they are high-level formatted, all hard disks are low-level formatted separately, that is 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 may 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, bad sectors appear, 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 and service technicians. 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

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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?

WARNING!
As with any low-level format, CSCFMT will destroy all existing data. Don't use CSCFMT unless you have a verified back-up of all data.

CSCFMT is a low-level format utility supplied on the Hard Drive Bible companion CD-ROM. CSCFMT works with most MFM,RLL, ESDI, IDE and EIDE 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.

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.

MFM Drive Types

Unlike the newer IDE drives, MFM drive configurations must match

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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 does not exceed 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 that 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 that 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.

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

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.

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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 of the 16-bit and all of the 8-bit RLL controllers that 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

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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.

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's overwritten with a WRITE command.

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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 a 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-13 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.

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 burn-in process, not through the interface.

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

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) that are not listed in your ROM BIOS, and you do not have a BIOS that 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.

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

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.

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

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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 that 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

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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 that 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 6.x 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.

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

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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 that 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.

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MACINTOSH DRIVE INSTALLATION

No hard drive technical manual would be complete without instructions for drive installation on the Apple Macintosh™. The Mac is the computer which popularized the SCSI standard. Every Mac since the Plus, introduced in 1984, has a built-in SCSI controller on the motherboard. This makes installing internal and external SCSI devices relatively easy, providing that you pay proper attention to cabling, termination, SCSI ID, and driver software installation.

As stated in the previous chapters, the SCSI bus utilizes "Daisy Chain" cabling with dual-ended termination. This means that each device must be connected in series with either a continuous ribbon cable or a series of external SCSI cables, with proper termination at both ends of the chain.

All Macintoshes use a standard DB-25 connector as the external SCSI port. Most computer stores carry a variety of cables which will connect your Mac to Centronics 50-pin or other industry standard SCSI connectors. If you are unable to locate the cable or terminators you need, CSC carries a comprehensive line of SCSI accessories at reasonable prices. We recommend that you do not use "T" type cables, as they can cause line noise and ringing which result in unreliable operation.

Correct termination is critical for any SCSI device installation. Every SCSI "Daisy Chain" must have a total of two terminating resistors, no more and no less. The first terminator is on the internal drive inside the Mac case. Do not remove the internal terminator for any reason. When upgrading the internal drive always make sure that the replacement device is terminated. If you are adding extra internal devices, you will need to remove all terminators from them, except from the last physical device. If you are adding extra external devices, only the internal drive and final device should be terminated.

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The Macintosh CPU is always at SCSI ID number 7 and the internal boot drive should always be set to ID number 0 for reliable operation. Any other external or internal SCSI devices can be set to any other ID numbers, 1 through 6, as long as the number is not duplicated anywhere else on the SCSI chain. Duplicate SCSI ID numbers will cause a Mac to hang on startup. External devices should have a SCSI ID switch somewhere on the outside of the case to set the ID number. Internal devices will have their SCSI ID number set by removing or moving the ID jumpers on the device itself. The jumper settings for most SCSI devices are given in following chapters.

All external SCSI devices attached to the Mac must be powered up before your Macintosh is switched on. Allow the external hard drives enough time to spin-up, and then turn on the Mac. External devices which are attached but not powered up or are started after the Mac can cause the SCSI bus to hang, preventing drive operation, causing unreliable data transfers and "Bombs" to occur.

If you intend to boot from a new hard drive, it is imperative that you install your personal version of the system folder to maintain compatibility and functionality with your existing software. It is vitally important that ONE and only ONE version of the System File is installed on the boot drive. It is possible to have different System Folder on different drives, and then boot from them by choosing which drive is the Start Up Drive in the Startup Disk Control Panel, if you so desire. However, DO NOT have more than one System Folder on any Start Up Drive. It will cause erratic computer behavior, random crashes, "System Bombs" and other problems, if you can get it to start up at all.

There are several ways to replace the internal Start Up drive on the Macintosh. The best way we have found is the following, which assumes that you have had your Mac apart in the past. If you are not familiar with or are uncomfortable with putting hardware into your Mac, there are many comprehensive and more specific books you can refer to, or you can have an authorized technician install the device.

You will need: the appropriate hand tools to open your specific Mac case, a Phillips screwdriver, a "Y" power connector, and a three connector SCSI ribbon cable, in addition to the new drive.

1. Clean up the existing drive. Put all those loose documents in folders, like you always meant to do, toss those games you haven't played in 5 years, and take a look at all those files labeled "stuff".
2. Optimize the drive. There are several good defragmenting and optimizing utilities available on the market. You should also get

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third party formatting software with the package. Find one and use it. You'll be amazed at how fast your old drive just became.

3. Shut everything off, but do not unplug the Mac.
4. Open the case and touch the power supply case. This grounds any static electricity.
5. Replace the power connector and the SCSI ribbon on the drive with the "Y" power connector and the three connector SCSI ribbon cable.
6. Set the replacement drive to any SCSI ID except 0 or 7, using the SCSI ID jumpers. Make sure that the drive is terminated as well. Then connect it to the power and ribbon cables.
7. Place it somewhere where the PCB cannot ground out. We pre fer a suitably sized piece of cardboard on top of the existing drive. In any case, make sure that it will not short anything out or fall.
8. Restart.
9. Format, initialize, and partition the new drive using the third party driver software you installed earlier.
10. The new partition(s) will now be on the desktop.
11. Open the old internal drive. Press "Command-A" to select all of its contents.
12. Drag to the new drive to copy all, then close all when done.
13. Using the Startup Disk Control Panel on the existing drive, change it to the new drive and restart to check that the instal lation went as planned.
14. After everything is confirmed, shutdown. Remove the old drive. Set the SCSI ID of the new drive to 0, and install it in the internal bay using the original power connector and SCSI rib bon cable.
15. Reassemble your Mac, and you're done.

Note: If you make the partitions under 500MB each, the drive will run faster and the minimum file sizes will be smaller.

Installing an external SCSI device is much simpler. You will need to obtain the correct external SCSI cable, usually a DB-25 to Centronics 50-pin, a terminator and some version of the aforementioned third party formatting software. The Apple Hard Drive Toolkit included on the Apple Macintosh System Disks may not work on hard disk drives without Apple firmware.

1. Once again, shut everything off. NEVER install or remove any device while power is on!
2. Connect the external device(s) with the appropriate SCSI cable(s).
3. Check that there are no duplicate SCSI IDs.

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Note #7:
If you make the partitions under 500MB each, the drive will run faster and the minimum file sizes will be smaller.

Note #8:
All new partitions will have individual icons on your desktop. It is possible to have only one hard drive installed and have a desktop full of partition icons, which for all intents and purposes look just like hard drive icons. It is advisable to change the names and icons of the individual partitions, if for no other reason than that it makes it far easier to tell them apart.

4. Confirm that the last device and only the last device has been terminated.
5. Power-up all external SCSI devices and allow them time to spin-up.
6. Switch on your Mac, and launch the third party formatting soft ware.
7. Format, initialize, and partition the new drive using the third party driver software you installed earlier. See note to left.
8. The new partition(s) will now be on the desktop. See note.

It is very important that all of the SCSI hard drives in your Mac SCSI chain have been formatted with the same third party software and are running the same SCSI driver. We often see a multiple hard drive Mac system suddenly report "THIS DISK IS UNREADABLE, WOULD YOU LIKE TO INITIALIZE?". This is most often caused by a SCSI driver conflict, in which two or more drives were formatted with different software. While most of the better third party software packages do offer "work arounds" for this situation, it is preferable that all of the devices be formatted with identical software. Even different versions of the same formatting software can and will cause conflicts.

Virtually all of the SCSI device installation problems which we encounter in Mac systems stem from cabling, termination, or SCSI ID errors. First of all, make absolutely sure of all cables and their orientation. Cables should fit tightly, but never be forced, and all securing clips should snap in to place. There must be two and only two terminators, one on the internal drive and one on the last physical device on the SCSI chain. No SCSI ID number can ever be duplicated on the chain. Please note that the physical placement of a device and its SCSI ID are NOT the same. It is very likely that a device can be set to the SCSI ID of 2, for example, and be the final physical device of four external SCSI devices on the SCSI chain.

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WINDOWS DRIVE FORMATTING

Windows '95 Disk Format

Windows '95 uses a standard DOS compatible File Allocation Table (FAT) type disk format. Windows '95 also keeps a reserved area of the disk available for long file name support. The first character of the DOS file name is changed in the directory to indicate that a long file name exists for each file.

Windows '95 should install easily on any preformatted BIOS supported drive. DOS FDISK and FORMAT will still work. Some work will be necessary to save the long file name attributes should you decide to repartition your drive. It's a good idea to back things up before upgrading to '95.

Windows '95 Enhanced IDE Support

Windows '95 supports IDE drives over 540MB (and 1024 cylinders) using one of four methods:

1. ROM BIOS support using 28 bit LBA addressing

This is the most common means of support. Things will work "transparently" if your motherboard BIOS supports LBA addressing and is properly configured. Newer Intel built PCI motherboards are an example.

2. Hard Disk BIOS support

If you have an "Enhanced IDE" controller *with* a BIOS, Windows '95 will support large drives through Int-13h.

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3. Truncation

This is a last resort. The capacity of your drive will be limited to 540MB, and only the first 1024 cylinders will work. In upgrading some older machines without EIDE support, truncation may be your only choice.

4. Real-Mode Geometry Support

This mode adds compatibility but sacrifices speed. You won't get true 32-bit driver support, and the Windows '95 protected mode disk driver (called ESDI_503.PDR) won't work. A slower choice,but if options #1 and #2 don't work, it's the only way to get the full capacity of a drive over 540MB.

Windows '95 SCSI Support through Int-13

Yes, your Windows '95 system can use SCSI hard drives and removable drives *without* 32 bit drivers. Things will work properly using Real-Mode Geometry support. Depending on the performance of your controller, you may still get acceptable performance levels. This is the trick to making older non-ASPI SCSI cards run under '95.

Windows '95 SCSI Support through ASPI

Many earlier SCSI cards include ASPI drivers but not Miniport drivers. For these cards, Microsoft provides a "DOS Compatibility Mode". Since CD-ROM's aren't normally supported through interrupt-13, Windows '95 switches into "real" mode and passes commands to these devices through a DOS ASPI manager. The frequent switches between "real" and "protected" modes tend to slow the system down.

This is the second level of compatibility and performance. It's faster than the Int-13 interface described above, but slower than the Miniport driver explained below. If you own an early model controller which doesn't have Windows '95 32 bit miniport driver support, consider upgrading to a newer PCI controller which does. An example is the CSC Universal PCI Wide/Narrow Card.

Windows '95 and NT SCSI Miniport Drivers

For top SCSI performance, your controller needs a Windows '95 "Miniport" driver. This driver passes packets of commands and data

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between the Windows '95 operating system and your SCSI controller hardware. Using a miniport driver provides true 32 bit performance. Using a miniport driver also helps free the system to "disconnect", "multitask", and complete other operations during the time that SCSI devices are accessed.

In some ways, a miniport driver is simpler than an ASPI driver. When a miniport driver is installed, the operating system becomes responsible for composing SCSI command packets. These packets are standardized and easy to create for devices for hard drives. But devices like CD-ROM changers, jukeboxes, and SCSI tape drives use "vendor unique" commands which vary from one device to another. This shifts the burden of compatibility from the driver to the operating system. So even if your miniport based system won't work with one SCSI application, it may work with others. Take Microsoft Backup as an example. Backup has limited compatibility with SCSI devices. Other tape backup programs such as FastCache backup work fine with devices like Digital Linear Tape (DLT) drives. Both programs pass commands through the same miniport driver "socket". But Backup has a limited number of supported devices.

Windows '95 and Windows NT miniport sockets are very similar in nature. Unfortunately, due to operating system differences, most '95 and NT SCSI software isn't compatible. Don't assume that a SCSI program written to work under '95 will operate when you upgrade to NT.

Disk Manager and Windows '95

Using both Disk Manager and Windows '95 can be opening a can of worms. Make sure you have the latest version (7.0 or later) of Disk Manager before you even attempt it. Disk Manager modifies the MBR (Master Boot Record) of your hard disk. It uses a small program located in the MBR to trap disk calls made through Interrupt 13h. Virus detection programs have been known to mistakenly identify the Disk Manager code stored in the MBR as a virus. If the Disk Manager code is accidentally removed by a virus checker, you'll need to reinstall it.

Windows '95 is smart enough to recognize Disk Manager, and will work with it. Make sure the Disk Manager file "XBIOS.OVL" is located in the root directory of your boot drive before loading Windows '95. The file "DMDRVR.BIN" should be loaded before any other files in your CONFIG.SYS that access the disk.

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Getting 32 bit Disk Access from Win 3.1

Windows 3.1 has a 32 bit disk access driver called WDCTRL. It offers a small performance improvement in systems that have AT compatible disks. As the name implies, it works only with devices that are compatible with the Wester Digital Controller used in the original IBM AT. Fortunately, compatible devices include most IDE and EIDE drives, as well as MFM, RLL, and ESDI devices. If WDCTRL won't work in your system, you'll know right away. If the drive and controller you're using doesn't fully comply to the IBM task file specifications, WDCTRL simply won't load. If the drive and controller are *partially* compatible, the system will lock up hard when the driver loads. WDCTRL is not compatible with SCSI controllers, of course.

To enable the 32 bit driver under Win 3.1, add the following lines under the [386Enh] section of your Windows SYSTEM.INI file:

```
device=*int13
device=*wdctrl
```

You can turn 32 bit access of in the system control panel or by placing a semicolon ";" before each of these lines to "comment them out".

SMARTDrive 32 bit Disk Access

Windows '95 contains it's own internal software disk cache architecture. The Windows '95 cache is also automatically configured, so you can skip this section if you're using Windows '95.

SMARTDrive is a 32 bit cache program that runs under Windows 386 enhanced mode. It has the ability to "double buffer" data stores frequently used data in system memory for faster access. SMARTDrive integrates well with Windows, and dynamically allocates memory as it is needed. This feature lets Windows use your EMS memory when the cache doesn't need it.

SMARTDrive Write Caching

Earlier versions of SMARTDrive (before version 4.0) only cached read data. Versions 4.0 and later can cache both reads and writes. Caching write data is commonly called "write-behind caching" or "lazy writes". Caching write data definitely improves performance and reduces the overall number of seeks, but it can be dangerous. Since

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data is written first to memory, not to disk, your data could be lost if a system interruption were to occur.

Enabling write cache will cause loss of data should a system crash or power interruption occur. SMARTDrive has built-in safety features that check for CTRL-ALT-DEL resets and "old" data in cache. Another safety feature flushes the SMARTDrive cache after five seconds. If the system doesn't crash hard enough to interrupt SMARTDrive's internal timer interrupt, these safety features will save your data.

To enable SMARTDrive Write caching, put a plus sign after the drive letter you wish to cache. For example,

```
SMARTDRV D+ /E:2048
```

will enable write cache on drive E: with an element size of 2048. The element size specifies the number of bytes to be moved at one time. For more options, type SMARTDRV /?.

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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.

Many newer controllers offer a "watered down" version of Compsurf in ROM BIOS. We have yet to find a controller card BIOS

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)

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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.

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HARDWARE COMPATABILITY 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.

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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.

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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.

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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.

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

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cable is used when installing multiple Floppy, MFM, RLL, or ESDI drives.

CMOS Setup

Be sure to read the chapter that 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.

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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 that may be installed on the controller card or host adapter.

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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 '95 that use the protected mode of the 386/486/Pentium 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 that 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

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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 that 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 that 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.

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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. Upgrade to a later version of DOS if you encounter this.

DOS and Windows '95 2.0GB Limit

Yes, there is a partition size limit under DOS and indow '95W. It is 2048MB per partition. If this becomes an issue, consider a different operating system like Windows NT™ or OS/2's high performance file system. Although DOS could theoretically be made to work on larger drives, it's not a great idea. The efficiency of DOS and Windows '95 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 that requires special write gate timing. Many controllers that 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.

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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, EIDE, 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

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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 that 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 "Zapdisk" is available from the CSC BBS at (408)541-8455 or www.corpsys.com to correct this. Zapdisk will remove all partition information without reformatting the entire drive.

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.

SCSI Cabling

SCSI cables MUST be shielded for reliable operation. Many newer SCSI cables have individually twisted pairs for each signal line. If you

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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 that are memory mapped. Controllers twhich 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)

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 COM-

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MAND.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.

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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.

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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 accidentally 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.

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UNIVERSAL IDE PARAMETERS

All newer IDE drives will accept any CMOS parameters that result in a total number of Logical Blocks (LBA's) that 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.

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FORMATTED CAPACITY	NUMBER OF HEADS	NUMBER OF CYLINDERS	NUMBER 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
635	16	1234	63
810	16	1572	63
850	16	1652	63
1050	16	2045	63
1060	16	2064	63
1080	16	2097	63
1260	16	2448	63
1280	16	2484	63
1626	16	3158	63
2161	16	4095	63

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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 thatuse 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 that was 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 that 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 that 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

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+ 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 that alters the timing of data written to a hard drive on particular cylinders. Since the track length of cylinders that 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" that alters the timing of data written to inner cylinders on the drive. All newer drives automatically generate "write precompensation" using internal logic that 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?

Due to financial difficulties, Maxtor Corporation aquired Miniscribe 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.

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CONVERTING IMPRIMIS TO SEAGATE NUMBERS					
IMPRIS	SEAGATE	IMPRIMIS	SEAGATE	IMPRIS	SEAGATE
94155-85	ST4085	94205-51	ST253	94351-00S	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	ST2074A	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	ST43836E	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		

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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.

CORETEST is included on the HDB companion CD-ROM.

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

CSC offers its own performance test program called CSCTEST that is supplied on the CD-ROM that is enclosed with the Hard Drive Bible. 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

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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 older MFM and RLL controllers:

Use 4:1 Sector Interleave With:

Older 4.77MHz XT class machines.

Use 3:1 Sector Interleave With:

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

Use 2:1 Sector Interleave With:

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

Use 1:1 Sector 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.

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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 that 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

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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. FASTOPEN is not needed under Windows '95.

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 that 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 defragmenting program free with DOS - smart buy. PC-Cache has an adjustable read-ahead feature which improves sequential access on large files.

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.

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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.

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HARD DRIVE PARAMETERS

MODEL NUMBER	FORMATTED CAPACITY	NO. OF HEADS	NO. OF CYLINDERS	SECTORS PER TRACK	AVERAGE IN MS	INTERFACE	FORM FACTOR	CMOS SETTINGS
ALPS AMERICA								
DRND-10A	10	2	615	17	60	MFM	3.5 x 1"	
DRND-20A	20	4	615	17	60	MFM	3.5 x 1"	
DRPO-20D	20	2	615	26	60	MFM	3.5 x 1"	
DR311C	106	2	2109	63	13	IDE	3.5"	13x954x63
DR311D	106	2	2109	63	13	SCSI	3.5"	
DR312C	212	4	2109	63	13	IDE	3.5"	13x965x33
DR312D	212	4	2109	63	13	SCSI	3.5"	
RPO-20A	20	2	615	26	60	RLL	3.5 x 1"	
AMPEX								
PYXIS-7	5	2	320	17	90	MFM	5.25" FH	
PYXIS-13	10	4	320	17	90	MFM	5.25" FH	
PYSIX-20	15	6	320	17	90	MFM	5.25" FH	
PYXIS-27	20	8	320	17	90	MFM	5.25" FH	
AREAL TECHNOLOGY								
A 120	136	4	1024	60	15	IDE	2.5"	8x548x61
A 180	81	4	1488	60	15	IDE	2.5"	10x715x50
MD-2060	62	2	1024	60	19	IDE	2.5"	2x1024x60
ND-2080	80	2	1323	60	19	IDE	2.5"	9x1021x17
2085	85	2	1410	59	19	IDE	2.5"	10x976x17
2100	100	2	1632	63	19	IDE	2.5"	12x957x17
ATASI TECHNOLOGY, INC.								
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	

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MODEL NUMBER	FORMATTED CAPACITY	NO. OF HEADS	NO. OF CYLINDERS	SECTORS PER TRACK	AVERAGE IN MS	INTERFACE	FORM FACTOR	CMOS SETTINGS
AT-3051	43	7	704	17	33	MFM	5.25" FH	
AT-3051+	44	7	733	17	33	MFM	5.25" FH	
AT-3075	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	13	ESDI	5.25" FH	
AURA ASSOCIATES								
AU63	63	2	1330	43	17	PCMCIA	1.8"	
AU126	125	4	1330	43	17	PCMCIA	1.8"	
BASF								
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 TECHNOLOGIES								
BT 3400	400	6	1800	72	12	IDE/SCSI	3.5 x 1"	15x1021x51
BT 3650	650	10	1800	36	12	IDE/SCSI	3.5 x 1"	16x1017x78
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	IDE	3.5 x 1"	9x968x33
BT 9170E	150	7	1166	36	16	ESDI	3.5 x 1"	
BT 9170S	150	7	1166	36	16	SCSI	3.5 x 1"	
BT 9220A	200	9	1209	36	16	IDE	3.5 x 1"	12x968x33
BT 9220E	200	9	1210	36	16	ESDI	3.5 x 1"	
BT 9220S	200	9	1210	36	16	SCSI	3.5 x 1"	
BULL								
D-530	25	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 ELECTRONICS (also see Ye-Data)								
YD-3042	44	4	788	26	26	RLL	5.25" FH	
YD-3082	87	8	788	26	26	RLL	5.25" FH	

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MODEL NUMBER	FORMATTED CAPACITY	NO. OF HEADS	NO. OF CYLINDERS	SECTORS PER TRACK	AVERAGE IN MS	INTERFACE	FORM FACTOR	CMOS SETTINGS
YD-3530	32	5	731	17	26	MFM	5.25" FH	
YD-3540	45	7	731	17	26	MFM	5.25" FH	
CARDIFF								
F-3053	44	5	1024	17	20	MFM	3.5 x 1"	
F-3080E	68	5	1024	26	20	ESDI	3.5 x 1"	
F-3080S	68	5	1024	26	20	SCSI	3.5 x 1"	
F-3127E	109	5	1024	35	20	ESDI	3.5 x 1"	
F-3127S	109	5	1024	35	20	SCSI	3.5 x 1"	
CDC (see also Seagate)								
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	926	17	28	MFM	5.25" FH	
94155-67 Wren II	56	7	926	17	28	MFM	5.25" FH	
94155-77 Wren II	64	8	926	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	
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	
94161-86 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	9	969	26	16	SCSI	5.25" FH	
94161-121 Wren III	120	7	969	26	17	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	

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MODEL NUMBER	FORMATTED CAPACITY	NO. OF HEADS	NO. OF CYLINDERS	SECTORS PER TRACK	AVERAGE IN MS	INTERFACE	FORM FACTOR	CMOS SETTINGS
94171-350 Wren IV	300	9	1412	46	17	SCSI	5.25" FH	
94171-375 Wren IV	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	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	319	15	1224	34	15	ESDI	5.25" FH	
94186-383S Wren V	338	13	1412	34	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	
94191-766M	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	IDE	5.25" HH	
94204-71	71	5	1032	26	29	IDE	5.25" HH	5x989x27
94204-74 Wren II	71	5	948	26	29	IDE	5.25" HH	8x933x17
94204-81 Wren II	71	5	1032	26	28	IDE	5.25" HH	8x1024x27
94205-30 Wren II	25	3	989	26	28	RLL	5.25" HH	
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	IDE	5.25" HH	5x989x26
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	
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	IDE	5.25" HH	16x536x44
94244-274 Wren VI	191	4	1747	54	16	IDE	5.25" HH	14x983x33
94244-383 Wren VI	338	7	1747	54	16	IDE	5.25" HH	11x952x63
94246-182 Wren VI	160	4	1453	54	15	ESDI	5.25" HH	

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MODEL NUMBER	FORMATTED CAPACITY	NO. OF HEADS	NO. OF CYLINDERS	SECTORS PER TRACK	AVERAGE IN MS	INTERFACE	FORM FACTOR	CMOS SETTINGS
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	120	5	1068	36	15	SCSI-2	3.5" 3H	
94314-136	120	5	1068	36	15	IDE	3.5" 3H	11x917x17
94316-111 Swift	98	5	1072	36	23	ESDI	3.5 x1"	
94316-136	120	5	1268	36	15	ESDI	3.5 x 1"	
94316-155	138	7	1072	36	15	ESDI	3.5 x 1"	
94316-200 Swift	177	9	1072	36	15	ESDI	3.5 x 1"	
94335-55	46	5	1268	17	25	MFM	3.5 x 1"	
94335-100	83	9	1268	17	25	MFM	3.5 x 1"	
94351-90	79	5	1068	29	15	SCSI	3.5 x 1"	
94351-111	98	5	1068	36	15	SCSI	3.5 x 1"	
94351-126	111	7	1068	29	15	SCSI	3.5 x 1"	
94351-128	111	7	1068	36	15	SCSI	3.5 x 1"	
94351-133 Swift	116	7	1268	36	15	SCSI	3.5 x 1"	
94351-133S Swift	116	5	1268	36	15	SCSI-2	3.5 x 1"	
94351-134	117	7	1068	36	15	SCSI	3.5 x 1"	
94351-155 Swift	138	7	1068	36	15	SCSI	3.5 x 1"	
94351-155S Swift	138	7	1068	36	15	SCSI-2	3.5 x 1"	
94351-160 Swift	142	9	1068	29	15	SCSI	3.5 x 1"	
94351-172	150	9	1068	36	15	SCSI	3.5 x 1"	
94351-186S	163	7	1268	36	15	SCSI-2	3.5 x 1"	
94351-200	177	9	1068	36	15	SCSI	3.5 x 1"	
94351-200S	177	9	1068	36	15	SCSI-2	3.5 x 1"	
94351-230 Swift	210	9	1272	36	15	SCSI	3.5 x 1"	
94351-230S Swift	210	9	1268	36	15	SCSI-2	3.5 x 1"	
94354-90 Swift	79	5	1072	29	15	IDE	3.5 x 1"	10x536x29
94354-111 Swift	98	5	1072	36	15	IDE	3.5 x 1"	10x1024x17
94354-126 Swift	111	7	1072	29	15	IDE	3.5 x 1"	13x984x17
94354-133 Swift	117	5	1272	36	15	IDE	3.5 x 1"	14x961x17
94354-155 Swift	138	7	1072	36	15	IDE	3.5 x 1"	16x993x17
94354-160 Swift	143	9	1072	29	15	IDE	3.5 x 1"	9x942x33
94354-186 Swift	164	7	1272	36	15	IDE	3.5 x 1"	10x971x33
94354-200 Swift	177	9	1072	36	15	IDE	3.5 x 1"	11x956x33
94354-230 Swift	211	9	1272	36	15	IDE	3.5 x 1"	12x989x3
94355-55 Swift	46	5	1072	17	16	MFM	3.5 x 1"	
94355-100 Swift	83	9	1072	17	15	MFM	3.5 x 1"	
94355-150 Swift	128	9	1072	25	15	RLL	3.5 x 1"	
94356-111 Swift	98	5	1072	36	15	ESDI	3.5 x 1"	
94356-155 Swift	138	7	1072	36	15	ESDI	3.5 x 1"	
94356-200 Swift	171	9	1072	36	15	ESDI	3.5 x 1"	

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MODEL NUMBER	FORMATTED CAPACITY	NO. OF HEADS	NO. OF CYLINDERS	SECTORS PER TRACK	AVERAGE IN MS	INTERFACE	FORM FACTOR	CMOS SETTINGS
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"	
9720-1123 SABRE	964	19	1610	VAR	15	SMD	8"	
9720-1230 SABRE	1236	15	1635	VAR	15	SMD/SCSI	8"	
9720-2270 SABRE	1948	19	2551	VAR	12	SMD	8"	
9720-2500 SABRE	2145	19	2220	VAR	12	SMD	8"	
9720-368 SABRE	368	10	1635	VAR	18	SMD/SCSI	8"	
9720-500 SABRE	500	10	1217	VAR	18	SMD/SCSI	8"	
9720-736 SABRE	741	15	1217	VAR	15	SMD/SCSI	8"	
9720-850 SABRE	851	15	1635	VAR	15	SMD/SCSI	8"	
97229-1150	990	19	1784	VAR	15	IPI-2	8"	
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								
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	
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								
CM 3206	10	4	306	17	99	MFM	5.25" FH	

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MODEL NUMBER	FORMATTED CAPACITY	NO. OF HEADS	NO. OF CYLINDERS	SECTORS PER TRACK	AVERAGE IN MS	INTERFACE	FORM FACTOR	CMOS SETTINGS
CM 3426	20	4	615	17	85	MFM	5.25" FH	
CM 5018H	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	
CN 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, INC.								
F115ESDI-T	114	7	915	35	30	ESDI	5.25" FH	
F150AT-CA	150	9	969	34	17	IDE	5.25" FH	9x986x33
F150AT-WCA	150	7	1224	36	17	IDE	5.25" FH	9x986x33
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								
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	
COMPORT								
2040	44	4	820	26	35	MFM	5.25" HH	
2041	44	4	820	26	29	IDE	5.25" HH	
2082	86	6	820	34	29	SCSI	5.25" HH	
CONNER PERIPHERALS, INC.								
CP-340	42	4	788	26	29	SCSI	3.5 x 1"	

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MODEL NUMBER	FORMATTED CAPACITY	NO. OF HEADS	NO. OF CYLINDERS	SECTORS PER TRACK	AVERAGE IN MS	INTERFACE	FORM FACTOR	CMOS SETTINGS
CP-342	40	4	805	26	29	IDE	3.5 x 1"	4x805x26
CP-344	43	4	788	26	29	IDE	3.5 x 1"	4x788x26
CP-2020	21	2	642	32	23	SCSI	3.5 x 1"	
CP-2024 KATO	21	2	653	32	40	IDE	2.5 HH	2x653x32
CP-2034 PANCHO	32	2	823	38	119	IDE	2.5 HH	2x823x38
CP-2064 PANCHO	64	4	823	38	19	IDE	2.5 HH	4x823x38
CP-2084 PANCHO	85	8	548	38	19	IDE	2.5 HH	8x548x38
CP-2304	215	8	1348	39	19	IDE	3.5 x 1"	12x989x35
CP-3000	43	5	976	17	27	IDE	3.5 x 1"	5x988x17
CP-3020	21	2	622	33	27	SCSI	3.5 x 1"	
CP-3022	21	2	622	33	27	IDE	3.5 x 1"	2x622x33
CP-3024	22	2	636	33	27	IDE	3.5 x 1"	2x636x33
CP-3040	42	2	1026	40	25	SCSI	3.5 x 1"	
CP-3044	43	2	1047	40	25	IDE	3.5 x 1"	5x988x17
CP-3100	105	8	776	33	25	SCSI	3.5 x 1"	
CP-3102	104	8	776	33	25	IDE	3.5 x 1"	8x776x33
CP-3104	105	8	776	33	25	IDE	3.5 x 1"	8x776x33
CP-3111	112	8	832	33	25	IDE	3.5 x 1"	8x832x33
CP-3114	112	8	832	33	25	IDE	3.5 x 1"	8x832x33
CP-3180	84	6	832	33	25	SCSI	3.5 x 1"	
CP-3184	84	6	832	33	25	IDE	3.5 x 1"	6x832x33
CP-3200F	213	8	1366	38	19/16	SCSI	3.5 x 1"	
CP-3204F	213	16	683	38	19/16	IDE	3.5 x 1"	6x683x33
CP-3209F	213	4	1366	38	16	MCA	3.5 x 1"	6x683x38
CP-3304	340	8	1806	46	16	IDE	3.5 x 1"	16x659x63
CP-3360	360	8	1806	49	12	SCSI-2	3.5 x 1"	
CP-3364	360	8	1806	6349	12	IDE	3.5 x 1"	11x702x63
CP-3500	510	12	1695	49	12	SCSI	3.5 x 1"	
CP-3504	509	12	1695	49	12	IDE	3.5 x 1"	16x987x63
CP-3540	540	12	1806	49	12	SCSI-2	3.5 x 1"	
CP-3544	540	12	1806	49	12	IDE	3.5 x 1"	16x987x38
CP-4024 STUBBY	22	2	627	34	29	IDE	3.5 x 1"	
CP-4044 STUBBY	43	2	1104	38	29	IDE	3.5 x 1"	7x699x17
CP-30060	60	2	1524	39	19	SCSI	3.5 x 1"	
CP-30064	61	2	1522	39	-	IDE	3.5 x 1"	4x762x39
CP-3544	540	12	1806	49	12	IDE	3.5 x 1"	16x987x38
CP-3554	544	16	1054	63	12	IDE	3.5 x 1"	CMOS
CP-4024 STUBBY	22	2	627	34	29	IDE	3.5 x 1"	2x627x34
CP-4044 STUBBY	43	2	1104	38	50	IDE	3.5 x 1"	7x699x17
CP-30060	60	2	1524	39	19	SCSI	3.5 x 1"	
CP-30064	61	2	1522	39	14	IDE	3.5 x 1"	4x762x39

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MODEL NUMBER	FORMATTED CAPACITY	NO. OF HEADS	NO. OF CYLINDERS	SECTORS PER TRACK	AVERAGE IN MS	INTERFACE	FORM FACTOR	CMOS SETTINGS
CP-30080E	85	2	1806	47	17	IDE/SCSI	3.5 x 1"	
CP-30080	84	4	1053	39	17	SCSI	3.5 x 1"	8x529x39
CP-30084	84	4	1058	39	19	IDE	3.5 x 1"	8x529x39
CP-30084E	85	4	903	46	19	IDE	3.5 x 1"	8x529x39
CP-30100 HOPI	120	4	1522	39	19	SCSI	3.5 x 1"	
CP-30104H Allegh.	120	4	1522	39	19	IDE	3.5 x 1"	8x762x39
CP-30104 HOPI	120	4	1522	39	19	IDE	3.5 x 1"	8x762x39
CP-30109 HOPI	120	4	1522	39	19	MCA	3.5 x 1"	
CP-30170E	170	4	1806	46	17	IDE	3.5 x 1"	11x941x33
CP-30200	212	4	2119	49	12	SCSI-2	3.5 x 1"	
CP-30204	213	4	2119	49	12	IDE	3.5 x 1"	16x683x38
CP-30254	251	4	1984	62	12	IDE	3.5 x 1"	4x990x33
CP-30344	343	4	1121	60	13	IDE	3.5 x 1"	11x966x63
CP-30540	545	6	1984	62	10	FSCSI-2	3.5 x 1"	
CP-31370	1371.80	14	2694	63	10	FSCSI-2	3.5 x 1"	
CORE INTERNATIONAL								
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	
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	

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MODEL NUMBER	FORMATTED CAPACITY	NO. OF HEADS	NO. OF CYLINDERS	SECTORS PER TRACK	AVERAGE IN MS	INTERFACE	FORM FACTOR	CMOS SETTINGS
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	72	9	918	17	26	MFM	5.25" FH	
OPTIMA 70R	109	9	918	26	26	RLL	5.25" FH	
CORPORATE SYSTEMS CENTER								
GD 2024	21	2	653	32	23	IDE	2.5" HH	4x615x17
GD 2044	40	4	552	38	19	IDE	2.5" HH	5x980x17
GD 2061	60	4	823	38	19	IDE	2.5" HH	4x823x38
GD 2064	60	4	823	38	19	IDE	2.5" HH	4x823x38
GD 2081	85	4	1097	38	19	IDE	2.5" HH	10x976x17
GD 2084	85	4	1097	38	19	IDE	2.5" HH	10x976x17
GD 2088	121	4	1097	38	19	IDE	2.5" HH	10x976x17
GD 2121	120	4	1123	53	17	IDE	2.5" HH	14x992x17
GD 2124	120	4	1123	53	19	IDE	2.5" HH	14x99x17
GD 2254	252	6	1339	47	12	IDE	2.5" HH	16x489x63
GD 30001A	42	2	1045	40	19	IDE	3.5 x 1"	5x980x17
GD 30080E	80	4	1053	39	15	SCSI	3.5 x 1"	
GD 30084E	85	4	1053	39	19	IDE	3.5 x 1"	8x526x39
GD 30085E	80	2	1806	46	19	IDE	3.5 x 1"	4x903x46
GD 30087	80	2	1806	46	19	IDE	3.5 x 1"	4x903x46
GD 30100	121	4	1522	39	19	SCSI-2	3.5 x 1"	
GD 30100D	121	4	1524	39	19	IDE	3.5 x 1"	8x762x39
GD 30174E	170	4	1806	46	15	IDE	3.5 x 1"	8x903x46
GD 30175E	170	2	2116	63	19	IDE	3.5 x 1"	8x904x46
GD 30200	212	4	2119	49	12	SCSI-2	3.5 x 1"	
GD 30204	212	4	2119	49	12	IDE	3.5 x 1"	12x989x35
GD 30214	213	4	2119	49	14	IDE	3.5 x 1"	16x685x38
GD 30254	251	4	1895	62	15	IDE	3.5 x 1"	10x895x55
GD 30270	270	16	524	63	10	SCSI-2	3.5 x 1"	
GD 30344	330	4	2116	63	12	IDE	3.5 x 1"	16x904x46
GD 3040A	42	2	1026	40	25	SCSI	3.5 x 1"	
GD 3044	42	2	1047	40	25	IDE	3.5 x 1"	5x988x17
GD 3045	42	2	1047	40	25	IDE	3.5 x 1"	5x977x17
GD 30540	545	6	2243	60	10	SCSI-2	3.5 x 1"	
GD 30544	540	6	2249	59	12	IDE	3.5 x 1"	16x1023x63
GD 30544	540	6	2242	47	10	SCSI-2	3.5 x 1"	
GD 31050	1037	8	2756	47	10	SCSI-2	3.5 x 1"	
GD 3114	112	8	832	33	15	IDE	3.5 x 1"	8x832x33
GD 31370	1300	14	2387	37	10	SCSI-2	3.5 x 1"	

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MODEL NUMBER	FORMATTED CAPACITY	NO. OF HEADS	NO. OF CYLINDERS	SECTORS PER TRACK	AVERAGE IN MS	INTERFACE	FORM FACTOR	CMOS SETTINGS
GD 3200D	212	8	1366	38	15	SCSI	3.5 x 1"	
GD 3200F	212	8	1366	38	15	SCSI	3.5 x 1"	
GD 3300	340	8	1807	46	12	SCSI-2	3.5 x 1"	
GD 3301	85	8	1806	46	12	IDE	3.5 x 1"	16x659x63
GD 3500	510	12	1695	49	12	SCSI-2	3.5 x 1"	
GD 3504	510	12	1806	46	12	IDE	3.5 x 1"	16x987x63
GD 3544	524	6	1053	63	12	IDE	3.5 x 1"	16x1023x63
GD 5500	510	16	1441	62	12	IDE	3.5 x 1"	
PI - 16E	1340	19	1772	77	15	ESDI	5.25" FH	
McHuge	334	20	1020	36	18	SCSI	EXT	
McHuge II	641	15	1224	48	16	SCSI	EXT	
DATA TECH MEMORIES								
DTM-553	44	5	1024	17	65	MFM	5.25" FH	
TM-853	44	8	640	17	65	MFM	5.25" FH	
DTM-885	71	8	1024	17	36	MFM	5.25" FH	
DIGITAL EQUIPMENT CORPORATION								
DSP2022A	220	5	-	-	-	IDE	2.5" 4H	
DSP2022S	220	5	-	-	-	FSCSI-2	2.5" 4H	
DSP3053L	535	4	-	-	9.5	FSCSI-2	3.5" 3H	
DSP3085	852	14	-	-	9	FSCSI-2	3.5 x 1"	
DSP3105	1050	14	-	-	9	FSCSI-2	3.5 x 1"	
DSP3107L	1070	8	-	-	9.5	FSCSI-2	3.5 3H	
DSP3133L	1337	10	-	-	9.5	FSCSI-2	3.5 3H	
DSP3160	1600	16	-	-	9.7	FSCSI-2	3.5 x 1"	
DSP3210	2148	16	-	-	9.5	FSCSI-2	3.5 x 1"	
DSP5200	2000	21	-	-	12	FSCSI-2	5.25" FH	
DSP5300	3000	21	-	-	12	FSCSI-2	5.25" FH	
DSP5350	3572	25	-	-	12	FSCSI-2	5.25" FH	
DSP5400	4000	26	-	-	12	FSCSI-2	5.25" FH	
DSP34300	4300	20	-	-	9	FSCSI-2	3.5 x 1"	
VP3107	1075	5	-	-	9	FSCSI-2	3.5" 3H	
VP3215	2150	10	-	-	9	FSCSI-2	3.5" 3H	
DISC TEC								
RHD-20	21	2	615	34	23	IDE	3.5 x 1"	
RHD-60	63	2	1024	60	22	IDE	3.5 x 1"	
DISCTRON (ALSO SEE OTARI)								
D-503	3	2	153	17	85	MFM	5.25" FH	

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MODEL NUMBER	FORMATTED CAPACITY	NO. OF HEADS	NO. OF CYLINDERS	SECTORS PER TRACK	AVERAGE IN MS	INTERFACE	FORM FACTOR	CMOS SETTINGS
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								
306	11	2	612	17	85	MFM	5.25" FH	
DTC								
HF12	10	2	301	78	65	SCSI	5.25" HH	
HF24	20	2	506	78	60	SCSI	5.25" HH	
ECOL. 2								
EC-50	50	1	1720	60	40	IDE	3.5 x 1"	2x860x60
EC-100	100	2	1720	60	40	IDE	3.5 x 1"	2x1005x17
EC3-100	100	1	2300	85	20	IDE	3.5 x 1"	2x957x17
EC3-200	200	2	2300	85	20	IDE	3.5 x 1"	2x986x33
ELCOH								
DISCACHE 10	10	4	320	17	65	MFM	5.25" FH	
DISCACHE 20	20	8	320	17	65	MFM	5.25" FH	
EMULEX								
EMS/760	663	-	-	-	18	ESDI	5.25"	
ER2E/760	663	-	-	-	17	ESDI	5.25"	
ES36/760-1	663	-	-	-	17	ESDI	5.25"	
EPSON								
HD 850	11	4	306	17	99	MFM	5.25" HH	
HD 860	21	4	612	17	99	MFM	5.25" HH	
ESPERT								
EP-340A	42	4	1040	27	25	IDE	3.5 x 1"	5x919x17

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MODEL NUMBER	FORMATTED CAPACITY	NO. OF HEADS	NO. OF CYLINDERS	SECTORS PER TRACK	AVERAGE IN MS	INTERFACE	FORM FACTOR	CMOS SETTINGS
FUJI								
FK301-13	10	4	306	17	65	MFM	3.5 x 1"	
FK302-13	10	2	612	17	65	MFM	3.5 x 1"	
FK302-26	21	4	612	17	65	MFM	3.5 x 1"	
FK302-39	32	6	612	17	65	MFM	3.5 x 1"	
FK303-52	40	8	615	17	65	MFM	3.5 x 1"	
FK305-26	21	4	615	17	65	MFM	3.5 x 1"	
FK305-39	32	6	615	17	65	MFM	3.5 x 1"	
FK305-39R	32	4	615	26	65	RLL	3.5 x 1"	
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 AMERICA, INC.								
M 2225D/D2	21	4	615	32	40/35	MFM	3.5 x 1"	
M 2225DR	32	4	615	26	35	RLL	3.5 x 1"	
M 2226D/D2	30	6	615	32	40/35	MFM	3.5 x 1"	
M 2225DR	49	6	615	26	35	RLL	3.5 x 1"	
M 2227D/D2	40	8	615	32	40/35	MFM	3.5 x 1"	
M 2227D/D2	65	8	615	26	35	RLL	3.5 x 1"	
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	
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" FH	
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	

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MODEL NUMBER	FORMATTED CAPACITY	NO. OF HEADS	NO. OF CYLINDERS	SECTORS PER TRACK	AVERAGE IN MS	INTERFACE	FORM FACTOR	CMOS SETTINGS
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 2261E	326	8	1658	53	16	ESDI	5.25" FH	
M 2262E	448	11	1658	48	16	ESDI	5.25" FH	
M 2614T	180	8	1334	33	20	IDE	3.5 x 1"	
M 26/22SA	330	8	1435	56	12	SCSI	3.5 x 1"	
M 2622T	330	8	1435	56	12	IDE	3.5 x 1"	
M 2623SA	425	10	1435	56	12	SCSI	3.5 x 1"	
M 2623T	425	10	1435	56	12	IDE	3.5 x 1"	
M 2624SA	520	12	1435	56	12	SCSI	3.5 x 1"	
M 2624T	520	12	1435	56	12	IDE	3.5 x 1"	
M 2635FA	425	9	1435	64	12	SCSI-1&2	3.5 x 1"	
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 x8.5 x15"	
HEWLETT-PACKARD								
HP-97500	20	-	-	-	-	SCSI	3.5x 1"	
HP-97530E	136	4	-	-	18	SCSI	5.25" FH	
HP-97530S	204	6	-	-	18	SCSI	5.25" FH	
HP-97532E	103	-	-	-	17	ESDI	5.25" FH	
HP-97500	20	4	615	17	28	SCSI	3.5 x 1"	
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	

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MODEL NUMBER	FORMATTED CAPACITY	NO. OF HEADS	NO. OF CYLINDERS	SECTORS PER TRACK	AVERAGE IN MS	INTERFACE	FORM FACTOR	CMOS SETTINGS
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	
HO-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	3.5 x 1"	
HP-C2233S	238	5	1511	49	13	SCSI-2	3.5 x 1"	
HP-C2234	328	7	1546	61	12.6	IDE	3.5 x 1"	10x1016x63
HP-C2234S	334	7	1511	61	13	SCSI-2	3.5 x 1"	
HP-C2235	422	9	1546	61	12.6	IDE/SCSI	3.5 x 1"	13x1006x63
HP-C2235S	429	9	1511	73	13	SCSI-2	3.5 x 1"	
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 AMERICA								
DK 301-1	10	4	306	17	85	MFM	3.5 x 1"	
DK 301-2	15	6	306	17	85	MFM	3.5 x 1"	
DK 312C-25	209	10	1076	38	16	SCSI	3.5 x 1"	
DK 312C-25	251	12	1076	38	16	SCSI	3.5 x 1"	
DK 314C-41	419	14	1076	38	17	SCSI	3.5 x 1"	
DK 315C-11	1100	15	1457	63	11.8	FSCSI-2	3.5 x 1"	
DK 315C-14	1400	15	1457	63	11.8	FSCSI-2	3.5 x 1"	
DK 502-2	21	4	615	17	85	MFM	5.25" HH	
DK 511-5	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	

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MODEL NUMBER	FORMATTED CAPACITY	NO. OF HEADS	NO. OF CYLINDERS	SECTORS PER TRACK	AVERAGE IN MS	INTERFACE	FORM FACTOR	CMOS SETTINGS
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	5.25" FH	
DK 515C-78	370.5	14	1261	69	16	ESDI	5.25" FH	
DK 515C-78	670.5	14	1261	69	16	ESDI	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	FSCSI-2	5.25" FH	
DK 517C-26	2000	14	2381	81	12	SCSI-2	5.25" FH	
DK 517C-37	2000	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	
HYOSUNG								
HC 8085	71	8	1024	17	25	MFM	5.25" FH	
HC 8128	109	8	1024	26	25	MFM	5.25" FH	
HC 8170E	150	8	1024	36	25	ESDI	5.25" FH	
IBM CORPORATION								
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	
0660-371	320	14	949	48	12	SCSI-2	3.5 x 1"	
0661-467	400	14	1199	48	11	SCSI-2	3.5 x 1"	
0663-H11/L11	868	13	2051	66	10	SCSI	3.5 x 1"	
0663-H12/L12	1004	15	2051	66	10	SCSI	3.5 x 1"	
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	3.5 x 1"	
WDA-L42	42	2	1067	39	17	IDE	3.5 x 1"	
WDS-L42	42	2	1066	39	17	SCSI	3.5 x 1"	
WS-240	43	2	1120	38	19	PS/2	2.5"	

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MODEL NUMBER	FORMATTED CAPACITY	NO. OF HEADS	NO. OF CYLINDERS	SECTORS PER TRACK	AVERAGE IN MS	INTERFACE	FORM FACTOR	CMOS SETTINGS
WDA-240	43	2	1122	38	19	IDE	2.5"	14x10214x33
WDS-240	43	2	1120	38	19	SCSI	2.5"	
WD-380	80	4	1021	39	16	PS/2	3.5 x 1"	
WDA-380	80	4	1021	39	16	IDE	3.5 x 1"	9x1021x17
WDS-380	80	4	1021	39	16	SCSI-2	3.5 x 1"	
WD-387	61	4	928	32	23	PS/2	3.5 x 1"	
WD-3100	105	2	1990	44	12	SCSI-2	3.5 x 1"	
WD-3158	120	8	920	32	23	PS/2	3.5 x 1"	
WD-3160	160	8	1021	39	16	PS/2	3.5 x 1"	
WDA-3160	160	8	1021	39	16	IDE	3.5 x 1"	8x1021x39
WDS-3160	160	8	1021	39	16	SCSI-2	3.5 x 1"	
WDS-2200	210	4	1990	44	12	SCSI	3.5 x 1"	
IMI								
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"	
7740	43	8	315	17	85	MFM	8"	
INTERGRAL PERIPHERALS								
1862	64	3	-	17	18	IDE	-	
IOMEGA								
MultiDisk 150	150	2	1380	36	18	SCSI-2	Remov 5.25"	
JCT								
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	Comm.	5.25" HH	
1005	7	4	306	17	110	Comm.	5.25" HH	
1010	14	8	306	-	130	Comm.	5.25" HH	
JVC COMPANIES OF AMERICA								
JD-E2042M	42	2	973	43	16	IDE	2.5" 4H	
JD-E2085M	85	4	973	43	16	IDE	2.5" 4H	
JD-E2825P(A)	21	2	581	36	25	IDE	3.5" 4H	

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JD-E2825P(S)	21	2	581	36	25	SCSI	3.5" 4H	
JD-E2825P(X)	21	2	581	36	25	IDE	3.5" 4H	
JD-E2850P(A)	42	3	791	35	25	IDE	3.5" 4H	
JD-E2850P(S)	42	3	791	35	25	SCSI	3.5" 4H	
JD-E2850P(X)	42	3	791	35	25	XT-IDE	3.5" 4H	
JD-E3824TA	21	2	436	48	28	-	3.5" 3H	
JD-E3848HA	42	4	436	48	29	-	3.5" 3H	
JD-E3848P(A)	42	2	862	48	25	IDE	3.5" 4H	
JD-E3848P(S)	42	2	862	48	25	SCSI	3.5" 4H	
JD-E3848P(X)	42	2	862	48	25	XT-IDE	3.5" 4H	
JD-E3896P(A)	84	4	862	48	25	IDE	3.5" 4H	
JD-E3896P(S)	84	4	862	48	25	SCSI	3.5" 4H	
JD-E3896P(X)	84	4	862	48	25	XT-IDE	3.5" 4H	
JD-E3896V(A)	84	4	862	48	25	IDE	3.5" 3H	
JD-E3896V(S)	84	4	862	48	25	SCSI	3.5" 3H	
JD-E3896V(X)	84	4	862	48	25	XT-IDE	3.5" 3H	
JD-F2042M	42	2	973	43	16	IDE	2.5" 4H	
JD3842HA	21	2	436	48	28	-	3.5" 3H	
JD3848HA	43	4	436	48	29	-	3.5" 3H	
KALOK CORPORATION								
KL 320 Octagon I	21	4	615	17	48	MFM	3.5 x 1"	
KL 330 Octagon I	32	4	615	26	40	RLL	3.5 x 1"	
KL 341 Octagon I	40	4	644	26	25	SCSI	3.5 x 1"	
KL 343 Octagon I	42	4	676	31	25	IDE	3.5 x 1"	
KL 3100 Octagon II	105	6	820	35	19	IDE	3.5 x 1"	
KL 3120 Octagon II	120	6	820	40	19	IDE	3.5 x 1"	
P5-125	125	2	2048	80	17	IDE	3.50 x .5"	
P5-250	251	4	2048	80	17	IDE	3.50 x .5"	
KYOCERA ELECTRONICS, INC.								
KC 20A/B	21	4	615	17	65/62	MFM	3.5 x 1"	
KC 30A/B	32	4	615	26	65/62	RLL	3.5 x 1"	
KC 40GA	41	2	1075	26	28	IDE	3.5 x 1"	
KC 80C	87	8	787	28	28	SCSI	3.5 x 1"	
LANSTOR								
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	

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MODEL NUMBER	FORMATTED CAPACITY	NO. OF HEADS	NO. OF CYLINDERS	SECTORS PER TRACK	AVERAGE IN MS	INTERFACE	FORM FACTOR	CMOS SETTINGS
LAPINE								
3522	10	4	306	17	65	MFM	3.5 x 1"	
LT 10	10	2	615	17	65	MFM	3.5 x 1"	
LT 20	20	4	615	17	65	MFM	3.5 x 1"	
LT 200	20	4	614	17	65	MFM	3.5 x 1"	
LT 300	32	4	614	26	65	RLL	3.5 x 1"	
LT 2000	20	4	614	17	65	MFM	3.5 x 1"	
TITAN 20	21	4	615	17	65	MFM	3.5 x 1"	
TITAN 30	33	4	615	26	65	RLL	3.5 x 1"	
TITAN 3532	32	4	615	26	65	RLL	3.5 x 1"	
MAXTOR CORPORATION								
2585	85	4	1092	36	15	IDE	2.5" HH	10x976x17
25128A	128.2	4	1092	48	15	IDE	2.5" HH	15x980x17
25252A, S	251	6	1320	63	12	IDE/SCSI	17 mm high	15x990x33
7080A, S	80	4	1170	36	17	IDE/SCSI	1" high	9x1021x17
7120A, S	120	4	1516	42	15	IDE/SCSI	1" high	14x984x17
7213A, S	213	4	1690	48	15	IDE/SCSI	1" high	13x969x33
7245A, S	244	4	1881	48	15	IDE/SCSI	1" high	15x962x33
LXT-50S	48	4	733	32	27	SCSI	3.5 x 1"	
LXT-100S	96	8	733	32	27	SCSI	3.5 x 1"	
LXT-200A	207	7	1320	45	15	IDE	3.5 x 1"	12x1020x33
LXT-200S	191	7	1320	33	15	SCSI	3.5 x 1"	
LXT-213A	213	7	1320	55	15	IDE	3.5 x 1"	13x969x33
LXT-213S	200	7	1320	55	15	SCSI	3.5 x 1"	
LXT-340A	320	7	1560	47	13	IDE	3.5 x 1"	10x992x63
LXT-340S	320	7	1560	47	15	SCSI	3.5 x 1"	
LXT-4/37A	437	9	1560	63	13	IDE	3.5 x 1"	14x967x63
LXT-437S	437	9	1560	63	13	SCSI	3.5 x 1"	
LXT-535A	535	11	1560	63	12	IDE	3.5 x 1"	
LXT-535S	535	11	1560	63	12	SCSI	3.5 x 1"	
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	

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MODEL NUMBER	FORMATTED CAPACITY	NO. OF HEADS	NO. OF CYLINDERS	SECTORS PER TRACK	AVERAGE IN MS	INTERFACE	FORM FACTOR	CMOS SETTINGS
MXT 540SL/AL	540	7	2367	41	7.5/8.5	IDE	3.5 x 1"	16x1024x63
MXT 1240S	1.24GB	15	2367	41	8.5/9	SCSI-2	3.5"	
RXT-800HS	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	
XT4179E	158	7	1224	36	14	ESDI	5.25" FH	
XT 4230E	203	9	1224	35	15	ESDI	5.25" FH	
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 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)

7040A Cheyene	42	2	1170	36	17	IDE	3.5 x 1"	5x977x17

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7040S Cheyene	40	2	1155	36	17	SCSI	3.5 x 1"	
7060A Cheyene	65	2	1516	42	15	IDE	3.5 x 1"	7x984x17
7060S Cheyene	65	2	1516	42	15	SCSI	3.5 x 1"	
7080A Cheyene	81	4	1170	36	17	IDE	3.5 x 1"	9x1021x17
7080S Cheyene	65	4	1155	36	15	IDE	3.5 x 1"	
7120A Cheyene	65	4	1516	42	15	IDE	3.5 x 1"	14x984x17
7120S Cheyene	130	4	1516	42	15	SCSI	3.5 x 1"	
8051A	43	4	745	28	28	IDE	3.5 x 1"	5x977x17
MEGA DRIVE SYSTEMS								
P-42	42	3	834	33	19	SCSI	3.5 x 1"	
P-84	84	6	834	33	19	SCSI	3.5 x 1"	
P-105	105	6	1019	33	19	SCSI	3.5 x 1"	
P-120	120	5	1123	33	14	SCSI	3.5 x 1"	
P-170	170	7	1123	33	14	SCSI	3.5 x 1"	
P-210	210	7	1156	33	14	SCSI	3.5 x 1"	
P-425	425	9	1512	63	12	SCSI	3.5 x 1"	
MEMOREX								
310	2	2	118	17	80	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 CORPORATION								
1202	45	7	977	17	-	MFM	8"	
1223	45	7	977	17	-	MFM	8"	
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	

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MODEL NUMBER	FORMATTED CAPACITY	NO. OF HEADS	NO. OF CYLINDERS	SECTORS PER TRACK	AVERAGE IN MS	INTERFACE	FORM FACTOR	CMOS SETTINGS
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	5.24" 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	
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	FSCSI-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	
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	

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MODEL NUMBER	FORMATTED CAPACITY	NO. OF HEADS	NO. OF CYLINDERS	SECTORS PER TRACK	AVERAGE IN MS	INTERFACE	FORM FACTOR	CMOS SETTINGS
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	
1578-12	535	12	1632	54	16	SCSI	5.25" FH	
1587-13	279	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	
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	FSCSI-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	
1664-7	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	5.25" HH	
1674-6	135	6	1249	36	16	SCSI	5.25" HH	
1674-7	158	7	1249	36	16	SCSI	5.25" HH	
1683-4	193	4	1776	54	14	SCSI	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	5.25" HH	
1743-5	112	5	1140	28	15	IDE	3.5 x 1"	
1744-6	135	6	1140	28	15	IDE	3.5 x 1"	
1744-7	157	7	1140	28	15	IDE	3.5 x 1"	10X929X33
1745-8	180	8	1140	28	15	IDE	3.5 x 1"	11X968X33

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MODEL NUMBER	FORMATTED CAPACITY	NO. OF HEADS	NO. OF CYLINDERS	SECTORS PER TRACK	AVERAGE IN MS	INTERFACE	FORM FACTOR	CMOS SETTINGS
1745-9	202	9	1140	28	15	IDE	3.5 x 1"	12X986X33
1773-5	115	5	1140	28	15	SCSI	3.5 x 1"	
1774-6	135	6	1140	28	15	SCSI	3.5 x 1"	
1774-7	157	7	1140	28	15	SCSI	3.5 x 1"	
1775-8	180	8	1140	28	15	SCSI	3.5 x 1"	
1775-9	202	9	1140	28	15	SCSI	3.5 x 1"	
MICROSCIENCE INTERNATIONAL CORPORATION								
4050	45	5	1024	17	18	MFM	3.5 x 1"	
4060	68	5	1024	26	18	RLL	3.5 x 1"	
4070	62	7	1024	17	18	MFM	3.5 x 1"	
4090	95	7	1024	26	18	RLL	3.5 x 1"	
5040	46	3	855	35	18	ESDI	3.5 x 1"	
5070	77	5	855	35	18	ESDI	3.5 x 1"	
5070-20	86	5	960	35	18	ESDI	3.5 x 1"	
5100	107	7	855	35	18	ESDI	3.5 x 1"	
5100-20	120	7	960	35	18	ESDI	3.5 x 1"	
5160	159	7	1271	35	18	ESDI	3.5 x 1"	
6100	110	7	855	36	18	SCSI	3.5 x 1"	
7040	47	3	855	36	18	IDE	3.5 x 1"	6x890x17
7070-20	86	5	960	35	18	IDE	3.5 x 1"	9x919x17
7100	107	7	855	35	18	IDE	3.5 x 1"	12x1024x17
7100-20	120	7	960	35	18	IDE	3.5 x 1"	14x984x17
7100-21	121	5	1077	44	18	IDE	3.5 x 1"	14x984x17
7200	201	7	1277	44	18	IDE	3.5 x 1"	12x964x33
7400	420	8	1904	39	15	IDE	3.5 x 1"	13x1001x63
8040	43	2	1047	40	25	IDE	3.5 x 1"	5x977x17
8040/MLC	42	2	1024	40	25	IDE	3.5 x 1"	5x977x17
8080	85	2	1768	47	17	IDE	3.5 x 1"	10x976x17
8200	210	4	1904	39	16	IDE	3.5 x 1"	12x986x33
FH 2414	367	8	1658	54	14	ESDI	5.25" FH	
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	

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MODEL NUMBER	FORMATTED CAPACITY	NO. OF HEADS	NO. OF CYLINDERS	SECTORS PER TRACK	AVERAGE IN MS	INTERFACE	FORM FACTOR	CMOS SETTINGS
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	
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 CORPORATION								
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	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	

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MODEL NUMBER	FORMATTED CAPACITY	NO. OF HEADS	NO. OF CYLINDERS	SECTORS PER TRACK	AVERAGE IN MS	INTERFACE	FORM FACTOR	CMOS SETTINGS
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	
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	IDE	3.5 x 1"	
7040S	40	2	1156	36	19	SCSI	3.5 x 1"	
7080A	80	4	980	36	19	IDE	3.5 x 1"	
7080S	81	4	1155	36	19	SCSI	3.5 x 1"	
7426	21	4	612	17	65	MFM	3.5"	
8048	40	4	1024	36	65	SCSI	3.5 x 1"	
8051A	43	4	745	28	28	IDE	3.5 x 1"	
8051AT	42	4	745	28	28	IDE	3.5 x 1"	
8051	45	4	793	28	28	SCSI	3.5 x 1"	
8212	11	2	612	17	68	MFM	3.5 x 1"	
8225	20	2	771	26	68	RLL	3.5 x 1"	
8225AT	21	2	745	28	28	IDE	3.5 x 1"	
8225C	21	2	798	26	68	RLL	3.5 x 1"	
8225S	21	2	804	26	68	SCSI	3.5 x 1"	
8225XT	21	2	805	26	68	XT-IDE	3.5 x 1"	
8412	10	4	306	17	50	MFM	3.5 x 1"	
8425/8425F	21	4	615	17	68/40	MFM	3.5 x 1"	
8425S	21	4	612	17	68	SCSI	3.5 x 1"	
8425XT	21	4	615	17	68	XT-IDE	3.5 x 1"	
8434F	32	4	615	26	40	RLL	3.5 x 1"	
8438/8438F	32	4	615	26	68/40	RLL	3.5 x 1"	
8438XT	31	4	615	26	68	XT-IDE	3.5 x 1"	
8450	40	4	771	26	45	RLL	3.5 x 1"	
8450AT	42	4	745	28	40	IDE	3.5 x 1"	
8450C	42	4	748	26	45	RLL	3.5 x 1"	
8450XT	42	4	805	26	45	XT-IDE	3.5 x 1"	
9000E	338	15	1224	36	16	ESDI	5.25" FH	

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MODEL NUMBER	FORMATTED CAPACITY	NO. OF HEADS	NO. OF CYLINDERS	SECTORS PER TRACK	AVERAGE IN MS	INTERFACE	FORM FACTOR	CMOS SETTINGS
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	5.25" FH	
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 ELECTRONICS								
M2860-1	21	4	620	17	120	MFM	8"	
M2860-2	50	6	681	17	120	MFM	8"	
M2860-3	85	8	681	17	120	MFM	8"	
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	
MITSUMI ELECTRONICS CORPORATION								
HD2509AA	92	4	-	52	16	IDE	2.5" x 4H	
HD 2513AA	130	4	-	52	16	ide	2.5" X 4H	
MMI								
M 106	5	2	306	17	75	MFM	3.5 x 1"	
M 112	10	4	306	17	75	MFM	3.5 x 1"	
M 125	20	8	306	17	75	MFM	3.5 x 1"	
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	3.5 x 1"	
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	3.5 x 1"	
NCR CORPORATION								
6091-5101	323	9	1350	26	27	SCSI	5.25"	
6091-5301	675	15	1350	26	25	SCSI	5.25"	

MODEL NUMBER	FORMATTED CAPACITY	NO. OF HEADS	NO. OF CYLINDERS	SECTORS PER TRACK	AVERAGE IN MS	INTERFACE	FORM FACTOR	CMOS SETTINGS
NEC TECHNOLOGIES INC.								
2247	87	6	841	VAR	80	SMD	8"	
D 3126	20	4	615	17	85	MFM	3.5 x 1"	
D 3142	42	8	642	17	28	MFM	3.5 x 1"	
D 3146H	40	8	615	17	35	MFM	3.5 x 1"	
D 3661	118	7	915	36	40	ESDI	3.5 x 1"	
D 3735	56	2	1084	41	20	AT-IDE	3.5 x 1"	
D 3755	105	4	1250	41	20	AT-IDE	3.5 x 1"	
D 3756	105	4	1251	41	19	PC/AT	3.5"	
D 3761	114	7	915	35	20	AT-IDE	3.5 x 1"	
D 3765	176	4	1486	58	16.5	PC/AT	3.5"	
D 3772	331	7	1468	63	14	PC/AT	3.5"	
D 3781	425	9	1464	63	15	PC/AT	3.5"	
D 3835	45	2	1084	41	20	SCSI	3.5 x 1"	
D 3855	105	4	1250	41	20	SCSI	3.5 x 1"	
D 3856	105	4	1251	41	19	SCSI	3.5"	
D 3861	114	7	915	35	20	SCSI	3.5 x 1"	
D 3865	176	4	1486	58	16.5	SCSI	3.5"	
D 3872	331	7	1468	63	14	SCSI	3.5"	
D 3881	425	9	1464	63	15	SCSI-2	3.5 "	
D 5114	5	2	305	17	-	MFM	5.25"	
D 5124	10	4	309	17	85	MFM	5.25" HH	
D 5126/D 5216H	20	4	612	17	85/40	MFM	5.25" HH	
D 5127H	32	4	615	26	85	RLL	5.25" HH	
D 5146/D 5146H	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	-	-	-	<.35	SCSI	5.25 "	
SD1205	120	-	-	-	<.35	SCSI	5.25 "	
NEI								
RD 3127	10	2	612	17	150	MFM	5.25"	
RD 3255	21	4	612	17	150	MFM	5.25"	

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MODEL NUMBER	FORMATTED CAPACITY	NO. OF HEADS	NO. OF CYLINDERS	SECTORS PER TRACK	AVERAGE IN MS	INTERFACE	FORM FACTOR	CMOS SETTINGS
RD 4127	10	4	3066	17	150	MFM	5.25"	
RD 4255	21	8	306	17	150	MFM	5.25"	
NEWBERRY DATA								
NDR 320	21	4	615	17	150	MFM	5.25"	
NDR 340	42	8	615	17	40	MFM	3.5 x 1"	
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	
NDR 3170S	146	9	1224	26	28	SCSI	5.25" FH	
NDR 3280S	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	
NDR 4380S	319	15	1224	34	28	SCSI	5.25" FH	
PENNY 340	42	8	615	17	28	MFM	5.25"	
NPL								
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								
OD 526	31	4	612	26	65	RLL	3.5 x 1"	
OD 540	47	6	612	26	65	RLL	3.5 x 1"	
OLIVETTI								
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	

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ORCA TECHNOLOGY CORPORATION								
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)								
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								
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	
MT-4170E	170	6	1600	35	16	ESDI	5.25" HH	
MT-4170S	170	6	1600	35	16	SCSI	5.25" HH	
MT-5400E	360	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								
JU-116	20	4	615	17	85	MFM	3.5 x 1"	
JU-128	42	7	733	17	35	MFM	3.5 x 1"	
PLUS DEVELOPMENT								
HARDCARD 20	21	47	615	17	40	IDE	3.5" 3H	
HARDCARD 40	42	8	612	17	40	IDE	3.5" 3H	
HARDCARD II-40	40	5	925	17	25	IDE	-	
HARDCARD II-80	80	10	925	17	25	IDE	3.5" 3H	
HARDCARD II-XL	105	105	15	806	17	17	IDE	
HARDCARD II-XL	50	52	10	601	17	17	IDE	

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IMPULSE 105AT/LP	105	16	755	17	17	IDE	3.5" 3H	16x755x17
IMPULSE 105S	105	6	1019	-	19	SCSI-2	3.5 x 1"	
IMPULSE 1005S/LP	105	4	1056	-	17	SCSI-2	3.5" 3H	
IMPULSE 120AT	120	5	1123	42	15	IDE	3.5 x 1"	9x814x32
IMPULSE 120S	120	5	1123	42	15	SCSI-2	3.5 x 1"	
IMPULSE 170AT	169	7	1123	42	15	IDE	3.5 x 1"	10x966x34
IMPULSE 170S	169	7	1123	42	15	SCSI-2	3.5 x 1"	
IMPULSE 210AT	174	7	1156	42	15	IDE	3.5 x 1"	13x873x36
IMPULSE 210S	174	7	1156	42	15	SCSI-2	3.5 x 1"	
IMPULSE 330AT	331	-	-	-	14	IDE	3.5 x 1"	
IMPULSE 330S	331	-	-	-	14	SCSI-2	3.5 x 1"	
IMPULSE 40AT	41	5	965	17	19	IDE	3.5 x 1"	5x968x17
IMPULSE 40S	42	3	834	-	19	SCSI-2	3.5 x 1"	
IMPULSE 425AT	425	-	-	-	14	IDE	3.5 x 1"	
IMPULSE 52AT/LP	52	8	751	17	17	IDE	3.5" 3H	8x751x17
IMPULSE 52S/LP	52	2	-	-	17	SCSI-2	3.5" 3H	
IMPULSE 80AT	83	10	965	17	19	IDE	3.5 x 1"	6x611x17
IMPULSE 80AT/LP	85	16	616	17	17	IDE	3.5" 3H	6x611x17
IMPULSE 80S	84	6	918	-	19	SCSI-2	3.5 x 1"	
IMPULSE 80S/LP	85	4	-	-	17	SCSI-2	3.5" 3H	
PRAIRIETEK CORPORATION								
Prairie 120	21	2	615	34	23	IDE	2.5"	
Prairie 140	40	2	615	34	23	IDE	2.5"	8x615x17
Prairie 220A	20	2	612	34	28	IDE	2.5"	4x615x17
Prairie 220B	20	4	612	34	28	SCSI	2.5"	
Prairie 240	43	4	615	34	28	IDE	2.5"	8x615x17
Prairie 242A	41	4	6615	34	28	IDE	2.5"	8x615x17
Prairie 242S	41	4	1820	34	28	IDE	2.5"	5x942x17
Prairie 282A	82	4	1031	34	28	IDE	2.5"	99x1021x17
Prairie 282S	82	4	1031	34	28	SCSI	2.5"	
PRIAM CORPORATION (also see Vertex)								
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	

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MODEL NUMBER	FORMATTED CAPACITY	NO. OF HEADS	NO. OF CYLINDERS	SECTORS PER TRACK	AVERAGE IN MS	INTERFACE	FORM FACTOR	CMOS SETTINGS
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	3.5 x 1"	
ID20	26	3	987	17	23	MFM	5.25" FH	
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	IDE	5.25" FH	15x1024x28
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	128	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	525" FH	
ID660-U	660	15	1628	54	16	ESDI	5.25" FH	
ID700E	701	15	1774	54	16	ESDI	5.25" FH	
ID700S	68	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-x	62	7	1024	17	28	MFM	5.25" FH	

PROCOM TECHNOLOGY

Propaq 185-15	189	5	1224	36	15	IDE	3.5 x 1"	11x1016x33
HiPer 380	388	8	1224	63	17	ESDI	5.25"	

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MODEL NUMBER	FORMATTED CAPACITY	NO. OF HEADS	NO. OF CYLINDERS	SECTORS PER TRACK	AVERAGE IN MS	INTERFACE	FORM FACTOR	CMOS SETTINGS
Si 200/PS3	209	4	1224	63	18	SCSI	3.5 x 1"	
Si 585/S5	601	8	1224	54	17	SCSI	5.25"	
Si 1000/S5	1037	8	1731	77	15	SCSI	5.25"	
PTI (PERIPHERAL TECHNOLOGY)								
PT-225	21	4	615	17	35	MFM	3.5 x 1"	
PT-234	28	4	820	17	35	MFM	3.5 x 1"	
PT-238A	32	4	615	26	35	IDE	3.5 x 1"	4x615x26
PT-238R	32	4	615	26	35	RLL	3.5 x 1"	
PT-238S	32	4	615	26	35	SCSI	3.5 x 1"	
PT-251A	43	4	820	26	33	IDE	3.5 x 1"	4x820x26
PT-251R	43	4	820	26	35	RLL	3.5 x 1"	
PT-251S	43	4	820	26	35	SCSI	3.5 x 1"	
PT-325R	21	4	615	26	65	RLL	3.5 x 1"	
PT-338	32	6	615	17	35	MFM	3.5 x 1"	
PT-338R	32	4	615	26	65	RLL	3.5 x 1"	
PT-351	42	6	820	17	35	MFM	3.5 x 1"	
PT-351R	60	6	820	26	35	RLL	3.5 x 1"	
PT-357A	49	6	615	26	35	IDE	3.5 x 1"	6x820x26
PT-357R	49	6	615	26	35	RLL	3.5 x 1"	
PT-357S	49	6	615	26	35	SCSI	3.5 x 1"	
PT-376A	65	6	820	26	35	IDE	3.5 x 1"	
PT-376R	65	6	820	26	35	RLL	3.5 x 1"	
PT-376S	65	6	820	26	35	SCSI	3.5 x 1"	
PT-468	57	8	820	17	35	MFM	3.5 x 1"	
PT-4102A	54	5	820	26	35	IDE	3.5 x 1"	8x820x26
PT-4102R	87	8	820	26	28	RLL	3.5 x 1"	
QUANTUM CORPORATION								
2010	10	-	-	17	-	MFM	8"	
2020	20	-	-	17	-	MFM	8"	
2030	30	-	-	17	-	MFM	8"	
2040	40	-	-	17	-	MFM	8"	
2080	80	-	-	17	-	MFM	8"	
GoDrive 40	43	2	957	48	16	IDE/SCSI2	2.5"	5x977x17
GoDrive 80	86	4	957	48	16	IDE/SCSI2	2.5"	10x977x17
GoDrive120	127	4	1097	19	<17	IDE/SCSI2	2.5"	15x965x17
GRS 160	169	4	966	38	<17	IDE/SCSI2	2.5"	4x839x19
Hardcard EZ42	42	5	977	17	19	PC ISA-Slot		
Hardcard EZ85	85	10	977	17	19	PC ISA-Slot		
Hardcard EZ127	127	16	919	17	19	PC ISA-Slot		

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MODEL NUMBER	FORMATTED CAPACITY	NO. OF HEADS	NO. OF CYLINDERS	SECTORS PER TRACK	AVERAGE IN MS	INTERFACE	FORM FACTOR	CMOS SETTINGS
Hardcard EZ240	245	15	966	33	16	PC ISA-Slot		
Passport XL42	42	5	965	17	19	SCSI-2	Remov	
Passport XL42	85	10	976	17	17	SCSI-2	Remov	
Passport XL127	127	15	973	17	17	SCSI-2	Remov	
Passport XL170	170	10	1005	33	17	SCSI-2	Remov	
Passport XL240	245	14	1014	33	16	SCSI-2	Remov	
Passport XL525	525	16	1015	63	10	SCSI-2	Remov	
Plus Hardcard XL	50	52	6	957	17	ISA-slot	Slot	
Plus Hardcard XL	105	105	12	1005	17	ISA-Slot	Slot	
XL 231 Plus HC	231	14	976	33	9	ISA-Slot	Slot	
XL 311 Plus HC	311	10	955	63	9	ISA-Slot	Slot	
XL 360 Plus HC	360	11	958	63	9	ISA-Slot	Slot	
ProDrive 40AT	42	3	834	52	19	IDE	3.5 x 1"	5x900x17
ProDrive 40S	42	3	834	52	19	SCSI	3.5 x 1"	
ProDrive 80AT	84	6	834	63	19	IDE	3.5 x 1"	10x960x17
ProDrive 80S	84	6	834	63	19	SCSI	3.5 x 1"	
ProDrive 105S	105	6	1019	63	19	SCSI	3.5 x 1"	
ProDrive 120AT	120	5	1123	63	19	IDE	3.5 x 1"	14x984x17
ProDrive 120S	120	5	1123	63	15	SCSI	3.5 x 1"	
ProDrive 170AT	168	4	1536	65	19	IDE	3.5 x 1"	
ProDrive 170S	168	4	1536	65	15	SCSI	3.5 x 1"	
ProDrive 210AT	210	7	1156	63	15	IDE	3.5 x 1"	13x950x33
ProDrive 210S	210	7	1156	63	15	SCSI	3.5 x 1"	
ProDrive 330AT	330	7	1536	63	14	IDE	3.5 x 1"	10x1023x63
ProDrive 330S	330	7	1536	63	14	SCSI	3.5 x 1"	
ProDrive 425AT	425	7	1800	63	14	IDE	3.5 x 1"	13x1013x63
ProDrive 425S	425	7	1800	63	14	SCSI	3.5 x 1"	
ProDrive 700S	700	8	1921	63	12	SCSI-2	3.5 x 1"	
ProDrive 1050	1050	12	2224	63	12	SCSI-2	3.5 x 1"	
ProDrive 1225	1225	14	2224	63	12	SCSI-2	3.5 x 1"	
ProDrive ELS 42	42	1	977	63	19	SCSI-2	3.5 x 1"	
ProDrive ELS 127	85	2	977	63	17	SCSI-2	3.5 x 1"	
ProDrive ELS 170	170	4	1011	63	17	SCSI-2	3.5 x 1"	
ProDrive LPS 80	85	4	611	63	15	SCSI	3.5 x 1"	
ProDrive LPS 105	105	4	1219	63	17	SCSI	3.5 x 1"	
ProDrive LPS 105AT	105	4	1219	63	17	IDE	3.5 x 1"	12x1000x17
ProDrive LPS 105S	105	4	1219	63	17	SCSI	3.5 x 1"	
ProDrive LPS 120	122	2	-	44	16	IDE/SCSI	3.5 x 1"	14x980x17
ProDrive LPS 240	245	4	1530	44	16	IDE	3.5 x 1"	14x1014x33
ProDrive LPS 525	525	6	1800	81	10	SCSI2/IDE	3.5 x 1"	16x1017x63
Q-160	200	12	971	36	16	SCSI	5.25" HH	

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MODEL NUMBER	FORMATTED CAPACITY	NO. OF HEADS	NO. OF CYLINDERS	SECTORS PER TRACK	AVERAGE IN MS	INTERFACE	FORM FACTOR	CMOS SETTINGS
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								
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								
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, INC.								
Cobra 40AT	44	8	640	17	20	IDE	3.5 x 1"	8x640x17
Cobra 80AT	80	4	1030	28	20	IDE	3.5 x 1"	4x1024x17
Cobra 110AT	105	7	1053	28	20	ESDI	3.5 x 1"	13x972x17
Cobra 110E	1105	7	1053	28	18	SCSI-2	3.5 x 1"	
Cobra 210AT	210	7	1156	62	20	IDE	3.5 x 1"	13x956x33
Cobra 210E	210	7	1156	62	18	SCSI-2	3.5 x 1"	
Cobra 650E	650	15	1224	63	17	SCSI-2	5.25"	
RODIME, INC.								
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	
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	

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MODEL NUMBER	FORMATTED CAPACITY	NO. OF HEADS	NO. OF CYLINDERS	SECTORS PER TRACK	AVERAGE IN MS	INTERFACE	FORM FACTOR	CMOS SETTINGS
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	3.5 x 1"	
RO 352	11	4	306	17	85	MFM	3.5 x 1"	
RO 652A	20	4	306	33	85	SCSI	3.5 x 1"	
RO 652B	20	4	306	33	85	SCSI	3.5 x 1"	
RO 752A	20	4	306	33	85	SCSI	3.5 x 1"	
RO 3045	37	5	872	17	28	MFM	3.5 x 1"	
RO 3055	45	6	872	17	28	MFM	3.5 x 1"	
RO 3055T	45	3	1053	28	24	SCSI	3.5 x 1"	
RO 3057S	45	5	680	26	28	SCSI	3.5 x 1"	
RO 3058A	45	3	868	34	18	IDE	3.5 x 1"	3x868x34
RO 3058T	45	3	868	34	18	SCSI	3.5 x 1"	
RO 3060R	49	5	750	26	28	RLL	3.5 x 1"	
RO 3065	53	7	872	17	28	MFM	3.5 x 1"	
RO 3075R	59	6	750	26	28	RLL	3.5 x 1"	
RO 3085R	69	7	750	26	28	RLL	3.5 x 1"	
RO 3085S	70	7	750	26	28	SCSI	3.5 x 1"	
RO 3088A	75	5	868	34	18	IDE	3.5 x 1"	5x868x34
RO 3088T	76	5	868	34	18	SCSI	3.5 x 1"	
RO 3090T	75	5	1053	28	24	SCSI	3.5 x 1"	
RO 3095A	80	5	923	34	19	IDE	3.5 x 1"	5x923x34
RO 3099AP	80	4	1030	28	18	IDE	3.5 x 1"	4x1024X29
RO 3121A	122	4	1207	53	14	IDE	3.5 x 1"	14x1001x17
RO 3128A	105	7	868	34	18	IDE	3.5 x 1"	14x868x17
RO 3128T	105	7	868	34	18	SCSI	3.5 x 1"	
RO 3129TS	105	5	1091	41	18	SCSI	3.5 x 1"	
RO 3130T	105	7	1053	28	24	SCSI	5.25" HH	
RO 3135A	112	7	923	34	19	IDE	3.5 x 1"	14x923x17
RO 3139A	112	7	923	28	18	IDE	3.5 x 1"	14x923x17
RO 3139TP	112	5	1148	42	18	SCSI	3.5 x 1"	
RO 3199AP	112	5	1168	28	18	IDE	3.5 x 1"	13x989X17
RI 3199TS	163	7	1216	41	18	SCSI	3.5 x 1"	
RO 3209A	163	15	759	28	18	IDE	3.5 x 1"	10x964x33
RO 3259A	213	15	990	28	18	IDE	3.5 x 1"	13x990x33
RO 3259AP	213	9	1235	28	18	IDE	3.5 x 1"	13x969x33
RO 3259T	210	9	1216	41	18	SCSI	3.5 x 1"	
RO 3259TP	210	9	1189	42	18	SCSI	3.5 x 1"	
RO 3259TS	210	9	1216	41	18	SCSI	3.5 x 1"	
RO 5065	53	5	1224	17	28	MFM	5.25" HH	
RO 5075E	65	3	1224	35	22	ESDI	5.25" HH	

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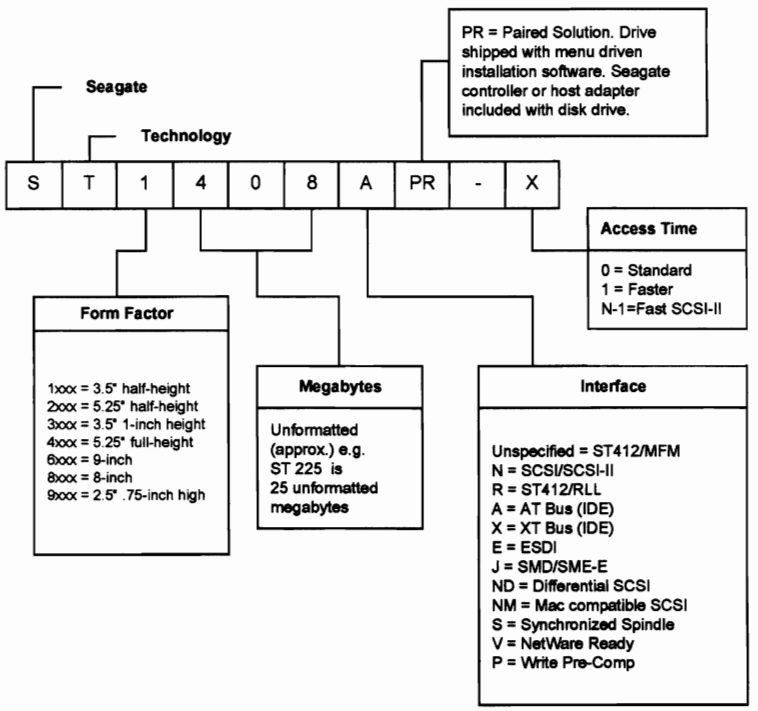
MODEL NUMBER	FORMATTED CAPACITY	NO. OF HEADS	NO. OF CYLINDERS	SECTORS PER TRACK	AVERAGE IN MS	INTERFACE	FORM FACTOR	CMOS SETTINGS
RO 5075S	61	3	1219	33	28	SCSI	5.25" HH	
RO 5078S	61	5	1219	33	18	SCSI	5.25" HH	
RO 5090	74	7	1224	17	28	MFM	5.25" HH	
RO 5125E	109	5	1224	35	22	ESDI	5.25" HH	
RO 5125S	103	5	1219	33	24	SCSI	5.25" HH	
RO 5128S	103	7	1219	33	19	SCSI	5.25" HH	
RO 54130R	114	7	1224	26	28	RLL	5.25" HH	
RP 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								
SHD-3101A	105	4	1282	40	19	IDE	3.5 x 1"	
SHD-3201S	211	7	1376	43	16	SCSI	3.5 x 1"	
SEAGATE TECHNOLOGIES								
This table shows how to identify Seagate drive model numbers								



ST 124	21	4	615	17	40	MFM	3.5 x 1"	
ST 125/-1	21	4	615	17	40/28	MFM	3.5 x 1"	
ST 125A/A-1	21	4	404	26	40/28	IDE	3.5 x 1"	4x404x26
ST 125N/N-1	21	4	407	26	40/28	SCSI	3.5 x 1"	
ST 138/-1	32	6	615	17	40/28	MFM	3.5 x 1"	
ST 138A/A-1	32	4	604	26	40/28	IDE	3.5 x 1"	4x604x26
ST 138N/N-1	32	4	615	26	40/28	SCSI	3.5 x 1"	

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MODEL NUMBER	FORMATTED CAPACITY	NO. OF HEADS	NO. OF CYLINDERS	SECTORS PER TRACK	AVERAGE IN MS	INTERFACE	FORM FACTOR	CMOS SETTINGS
ST 138R/R-1	33	4	615	26	40/28	RLL	3.5 x 1"	
ST 151	43	5	977	17	24	MFM	3.5 x 1"	
ST 157A/A-1	45	6	560	26	40/28	IDE	3.5 x 1"	6x560x26
ST 157N/N-1	49	6	615	26	40/28	SCSI	3.5 x 1"	
ST 157R/R-1	49	6	615	26	40/28	RLL	3.5 x 1"	
ST 177N	61	5	921	26	24	SCSI	3.5 x 1"	
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	
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/-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	IDE	5.25" HH	5x948x26
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/R-1	66	6	820	26	40/28	RLL	5.25" HH	
ST 278R/R-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	IDE	5.25" HH	5x1024x27
ST 296N	80	6	820	34	28	SCSI	5.25" HH	
ST 325A/X	21	4	615	17	28	IDE	3.5 x 1"	4x615x17
ST 351 A/X	42.8	6	820	17	28	IDE	3.5 x 1"	6x820x17
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	IDE	3.5 x 1"	6x1024x17
ST 1090A	79	5	1072	29	15	IDE	3.5 x 1"	5x1024x33
ST 1090N	79	5	1068	29	15	SCSI	3.5 x 1"	
ST 1096N	80	7	906	26	20	SCSI	3.5 x 1"	
ST 1100	83	9	1072	17	15	MFM	3.5 x 1"	
ST 1102A	89	10	1024	17	18	IDE	3.5 x 1"	10x1024x17
ST 1106R	91	7	977	26	24	RLL	3.5 x 1"	
ST 1111A	98	5	1072	36	15	IDE	3.5 x 1"	5x1024x37

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MODEL NUMBER	FORMATTED CAPACITY	NO. OF HEADS	NO. OF CYLINDERS	SECTORS PER TRACK	AVERAGE IN MS	INTERFACE	FORM FACTOR	CMOS SETTINGS
ST 1111E	98	5	1072	36	15	ESDI	3.5 x 1"	
ST 1111N	98	5	1068	36	15	SCSI	3.5 x 1"	
ST 1126A	111	7	1072	29	15	IDE	3.5 x 1"	13x980x17
ST 1126N	111	7	1068	29	15	SCSI	3.5 x 1"	
ST 1133A	117	5	1272	36	15	IDE	3.5 x 1"	14x960x17
ST 1133NS	116	5	1268	36	15	SCSI-2	3.5 x 1"	
ST 1144A	130	15	1385	36	18	IDE	3.5 x 1"	15x1001x17
ST 1150R	128	9	1072	26	15	RLL	3.5 x 1"	
ST 1156A	138	7	1072	36	15	IDE	3.5 x 1"	16x990x17
ST 1156E	138	7	1072	36	15	ESDI	3.5 x 1"	
ST 1156N/NS	138	7	1068	36	15	SCSI 1&2	3.5 x 1"	
ST 1162A	143	9	1072	29	15	IDE	3.5 x 1"	9x1024x30
ST 1162N	142	9	1068	29	15	SCSI	3.5 x 1"	
ST 1186A	164	7	1272	36	15	IDE	3.5 x 1"	10x970x33
ST 1186NS	163	7	1268	36	15	SCSI-2	3.5 x 1"	
ST 1201A	177	9	1072	36	15	IDE	3.5 x 1"	9x804x48
ST 1201E	177	9	1072	36	15	ESDI	3.5 x 1"	
ST 1201N/NS	177	9	1068	36	15	SCSI 1&2	3.5 x 1"	
ST 1239A	211	9	1272	36	15	IDE	3.5 x 1"	12x954x36
ST 1239NS	210	9	1268	36	15	SCSI-2	3.5 x 1"	
ST 1400A	331	7	1475	62	14	IDE	3.5 x 1"	15x736x62
ST 1400N	331	7	1476	62	14	SCSI-2	3.5 x 1"	
ST 1401A	340	9	1121	62	12	IDE	3.5 x 1"	15x736x62
ST 1401N	338	9	1121	62	12	SCSI-2	3.5 x 1"	
ST 1480A	426	9	1474	-	14	IDE	3.5 x 1"	15x895x62
ST 1480N/ND	426	9	1476	62	14	SCSI-2	3.5 x 1"	
ST 1480N/NV	426	9	1476	62	14	SCSI-2	3.5 x 1"	
ST 1481N	426	9	1476	62	14	F SCSI	3.5 x 1"	
ST 1581N	525	9	1476	77	14	F SCSI	3.5 x 1"	
ST 1980N/ND	860	13	1730	77	9.9/11.4	F SCSI	3.5 x 1"	
ST 2106E	92	5	1024	36	18	ESDI	5.25" HH	
ST 2106N/NM	91	5	1022	36	18	SCSI	5.25" HH	
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	IDE	5.25" HH	16x465x63
ST 2383A	338	7	1747	54	16	IDE	5.25" HH	16x737x56
ST 2383A	338	7	1747	54	16	ESDI	5.25" HH	
ST 2383 ALL	332	7	1261	74	14	SCSI 1&2	5.25" HH	
ST 2502 ALL	435	7	1755	69	16	SCSI 1&2	5.25" HH	
ST 3051A	43.1	7	706	17	16	IDE	3.5 x 1"	6x820x17

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MODEL NUMBER	FORMATTED CAPACITY	NO. OF HEADS	NO. OF CYLINDERS	SECTORS PER TRACK	AVERAGE IN MS	INTERFACE	FORM FACTOR	CMOS SETTINGS
ST 3096A	89.1	16	590	17	14	IDE	3.5 x 1"	10x1024x17
ST 3120A	106.9	16	754	17	15	IDE	3.5 x 1"	12x1024x17
ST 3144A	130.7	16	953	17	16	IDE	3.5 x 1"	15x1001x17
ST 3243S	214	16	413	63	16	IDE	3.5 x 1"	12x1024x36
ST 3283A	245.3	16	470	63	12	IDE	3.5 x 1"	16x470x63
ST 3283N	248.6	N/A	N/A	-	12	FSCSI	3.5 x 1"	
ST 3385A	340	14	767	63	12	IDE	3.5 x 1"	16x659x63
ST 3500A	426	8	1820	36	10	IDE	3.5 x 1"	16x825x63
ST 3500N/ND	426	16	825	63	10	SCSI-2	3.5 x 1"	
ST 3550A	452.4	7	1810	63	12	IDE	3.5 x 1"	16x876x63
ST 3550N	456.5	7	1810	63	12	FSCSI	3.5 x 1"	
ST 3600A	540	7	1874	-	10.5/12	IDE	3.5 x 1"	16x1024x63
ST 3600N/ND	525	7	1872	-	10.2/12	FSCSI-2	3.5 x 1"	
ST 3601N/ND	535	7	1872	-	10.2/12	FSCSI	3.5 x 1"	
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	MFM	5.25" FH	
ST 4182E	160	9	969	36	16	ESDI	5.25" FH	
ST 4182N/NM	155	9	969	35	16	SCSI	5.25" FH	
ST 4350N/NM	300	9	1412	46	17	SCSI	5.25" FH	
ST 4376N/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 4385N/NM/NV	330	15	1412	55	10.7	SCSI	5.25" FH	
ST 4442E	380	15	1412	36	16	ESDI	5.25" FH	
ST 4702N/NM	601	15	1546	50	16.5	SCSI	5.25" FH	
ST 4766E	676	15	1632	54	15.5	SCSI	5.25" FH	
ST 9095A	85.3	16	1024	63	16	IDE	2.5"	
ST 9096A	85.3	16	1024	63	16	IDE	2.5"	
ST 9096N	85	-	-	-	16	SCSI-2	2.5 x .75"	
ST 9100AG	85.3	16	1024	-	16	IDE	2.5"	
ST 9144	42.6	16	1024	63	16	IDE	2.5"	
ST 9144A	127.9	16	1024	63	16	IDE	2.5 x.75"	
ST 9144N	128	-	-	-	16	SCSI-2	2.5 x.75"	

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MODEL NUMBER	FORMATTED CAPACITY	NO. OF HEADS	NO. OF CYLINDERS	SECTORS PER TRACK	AVERAGE IN MS	INTERFACE	FORM FACTOR	CMOS SETTINGS
ST 9235N	209	N/A	N/A	-	16	SCSI	2.5"	
ST 9295AG	261	16	1024	-	16	IDE	2.5"	
ST 11200N/ND	1050	15	1877	-	10.5/	FSCSI2	3.5 x 1"	
ST 11200N/ND	1050	15	1877	-	10.512/	FWSCSI2	3.5 x 1"	
ST 11700N/ND	1430	13	2626	-	9/10.5	FSCSI2	3.5 x 1"	
ST 11701N/ND	1430	13	2626	63	9/10.5	FWSCSI2	3.5 x 1"	
ST 11750N/ND	1437	12	2756	63	8/9	FSCSI2	3.5 x 1"	
ST 11751N/ND	1437	12	2756	63	8/9	FWSCSI2	3.5 x 1"	
ST 12400N/ND	2100	19	2626	63	9/10.5	FSCSI2	3.5 x 1"	
ST 12401N/ND	2100	19	2626	63	9/10.5	FWSCSI2	3.5 x 1"	
ST 12550N/ND	2100	19	2756	63	8/9	FSCSI2	3.5 x 1"	
ST 12551N/ND	2100	19	2756	63	8/9	FSCSI2	3.5 x 1"	
ST 31200N/ND	1050	9	2626	63	9/10.5	FSCSI2	3.5 x 1"	
ST 41097J	1097	17	2101	71	12	SMD	5.25" FH	
ST 41200N/NM/NV	1037	15	1931	71	15	SCSI	5.25" FH	
ST 41201J/K	1200	15	2101	71	11.5	SMD	5.25" FH	
ST 41291K	1200	15	2101	71	11.5	DP-IPI	5.25" FH	
ST 41520K	1370	18	2101	71	11.5	DP-SCSI2	5.25" FH	
ST 41600N/ND	1370	18	2101	75	11.5	SCSI2	5.25" FH	
ST 41601N/ND	1370	18	2101	75	11.5	FSCSI2	5.25" FH	
ST 41650N/ND	1415	15	2107	87	15	SCSI-2	5.25" FH	
ST 41651N/ND	1415	15	2107	77	15	FSCSI2	5.25" FH	
ST 41800K	1624	15	2627	81	11	DP IPI-2	5.25" FH	
ST 42000N/ND	1792	15	2627	84	11	FSCSI2	5.25" FH	
ST 42100N	1900	15	2574	84	12.9	FSCSI2	5.25" FH	
ST 42100NM/ND/NV	1037	15	1931	84	15	SCSI-2	5.25" FH	
ST 42101N/ND	1900	15	2574	84	13	FWSCSI2	5.25" FH	
ST 42400N	2100	19	2653	84	11	SCSI-2	5.25" FH	
ST 43200K	3385*	19	2738	91	10/11	FWSCSI2	5.25" FH	
ST 43400N/ND	2912	19	2738	88	11	FSCSI2	5.25" FH	
ST 43401N/ND	2912	19	2738	88	10/11	FWSCSI2	5.25" FH	
ST 43402ND	2912	19	2738	88	10/11	FWSCSI2	5.25" FH	
ST 81236J/K/N	1056	17	1635	64	15	IPI-2/SCSI	8"	
ST 81123J	1123*	17	1635	64	15	SMD	8"	
ST 81154K	1154*	17	1635	64	15	IPI-2	8"	
ST 82030J/K	2030*	21	2120	64	11	IPI-2	8"	
SHUGART								
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	

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MODEL NUMBER	FORMATTED CAPACITY	NO. OF HEADS	NO. OF CYLINDERS	SECTORS PER TRACK	AVERAGE IN MS	INTERFACE	FORM FACTOR	CMOS SETTINGS
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"	
SA 1004	10	-	-	17	-	MFM	8"	
SA 1106	30	-	-	17	-	MFM	8"	
SA 4004	14	-	-	17	-	MFM	14"	
SA 4008	29	-	-	17	-	MFM	14"	
SA 4100	56	-	-	17	-	MFM	14"	
SIEMENS								
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								
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	3.5 x 1"	
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	3.5 x 1"	
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	

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MODEL NUMBER	FORMATTED CAPACITY	NO. OF HEADS	NO. OF CYLINDERS	SECTORS PER TRACK	AVERAGE IN MS	INTERFACE	FORM FACTOR	CMOS SETTINGS
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	3.5 x 1"	
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 TECHNOLOGY								
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" HH	
SQ 312RD	10	2	615	17	85	MFM	4" HH	
SQ 315F	21	4	612	17	65	MFM	4" HH	
SQ 319	10	2	612	17	85	MFM	4" HH	
SQ 325	21	4	612	17	85	MFM	4" HH	
SQ 325F	20	4	615	17	65	MFM	4" HH	
SQ 338F	30	6	615	17	65	MFM	4" HH	
SQ 340AF	38	6	640	17	65	MFM	4" HH	
SQ 555	44	2	1021	42	20	SCSI	5.25" HH	5x1011x17
SQ 2542A	43	2	1481	41	15	IDE	2.5"	5x988x17
SQ 5110	89	2	1720	82	20	SCSI	5.25" HH	13x972x17
TANDON COMPUTER CORPORATION								
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	3.5 x 1"	
TM 262	21	4	615	17	65	MFM	3.5 x 1"	
TM 262R	20	2	782	26	85	RLL	3.5 x 1"	
TM 264	41	4	782	26	85	RLL	3.5 x 1"	
TM 344	41	4	782	26	37	RLL	3.5 x 1"	
TM 346	62	6	782	26	37	RLL	3.5 x 1"	
TM 361	10	2	615	17	65	MFM	3.5 x 1"	
TM 362	21	4	615	17	65	MFM	3.5 x 1"	
TM 362R	20	2	782	26	85	RLL	3.5 x 1"	
TM 364	41	4	782	26	85	RLL	3.5 x 1"	

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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	
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 703C	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	3.5 x 1"	
TM 3085R	71	8	1024	17	37	MFM	3.5 x 1"	
TM 3085R	104	8	1024	26	37	RLL	3.5 x 1"	
TANDY CORPORATION								
25-1045	20	4	615	17	35	IDE	5.25" HH	4x615x17
25-1046	43	4	782	27	28	IDE	5.25" HH	
25-1047	20	4	615	17	35	IDE	-	4x615x17
TEAC AMERICA, INC.								
SD 150	10	4	306	17	80	MFM	5.25" FH	
SD 340A	43	2	1050	40	23	IDE	3.5 x 1"	
SD 340S	43	2	1050	40	23	SCSI	3.5 x 1"	
SD 380	86	4	1050	40	20	IDE	3.5 x 1"	
SD 380S	86	4	1050	40	20	SCSI	3.5 x 1"	
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	3.5 x 1"	12x1005x17
TEXAS INSTRUMENTS								
TI-5	5	4	153	17	65	MFM	5.25" FH	
TOKICO								
DK 503-2	10	4	306	17	105	MFM	5.25" FH	

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TOSHIBA AMERICA, INC.								
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	831	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	3.5 x 1"	
MK 72PCR	105	10	830	26	25	RLL	3.5 x 1"	
MK 130	53	9	733	17	25	MFM	3.5 x 1"	
MK 134FA (M)	44	7	733	17	25	MFM	3.5 x 1"	
MK 134FA (R)	65	7	733	26	23	RLL	3.5 x 1"	
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	ESDI	5.25" FH	
MK 156FB	145	10	830	35	23	SCSI	5.25" FH	
MK 232FB	45	3	845	35	25	SCSI	3.5 x 1"	
MK 233FB	76	5	845	35	25	SCSI	3.5 x 1"	
MK 234FB	101	7	845	35	25	IDE	3.5 x 1"	12x945x17
MK 234FC	101	7	845	35	25	IDE	3.5 x 1"	12x945x17
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 556FA	152	10	830	36	23	ESDI	5.25" FH	
MK 1034FC	107	4	1339	39	16	IDE	3.5"	8x664x39
MK 1122FC	43	5	988	17	23	IDE	2.5"	
MK 2024FC	86	2	988	17	19	IDE	2.5"	16x615x17
MK 2124FC	130	6	1820	48	17	IDE	2.5"	16x1155x17

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MODEL NUMBER	FORMATTED CAPACITY	NO. OF HEADS	NO. OF CYLINDERS	SECTORS PER TRACK	AVERAGE IN MS	INTERFACE	FORM FACTOR	CMOS SETTINGS
TULIN								
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)								
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								
WS 262	20	4	615	17	80	MFM	3.5 x 1"	
WD 344R	40	4	782	26	40	RLL	3.5 x 1"	
WD 362	20	4	615	17	80	MFM	3.5 x 1"	
WD 382R	20	2	782	26	85	RLL	3.5 x 1"	
WD 383R	30	4	615	26	85	RLL	3.5 x 1"	
WD 384R	40	4	782	26	85	RLL	3.5 x 1"	
WD 544R	40	4	782	26	40	RLL	3.5 x 1"	
WD 582R	20	2	782	26	85	RLL	3.5 x 1"	
WD 383R	30	4	615	26	85	RLL	3.5 x 1"	
WD 384R	40	4	782	26	85	RLL	3.5 x 1"	
WD 93024A	20	2	782	27	28	IDE	3.5 x 1"	
WD 93024X	20	2	782	27	39	IDE	3.5 x 1"	
WD 93028A/AD	20	2	782	27	69	IDE	3.5 x 1"	
WD 93028X	20	2	782	27	80	IDE	3.5 x 1"	
WD 93034X	30	3	782	27	39	IDE	3.5 x 1"	
WD 93038X	30	3	782	27	80	IDE	3.5 x 1"	
WD 93044A	40	4	782	27	28	IDE	3.5 x 1"	
WD 93044X	40	4	782	27	39	IDE	3.5 x 1"	
WD 93048AD	40	4	782	27	69	IDE	3.5 x 1"	
WD 93048A	40	4	782	27	69	IDE	3.5 x 1"	
WD 93048X	40	4	782	27	80	IDE	3.5 x 1"	
WD 95024A	20	2	782	27	28	IDE	5.25" HH	
WD 95024X	20	2	782	27	39	IDE	5.25" HH	
WD 95028Z	20	2	782	27	39	IDE	5.25" HH	
WD 95028AD	20	2	782	27	69	IDE	3.5 x 1"	
WD 95028X	20	2	782	27	80	IDE	5.25" HH	

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MODEL NUMBER	FORMATTED CAPACITY	NO. OF HEADS	NO. OF CYLINDERS	SECTORS PER TRACK	AVERAGE IN MS	INTERFACE	FORM FACTOR	CMOS SETTINGS
WD 95034X	30	3	782	27	39	IDE	3.5 x 1"	
WD 95044A	40	4	782	27	28	IDE	3.5 x 1"	
WD 95044X	40	4	782	27	39	IDE	3.5 x 1"	
WD 95048A	40	4	782	27	69	IDE	3.5 x 1"	
WD 95048AD	40	4	782	27	69	IDE	3.5 X 1"	
WD 95048X	40	4	782	27	80	IDE	5.25" HH	
WD AB130	32	5	733	17	19	IDE	2.5"	
WD AH260	63	7	1024	17	19	IDE	2.5"	
WD AC140	42	5	980	17	18	IDE	3.5"	
WD AC160	62	7	1024	17	17	IDE	3.5 x 1"	
WD AC280	85	10	980	17	18	IDE	3.5 x 1"	
WD AC2120	125	8	872	35	17	IDE	3.5 x 1"	
WD AP4200	212	12	987	35	15	IDE	3.5 x 1"	
WD M1130-44	41	2	1104	33	19	MCA	3.5 x 1"	
WD M1130-72	68	4	1104	32	19	MCA	3.5 x 1"	
WD SC8320	320	6	2105	35	12	SCSI-2	3.5 x 1"	
WD SC8400	400	8	1900	35	12	SCSI-2	3.5 x 1"	
WD SP4200	209	4	1900	35	14	SCSI-2	3.5 x 1"	
Condor	320	6	2105	35	13	SCSI	3.5 x 1"	
Piranha 105A	105	2	1917	35	15	IDE	3.5 x 1"	13x1000x16
Piranha 105S	105	2	1917	35	15	SCSI	3.5 x 1"	
Piranha 210A	210	4	1917	35	15	IDE	3.5 x 1"	13x950x33
Piranha 210S	210	4	1917	35	15	SCSI	3.5 x 1"	
XEBEX								
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 AMERICA, INC. (also see C. Itoh)								
YD-3042	44	4	788	42	28	SCSI	3.5 x 1"	
YD-3081B	45	2	1057	42	28	SCSI	3.5 x 1"	
YD-3082	87	8	788	42	28	SCSI	3.5 x 1"	
YD-3082B	90	4	1057	42	28	SCSI	3.5 x 1"	
YD-3083B	136	6	1057	42	28	SCSI	3.5 x 1"	
YD-3084B	181	8	1057	42	28	SCSI	3.5 x 1"	
YD-3161B	45	2	1057	42	19	IDE	3.5 x 1"	
YD-3162B	90	4	1057	42	19	IDE	3.5 x 1"	
YD-3181B	45	2	1057	42	19	SCSI	3.5 x 1"	
YD-3182B	90	4	1057	42	19	SCSI	3.5 x 1"	
YD-3530	32	5	731	17	-	MFM	5.25" HH	

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MODEL NUMBER	FORMATTED CAPACITY	NO. OF HEADS	NO. OF CYLINDERS	SECTORS PER TRACK	AVERAGE IN MS	INTERFACE	FORM FACTOR	CMOS SETTINGS
YD-3540	45	7	731	17	-	MFM	5.25" HH	
ZENTEC								
ZH 3100	86	-	-	-	20	IDE/SCSI	3.5 x 1"	
ZH 3140	121	-	-	-	20	IDE/SCSI	3.5 x 1"	
ZH 3240	237	-	-	-	12	IDE/SCSI	3.5 x 1"	
ZH 3380	332	-	-	-	12	IDE/SCSI	3.5 x 1"	
ZH 3490	427	-	-	-	12	IDE/SCSI	3.5 x 1"	

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CONTROLLER INFORMATION

Listed on the following pages are descriptions of common controller cards with performance ratings and jumper settings. The jumper setting 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 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-II. 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).

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Adaptec 1540A
Adapted 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.

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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 2322A-8 supports data rates up to 15 MHz.

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.

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 drives.

Default Jumpers:
E1, E2, and E4 installed.

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CORPORATE SYSTEM CENTER 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 up to 4 floppy drives. Up to 32MB on board cache.

Jumper Functions and Defaults

Jumper	Function	Default	Jumper
W1	BIOS Address	On	On
W2	BIOS Address	On	On

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Jumper	Function	Default	Jumper
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 FastCache 32

Supports up to 7 SCSI devices and 4 floppy drives. Up to 32MB on board cache. A single 8-bit position dipswitch is used for hardware configurationsa and are shown below.

Base Address

SW0	SW1	
On	On	D000
On	Off	C800
Off	On	E000
Off	Off	D800

Bus Speed

SW4	
On	Fast
Off	Faster

Floppy Drive

SW5	
On	Enabled
Off	Disabled

Module Type

SW2	SW3	
On	On	256K
On	Off	1MB
Off	On	4MB

Notes: Switches 6 & 7 controll the floppy disk density and should be left ON for standard floppy drives. Switch 8 is not in use.

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CSC FastCache 64

Supports up to 7 SCSI devices and 4 floppy drives. Up to 64MB onboard cache. A single 8-bit position dipswitch is used for hardware configurations and are shown below.

Interrupt

SW1	SW2	
Off	Off	None
On	Off	IRQ14
Off	On	IRQ15

Floppy Drive

SW3	
On	Enabled
Off	Disabled

Bus Speed

SW4	
On	Non-Std.
Off	Standard

Module Type

SW%	SW6	
On	On	256K
Off	On	1MB
On	Off	4MB
Off	Off	16MB

Base Address

SW7	SW8	Address
Off	On	C800
On	Pn	D000
Off	Off	D800
On	Off	E000

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

SW1	SW2	Address
On	Off	C800*
On	On	D000
Off	Off	D800
Off	On	E000

SIMM Type

SW3	SW4	Module
On	On	256KB
On	Off	1MB
Off	On	4MB
Off	Off	16MB

Bus Compatibility

SW5	
Off	Primary*
On	Non-Standard

Floppy Drives

SW6	
On	Enabled*
Off	Disabled

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IDE Address		Drive Interrupt	
SW7		SW8	
On	Primary*	On	Buffered*
Off	Secondary	Off	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:
In: W1-2 &3, W2-1 & 2*, SW1-8*, SW1-10*

To format, use: GSDIAG program

Notes: * 3280 only for floppy drives.

DTC 3290

An EISA bus SCSI controller with up to 4MB cache RAM. Controls up to 7 SCSI devices and two floppy drives.

Default Jumpers:
None installed

To format, use: GSDIAG program

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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 5180 CRH
DTC 5180I

These are 16-bit MFM hard drives, 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 drives, 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

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

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

Default Jumpers:
All Models: W5, W6

To format, use: G=C800:5

DTC 5387
DTC 5287CR
DTC 5287IO

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 drives at 10MHz. Model 6280 also controls 2 floppy drives.

Default Jumpers:
6180: W3, SW1-4
6280: W2

To format, use: G=C800:5

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DTC 6180-15T
DTC 6280-15T

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

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 floppy drives.

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.

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DTC 6195
DTC 6295

EISA, ESDI, 1:1 interleave hard drive controllers. 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 controller. 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

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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 controlls 2 floppy drives.

Default Jumpers: None

To format, use: Future Domain software.

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

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

Default Jumpers: None.

To format, use: Future Domain software.

LONGSHINE CONTROLLERS

Longshine LCS-6210D

A 8-bit MFM controller for 2 hard drives.

Default Jumpers:
1-8 heads: JPI 1 & 2
9-16 heads: JPI 2 & 3

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.

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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:
JP6-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 ST08A

A 16-bit AT-ide controller for up to 2 hard drives. Model ST-08A also controls up to 2 floppy drives.

Default Jumpers:
JP4-1 & 1*, JP5-1 & 2

To format, use: DOS

Notes: * For ST-08A

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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 SR21-M
Seagate SR21-R
Seagate SR22-M
Seagate SR21-R

ST-21M and ST-22M are 16-bit MFM hard drive ontrollers. 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 pr OMT/DISK

Notes: HA7 BIOS may cause partitioning problems with DOS 4.0 or later.

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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=C800:6

Notes: Drivers for Novell and more than 2 SCSI drives are available. May not operated 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

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SMS/OMTI 8140
SMS/OMTI 8240

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

Default Jumpers:
None installed.

To format, use: OMPI/DISK software.

Notes: Incompatible with some motherboards due to timing problem., but runs solid as a rock in boards with the original AT-IBM 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 10MHz. Supports 1:1 interleave, and has 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 15MHZ. Supports 1:1 interleave, and has 32K look-ahead cache.

Default Jumpers:
W17, W20-2 &3, W23, W24, W25

To format, use: G=CA00:6

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Storage Dimension Controllers

Storage Dimension SDC-801
Storage Dimension SDC-802

An 8-bit SCSI host adapter. SDC-802 also controlls 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:
None installed.

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:
None installed.

To format, use: G=C800:5

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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 15CM also provides 2 serial ports, 2 parallel ports, and a game port.

Default Jumpers:
None installed.

To format, use: G=C800:5

Ultrastor 22C
Ultrastor 22F

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

Default Jumpers:
None installed.

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 16MB of cache memory.

Default Jumpers:
None installed.

To format, use: G=C800:5

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Wangtec Controllers

Wangtec EV-831

Controls QIC-36 tape drives.

Default Jumpers:
E 3 & 4, E 8 & 9, E 11 & 12, W1, W2, W3

Notes: See manual for switch settings, DMA settings and interrupt jumpers. Most reported problems with this card are a result of DMA interrupt problems.

Western Digital Controllers

Western Digital WD AT140

A 16-bit adapter board for 2 AT type IDE drives and 2 floppy 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

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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 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.

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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.

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Default jumpers:
W1-2 & 3, W2-2 & 3, W3-1 & 2, W5-2 & 3, W6-2 & 3

To format, use: DOS

Notes: Uses WS-37C65 chip, works well in 286/386 machines.

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 WD 1004-27X
Western Digital WD 1004A-27X

An 8-bit controller for 2 hard drives only.

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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.

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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, SpeedStorm 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 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.

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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 supplies 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 look-ahead cache. Model SE2 also controls 2 floppy drives.

Default jumpers:
W7-1 & 2, W8-2 & 3

To format, use: G=C00:5 or C800:5 is W8 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

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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. Driver s available for Novell and Xenix.

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CONNECTOR PINOUTS

The following pages contain pinout information on various interfaces.

Table A - Pinout for Apple's External HDI-30 Connector

Pin	Internal Connector	External Connector
1	DISK.+5	-LINK.SEL
2	DISK.+5	-DB(0)
3	GROUND	GROUND
4	GROUND	-DB(1)
5	GROUND	TERMPWR*
6	-DB(0)	-DB(2)
7	-DB(1)	-DB(3)
8	-DB(2)	GROUND
9	-DB(3)	-ACK
10	-DB(4)	GROUND
11	-DB(5)	-DB(4)
12	-DB(6)	GROUND
13	-DB(7)	GROUND
14	-DB(P)	-DB(5)
15	DISK.+5	GROUND
16	-BSY	-DB(6)
17	-ATN	GROUND
18	-ACK	-DB(7)
19	GROUND	-DB(P)
20	-MSG	GROUND
21	-RST	-REQ
22	-SEL	GROUND
23	-C/D	-BSY
24	-I/O	GROUND
25	-REQ	-ATN
26	GROUND	-C/D
27	GROUND	-RST
28	GROUND	-MSG
29	DISK.+5	-SEL
30	DISK.+5	-I/O

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Figure B - Apple and Future Domain 25-Pin D-Sub

ALERT
When looking at Table B, keep in mind that the connector numbers shown in the table and in Figure B are the ones that connector manufacturers, like AMP, use on the connectors. These are not the numbers used by SUN. For whatever reason, SUN used an unusual numbering scheme, which differs from the counting scheme the connector manufacturers use and print on the connector bodies. So, if you use an older SUN device, be extremely careful when using factory cables.

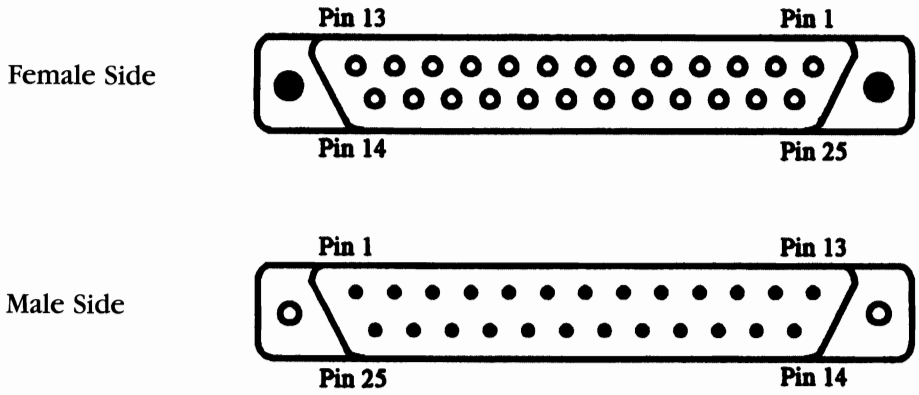

Table B - Pinout for Apple and Future Domain Single-Ended SCSI Connectors Shown Above

Apple Single-ended SCSI Pinout				Future Domain Single-ended SCSI Pinout			
Pin	Signal	Pin	Signal	Pin	Signal	Pin	Signal
1	-REQ	14	RES/GND	1	GND	14	-DB(0)
2	-MSG	15	-C/D	2	-DB(1)	15	-DB(2)
3	-I/O	16	RES/GND	3	-DB(3)	16	-DB(4)
4	-RST	17	-ATN	4	-DB(5)	17	-DB(6)
5	-ACK	18	GND	5	-DB(7)	18	-DB(P)
6	-BSY	19	-SEL	6	GND	19	GND
7	GND	20	-DBP	7	-SEL	20	-ATN
8	-DB0	21	-DB1	8	GND	21	-MSG
9	GND	22	-DB2	9	Spare	22	-ACK
10	-DB3	23	-DB4	10	-RST	23	-BSY
11	-DB5	24	GND	11	-C/D	24	-REQ
12	-DB6	25	TermPwr*	12	-I/O	25	-GND
13	-DB7			13	GND		

**Pin 25 - Termination Power is not connected in the Mac Plus connector.*

Non-Official Standard SCSI Connectors

For whatever reasons, some companies decided to introduce non-standard SCSI connectors. The most common are Future Domain's 25-pin D-sub connector, used on their early SCSI host adapters, Apple's 25-pin D-sub connector with a different and totally incompatible pinout scheme, and IBM's proprietary PS/2 SCSIL connector. See above figures and tables.

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Table C - Pinout for Single-Ended and Differential B-Cables

Single-ended SCSI Pinout, B-Cable				Differential SCSI Pinout, B-Cable			
Pin	Signal	Pin	Signal	Pin	Signal	Pin	Signal
1	GND	35	GND		GND		GND
2	GND	36	-DB(8)		+DB(8)		-DB(8)
3	GND	37	-DB(9)		+DB(9)		-DB(9)
4	GND	38	-DB(10)		+DB(10)		-DB(10)
5	GND	39	-DB(11)		+DB(11)		-DB(11)
6	GND	40	-DB(12)		+DB(12)		-DB(12)
7	GND	41	-DB(13)		+DB(13)		-DB(13)
8	GND	42	-DB(14)		+DB(14)		-DB(14)
9	GND	43	-DB(15)		+DB(15)		-DB(15)
10	GND	44	-DB(P1)		+DB(P1)		-DB(P1)
11	GND	45	-ACKB		+ACKB		-ACKB
12	GND	46	GND		GND		DIFFSENS
13	GND	47	-REQB		+REQB		-REQB
14	GND	48	-DB(16)		+DB(16)		-DB(16)
15	GND	49	-DB(17)		+DB(17)		-DB(17)
16	GND	50	-DB(18)		+DB(18)		-DB(18)
17	TermPwrB	51	TermPwrB		TermPwrB		TermPwrB
18	TermPwrB	52	TermPwrB		TermPwrB		TermPwrB
19	GND	53	-DB(19)		+DB(19)		-DB(19)
20	GND	54	-DB(20)		+DB(20)		-DB(20)
21	GND	55	-DB(21)		+DB(21)		-DB(21)
22	GND	56	-DB(22)		+DB(22)		-DB(22)
23	GND	57	-DB(23)		+DB(23)		-DB(23)
24	GND	58	-DB(P2)		+DB(P2)		-DB(P2)
25	GND	59	-DB(24)		+DB(24)		-DB(24)
26	GND	60	-DB(25)		+DB(25)		-DB(25)
27	GND	61	-DB(26)		+DB(26)		-DB(26)
28	GND	62	-DB(27)		+DB(27)		-DB(27)
29	GND	63	-DB(28)		+DB(28)		-DB(28)
30	GND	64	-DB(29)		+DB(29)		-DB(29)
31	GND	65	-DB(30)		+DB(30)		-DB(30)
32	GND	66	-DB(31)		+DB(31)		-DB(31)
33	GND	67	-DB(P3)		+DB(P3)		-DB(P3)
34	GND	68	GND		GND		GND

68-Pin Wide SCSI B-, P-, and Q-Cables

The pinout for single-ended and differential B-cables is shown in Table C.

The P-cable use a much smaller high-density connector because the smaller 3½-inch devices don't have enough mounting space to fit an IDC connector with 68 pins. The connector is the same for internal and external cables, but the internal version is unshielded with a plastic body and without locking mechanisms. The male connector is the cable connector, and the device has the female connector.

In 1992, there was a proposed cable standardization for Wide SCSI devices but the Q-cable did not gain industry acceptance.

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Table D - Pinout for Single-Ended and Differential P-Cables

Single-ended SCSI Pinout, P-Cable				Differential SCSI Pinout, P-Cable			
Pin	Signal	Pin	Signal	Pin	Signal	Pin	Signal
1	GND	35	-DB(12)		+DB(12)		-DB(12)
2	GND	36	-DB(13)		+DB(13)		-DB(13)
3	GND	37	-DB(14)		+DB(14)		-DB(14)
4	GND	38	-DB(15)		+DB(15)		-DB(15)
5	GND	39	-DB(P1)		+DB(P1)		-DB(P1)
6	GND	40	-DB(0)		GND		GND
7	GND	41	-DB(1)		+DB(0)		-DB(0)
8	GND	42	-DB(2)		+DB(1)		-DB(1)
9	GND	43	-DB(3)		+DB(2)		-DB(2)
10	GND	44	-DB(4)		+DB(3)		-DB(3)
11	GND	45	-DB(5)		+DB(4)		-DB(4)
12	GND	46	-DB(6)		+DB(5)		-DB(5)
13	GND	47	-DB(7)		+DB(6)		-DB(6)
14	GND	48	-DB(P)		+DB(7)		-DB(7)
15	GND	49	GND		+DB(P)		-DB(P)
16	GND	50	GND		DIFFSENS		GND
17	TermPwr	51	TermPwr		TermPwr		TermPwr
18	TermPwr	52	TermPwr		TermPwr		TermPwr
19	Reserved	53	Reserved		Reserved		Reserved
20	GND	54	GND		+ATN		-ATN
21	GND	55	-ATN		GND		GND
22	GND	56	GND		+BSY		-BSY
23	GND	57	-BSY		+ACK		-ACK
24	GND	58	-ACK		+RST		-RST
25	GND	59	-RST		+MSG		-MSG
26	GND	60	-MSG		+SEL		-SEL
27	GND	61	-SEL		+C/D		-C/D
28	GND	62	-C/D		+REQ		-REQ
29	GND	63	-REQ		+I/O		-I/O
30	GND	64	-I/O		GND		GND
31	GND	65	-DB(8)		+DB(8)		-DB(8)
32	GND	66	-DB(9)		+DB(9)		-DB(9)
33	GND	67	-DB(10)		+DB(10)		-DB(10)
34	GND	68	-DB(11)		+DB(11)		-DB(11)

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Table E - Pinout for 50-Pin, Single-Ended and Differential Centronics-Syyle Connector (A Cable)

Single-ended SCSI Pinout				Differential SCSI Pinout			
Pin	Signal	Pin	Signal	Pin	Signal	Pin	Signal
1	GND	26	-DB(0)	1	GND	26	GND
2	GND	27	-DB(1)	2	+DB(0)	27	-DB(0)
3	GND	28	-DB(2)	3	+DB(1)	28	-DB(1)
4	GND	29	-DB(3)	4	+DB(2)	29	-DB(2)
5	GND	30	-DB(4)	5	+DB(3)	30	-DB(3)
6	GND	31	-DB(5)	6	+DB(4)	31	-DB(4)
7	GND	32	-DB(6)	7	+DB(5)	32	-DB(5)
8	GND	33	-DB(7)	8	+DB(6)	33	-DB(6)
9	GND	34	-DB(P)	9	+DB(7)	34	-DB(7)
10	GND	35	GND	10	+DB(P)	35	-DB(P)
11	GND	36	GND	11	DIFFSENS	36	GND
12	Reserved	37	Reserved	12	Reserved	37	Reserved
13	Not Connected	38	TERMPWR	13	TERMPWR	38	TERMPWR
14	Reserved	39	Reserved	14	Reserved	39	Reserved
15	GND	40	GND	15	+ATN	40	-ATN
16	GND	41	-ATN	16	GND	41	GND
17	GND	42	GND	17	+BSY	42	-BSY
18	GND	43	-BSY	18	+ACK	43	-ACK
19	GND	44	-ACK	19	+RST	44	-RST
20	GND	45	-RST	20	+MSG	45	-MSG
21	GND	46	-MSG	21	+SEL	46	-SEL
22	GND	47	-SEL	22	+C/D	47	-C/D
23	GND	48	-C/D	23	+REQ	48	-REQ
24	GND	49	-REQ	24	+I/O	49	-I/O
25	GND	50	-I/O	25	GND	50	GND

Table F - 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

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Table G - ESDI Control Signals Continued (J2/P2)

Control Signal Name	Ground	Signal Pin	Transmission
-Drive Selected		1	To Controller
-Sector Address Mark		2	To Controller
Found		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 H - IBM I/O Channel Pinout (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

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Table I - IBM I/O Channel Pinout Continued (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

Table J - Pinout Table for IBM High-Density PS/2 Connector

Pin	Signal Name	Pin	Signal Name
1	GND	31	GND
2	-DB(0)	32	-ATN
3	GND	33	GND
4	-DB(1)	34	GND
5	GND	35	GND
6	-DB(2)	36	-BSY
7	GND	37	GND
8	-DB(3)	38	-ACK
9	GND	39	GND
10	-DB(4)	40	-RST
11	GND	41	GND
12	-DB(5)	42	-MSG
13	GND	43	GND
14	-DB(6)	44	-SEL
15	GND	45	GND
16	-DB(7)	46	-C/D
17	GND	47	GND
18	-DB(P)	48	-REQ
19	GND	49	GND
20	GND	50	-I/O
21	GND	51	GND
22	GND	52	Reserved
23	Reserved/GND	53	Reserved
24	Reserved/GND	54	Reserved
25	Not Connected	55	Reserved
26	TERMPWR	56	Reserved
27	Reserved	57	Reserved
28	Reserved	58	Reserved
29	GND	59	Reserved
30	GND	60	Reserved

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Table K - IDE Interface Pinout

Pin	Signal Name	Pin	Signal Name
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

Table L - QIC-36 Connector Pin Assignments

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).

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

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Table M - SCSI Pinout - Centronics, Mac, and Differential

IDC Pin Number	Centronics Pin Number	Mac DB-25 Pin Number	Signal-Ended Signal Name	Differential Signal Name
1	1		Ground	Shield Gnd
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	-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		TERMPWR	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	Ground
33	17		Ground	+BSY
34	42	18	Ground	-BSY
35	18		Ground	+ACK
36	43	6	-BSY	-ACK
37	19		Ground	+RST
38	44	5	-ACK	-RST
39	20		Ground	+MSG
40	45	4	-RST	-MSG
41	21		Ground	+SEL
42	46	2	-MSG	-SEL
43	22		Ground	+C/D
44	47	19	-SEL	-C/D
45	23		Ground	+REQ
46	48	15	-C/D	-REQ
47	24		Ground	+I/O
48	49	1	-REQ	-I/O
49	25		Ground	Ground
50	50	3	-I/O	Ground

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Table N - SA-400 Interface Signals and Pin Designations

Signal Name	Direction	Signal Pin	Return Pin
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

Table O - 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		- - - - - - -

Figure P - Sun Microsystems' 50-Pin D-Sub Connector

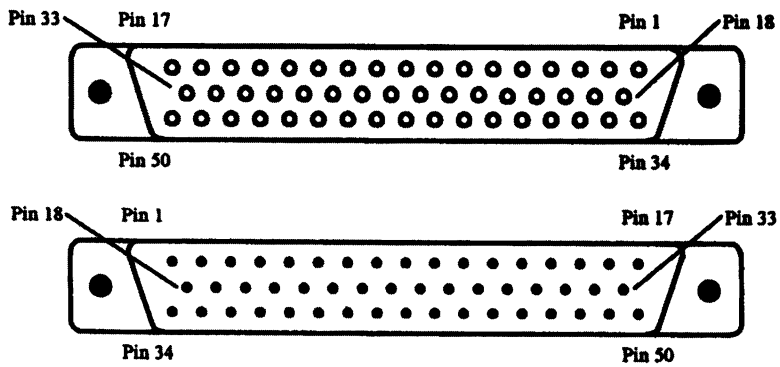

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Table P - Sun Single-Ended SCSI Cable

Pin	Signal	Pin	Signal
1	Ground	26	Reserved
2	-DB(1)	27	Ground
3	Ground	28	Ground
4	-DB(4)	29	-BSY
5	Ground	30	Ground
6	-DB(7)	31	-MSG
7	Ground	32	Ground
8	Ground	33	-REQ
9	Not Connected	34	-DB(0)
10	Reserved	35	Ground
11	Ground	36	-DB(3)
12	Ground	37	Ground
13	Ground	38	-DB(6)
14	-RST	39	Ground
15	Ground	40	Ground
16	-C/D	41	Reserved
17	Ground	42	TERMPWR
18	Ground	43	Ground
19	-DB(2)	44	-ATN
20	Ground	45	Ground
21	-DB(5)	46	-ACK
22	Ground	47	Ground
23	-DB(P)	48	-SEL
24	Ground	49	Ground
25	Reserved	50	-I/O

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DRIVE JUMPERS

The following pages contain information on jumper settings for common hard drives. This information has been complied from numerous sources, including the manufacturers of the drives. When compiling a chapter of this length, the chances for typing and resource error is great. The authors and publisher would greatly appreciate being notified of any inaccurate or missing information. Some of the older drives (especially those from companies who have gone out of business) are very difficult to obtain accurate and verifiable specifications for. If you have access to non-copyrighted specification sheets, etc. please send us a copy so that we may add the information to future editions.

For more complete information on your particular drive(s), refer to the OEM manual available from your supplier.

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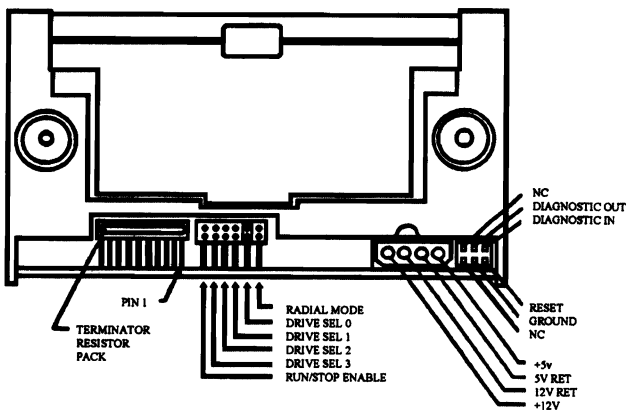
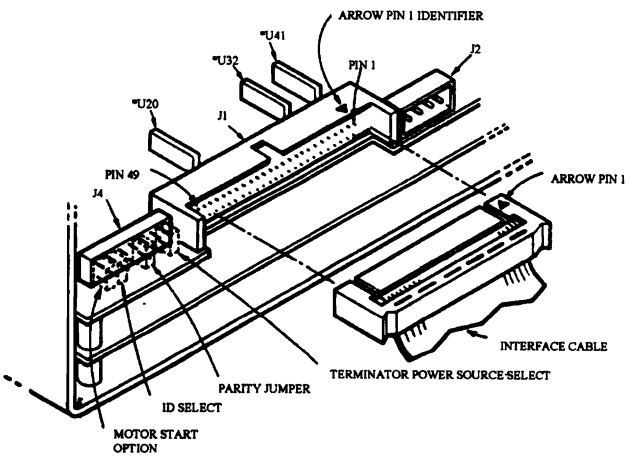
ATASI 3085



CDC WREN III SERIES



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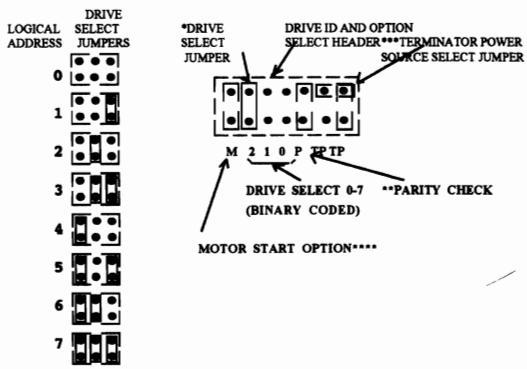
CDC WREN III SERIES (SCSI JUMPER LOCATION)



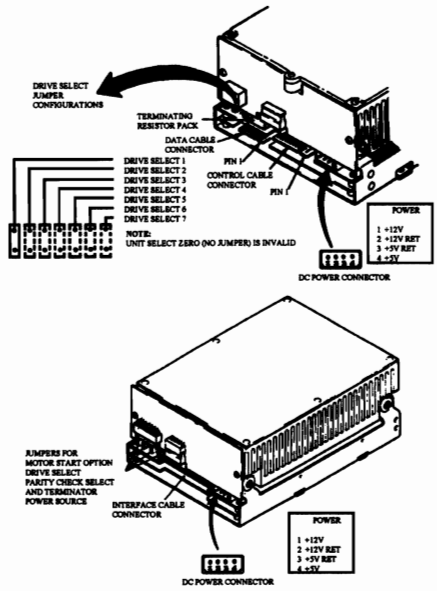
* Drive ID is binary coded jumper position (most significant bit on left). i.e., jumper in position 2 would be Drive ID 4, no jumpers mean ID 0.

** Jumper plug installed means parity checking by the WREN III is enabled.

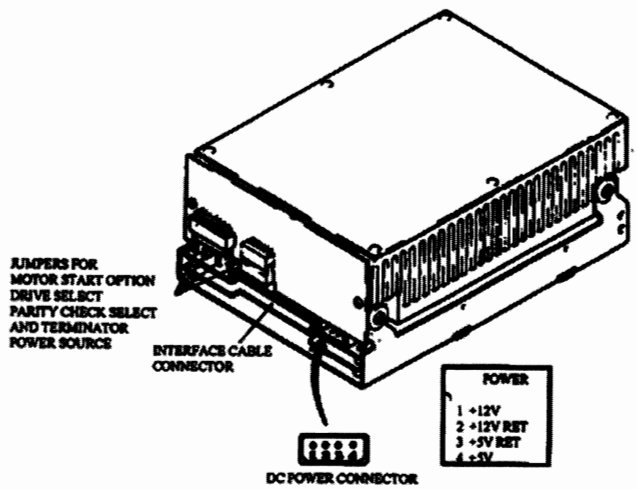
*** Jumper in vertical position means terminator power (+5V) is from WREN III power connector. Jumper in horizontal position means terminator power is taken from interface cable. If unit is not terminated, TP jumper is to be left off.

**** 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.

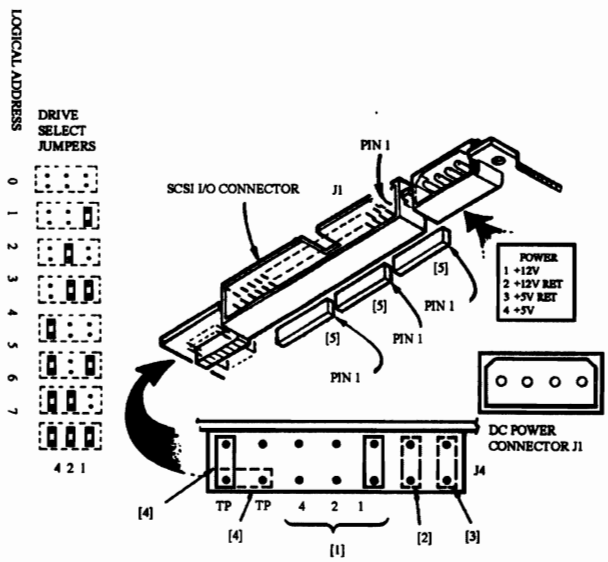
CDC WREN III SERIES ESDI



CDC WREN III SERIES (SCSI JUMPER LOCATION)



CDC WREN V SERIES



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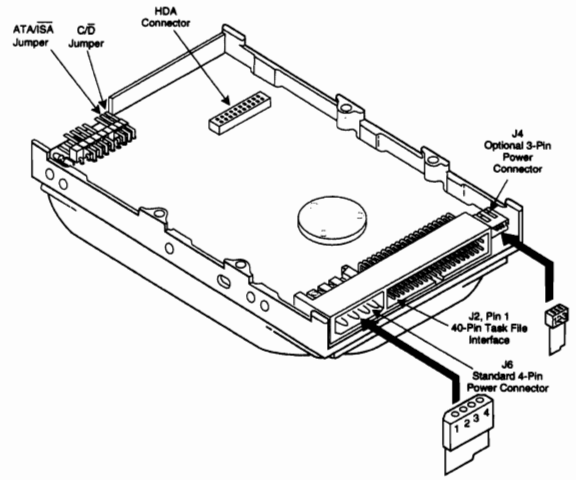
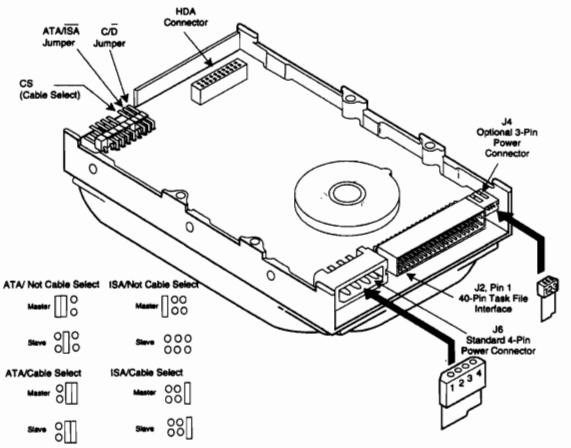
CONNER CFA1080A

The C/D jumper is used to determine whether the drive is a master (drive C) or a slave (drive D). The drive is configured as a master, when jumpered, and a slave when not jumpered. The ATA/ISA jumper is used when when daisy-chaining two drives. This jumper may have to be removed when this drive is used together with older (Pre-ATA) drives.



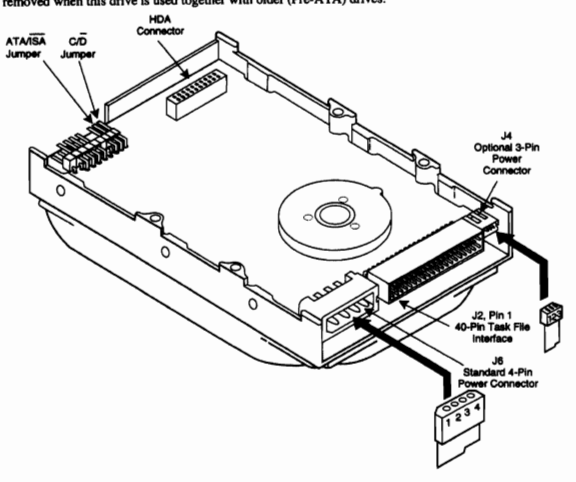
CONNER CFA1275A

The C/D jumper is used to determine whether the drive is a master (drive C) or a slave (drive D). The drive is configured as a master, when jumpered, and a slave when not jumpered. The ATA/ISA jumper is used when when daisy-chaining two drives. This jumper may have to be removed when this drive is used together with older (Pre-ATA) drives.



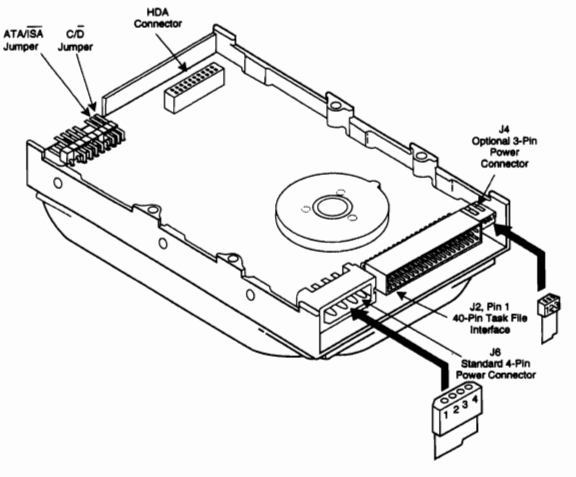
CONNER CFA170A (CP3017)

The C/D jumper is used to determine whether the drive is a master (drive C) or a slave (drive D). The drive is configured as a master, when jumpered, and a slave when not jumpered. The ATA/ISA jumper is used when when daisy-chaining two drives. This jumper may have to be removed when this drive is used together with older (Pre-ATA) drives.



CONNER CFA340A (CP3034)

The C/D jumper is used to determine whether the drive is a master (drive C) or a slave (drive D). The drive is configured as a master, when jumpered, and a slave when not jumpered. The ATA/ISA jumper is used when when daisy-chaining two drives. This jumper may have to be removed when this drive is used together with older (Pre-ATA) drives.



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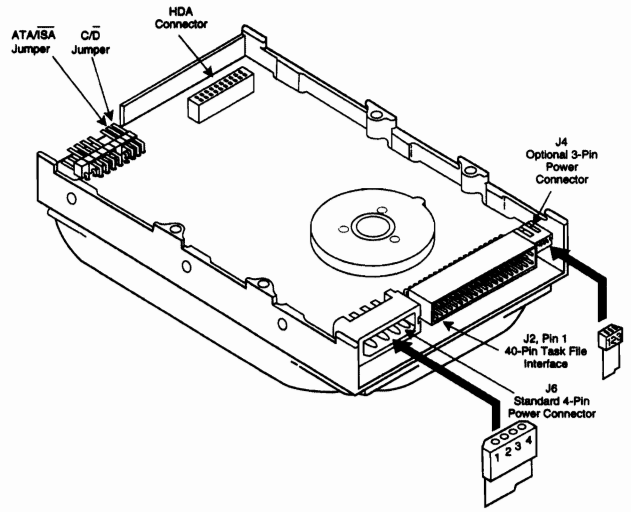
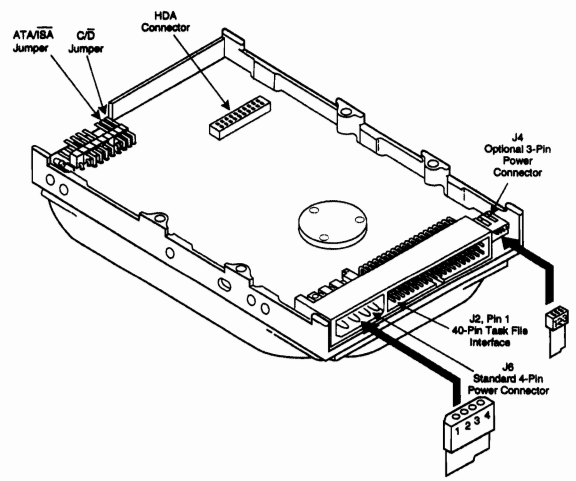
CONNER CFA540A

The C/D jumper is used to determine whether the drive is a master (drive C) or a slave (drive D). The drive is configured as a master, when jumpered, and a slave when not jumpered. The ATA/ISA jumper is used when when daisy-chaining two drives. This jumper may have to be removed when this drive is used together with older (Pre-ATA) drives.



CONNER CFA810A

The C/D jumper is used to determine whether the drive is a master (drive C) or a slave (drive D). The drive is configured as a master, when jumpered, and a slave when not jumpered. The ATA/ISA jumper is used when when daisy-chaining two drives. This jumper may have to be removed when this drive is used together with older (Pre-ATA) drives.

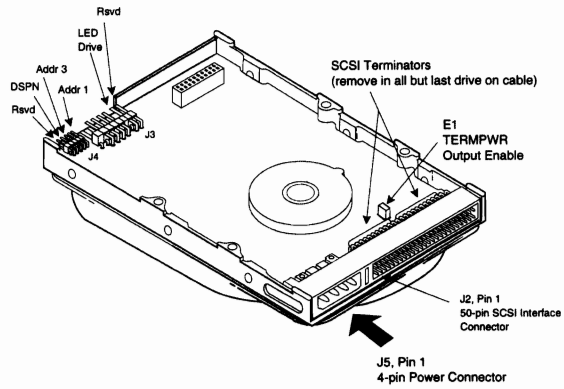


CONNER CFA340S/CFA170S

SCSI Bus Address
There are three jumpers available for configuration of SCSI ID: ADDR1, ADDR 2, and ADDR 3. The following table defines the settings:

SCSI Bus Addresses			
ADDR 1	ADDR 2	ADDR 3	SCSI ID
OUT	OUT	OUT	0
IN	OUT	OUT	1
OUT	IN	OUT	2
IN	IN	OUT	3
OUT	OUT	IN	4
IN	OUT	IN	5
OUT	IN	IN	6
IN	IN	IN	7

Disable Spin: A jumper in the DSPN location, disables spin up on power-on. Disabling spin up on application of power can also be enabled by settting the DSPN bit in MODE SELECT page 0.



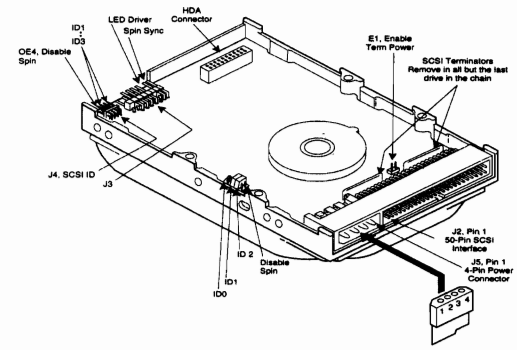
CONNER CFA540S

SCSI Bus Address
There are three jumpers available for configuration of SCSI ID: ID1, ID2, and ID3. The following
table defines the settings:

SCSI Bus Addresses*			
ID1	ID2	ID3	SCSI ID
OUT	OUT	OUT	0
IN	OUT	OUT	1
OUT	IN	OUT	2
IN	IN	OUT	3
OUT	OUT	IN	4
IN	OUT	IN	5
OUT	IN	IN	6
IN	IN	IN	7

Disable spin: A jumper in the 0E4 location, disables spin up on power-on. Disabling spin up on application of power can also be enabled by settting the DSPN bit in MODE SELECT page 0.

0E4	Disable Spin on Power on
E1	Term Power In/Out enable



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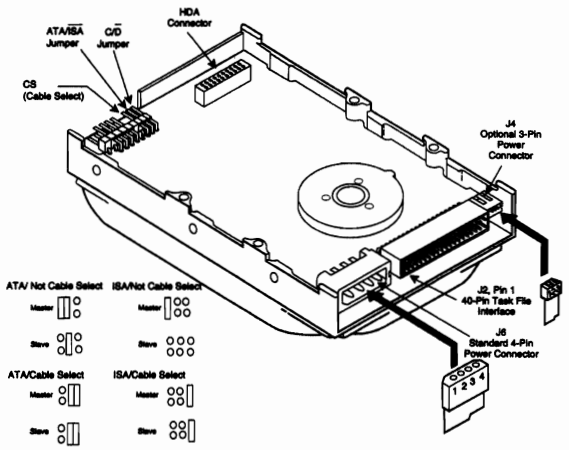
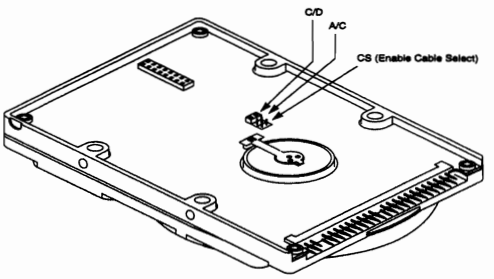
CONNER CFA850A

The C/D jumper is used to determine whether the drive is a master (drive C) or a slave (drive D). The drive is configured as a master, when jumpered, and a slave when not jumpered. The ATA/ISA jumper is used when when daisy-chaining two drives. This jumper may have to be removed when this drive is used together with older (Pre-ATA) drives.



CONNER CFL350A

The CFL350A drive is designed to operate either as a Master drive (C Drive) or a Slave Drive (D Drive). Commands from the host are written in parallel to both drives. When the C/D jumper on the drive is closed, the drive will assume the role of a master. When C/D is open, the drive will act as a slave. In Single-drive configurations, C/D must remain in the closed (master) position.



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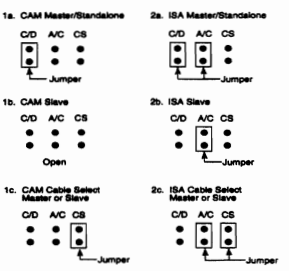
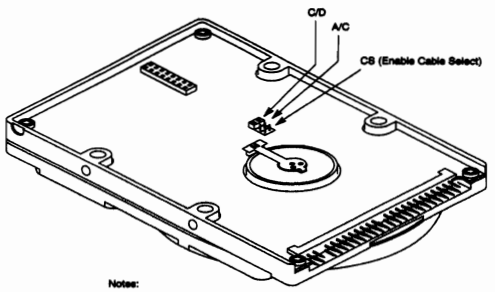
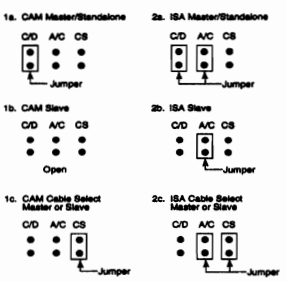


CONNER CFL420A

The CFL420A drive is designed to operate either as a Master drive (C Drive) or a Slave Drive (D Drive). Commands from the host are written in parallel to both drives. When the C/D jumper on the drive is closed, the drive will assume the role of a master. When C/D is open, the drive will act as a slave. In Single-drive configurations, C/D must remain in the closed (master) position.

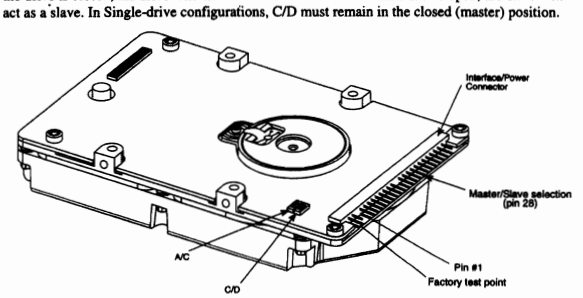


Notes:

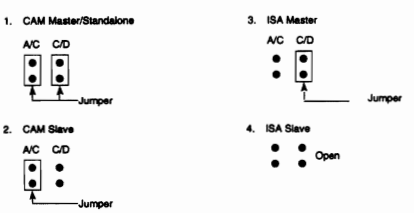


CONNER CFN170A

The CFN170A drive is designed to operate either as a Master drive (C Drive) or a Slave Drive (D Drive). Commands from the host are written in parallel to both drives. When the C/D jumper on the drive is closed, the drive will assume the role of a master. When C/D is open, the drive will act as a slave. In Single-drive configurations, C/D must remain in the closed (master) position.



Notes:



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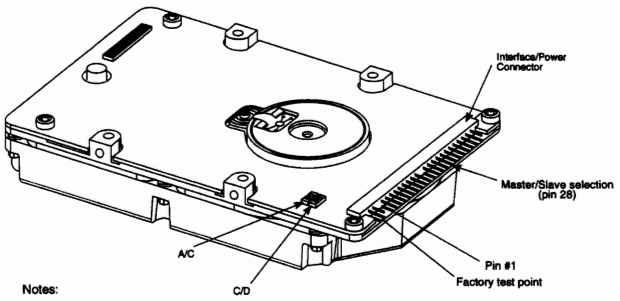
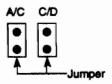
CONNER CFN250A

The CFN250A drive is designed to operate either as a Master drive (C Drive) or a Slave Drive (D Drive). Commands from the host are written in parallel to both drives. When the C/D jumper on the drive is closed, the drive will assume the role of a master. When C/D is open, the drive will act as a slave. In Single-drive configurations, C/D must remain in the closed (master) position.

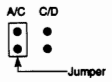


Notes:

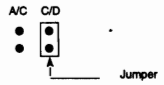
1. CAM Master/Standalone



2. CAM Slave



3. ISA Master

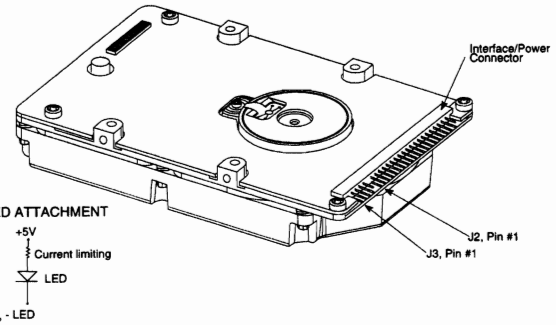


4. ISA Slave

CONNER CFN170S

The following table defines the settings:

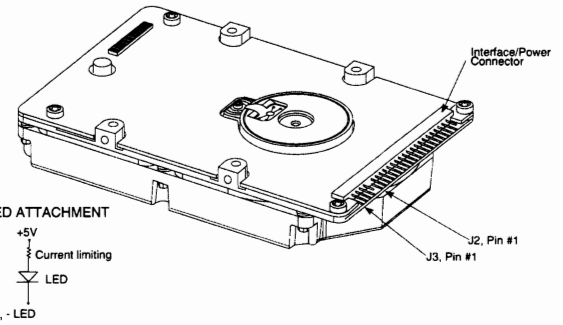
J3, Pin	5	6	7
SCSI ID	E1	E2	E3
0	high	high	high
1	low	high	high
2	high	low	high
3	low	low	high
4	high	high	low
5	low	high	low
6	high	low	low
7	low	low	low



CONNER CFN250S

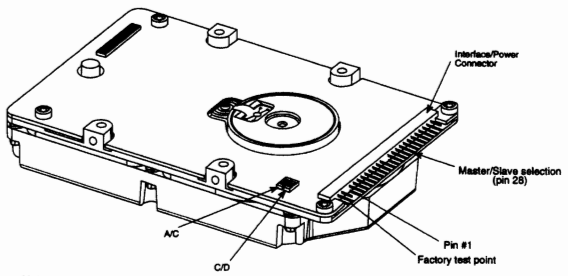
The following table defines the settings:

J3, Pin	5	6	7
SCSI ID	E1	E2	E3
0	high	high	high
1	low	high	high
2	high	low	high
3	low	low	high
4	high	high	low
5	low	high	low
6	high	low	low
7	low	low	low



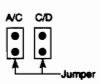
CONNER CFN340A

The CFN340A drive is designed to operate either as a Master drive (C Drive) or a Slave Drive (D Drive). Commands from the host are written in parallel to both drives. When the C/D jumper on the drive is closed, the drive will assume the role of a master. When C/D is open, the drive will act as a slave. In Single-drive configurations, C/D must remain in the closed (master) position.

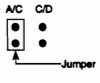


Notes:

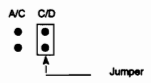
1. CAM Master/Standalone



2. CAM Slave



3. ISA Master



4. ISA Slave

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CONNER CFP1060S

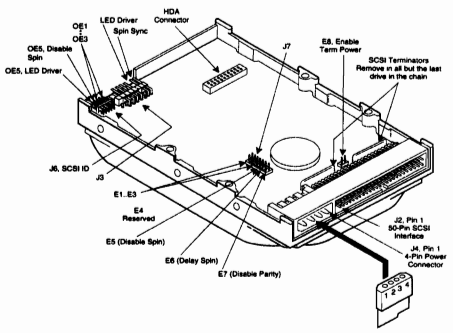
SCSI Bus Address
There are three jumpers available for configuration of SCSI ID: E1, E2, and E3. The following table defines the settings:

SCSI Bus Addresses*			
E1/OE1	E2/OE2	E3/OE3	SCSI ID
OUT	OUT	OUT	0
IN	OUT	OUT	1
OUT	IN	OUT	2
IN	IN	OUT	3
OUT	OUT	IN	4
IN	OUT	IN	5
OUT	IN	IN	6
IN	IN	IN	7

*Use either but not both : E1 to E3 or 0E1 to 0E3. The 0E header is not installed on drive configurations with a LED on the PCBA.

Disable Spin: A jumper in the E5 or 0E5 location, disables spin up on power-on. Disabling spin up on application of power can also be enabled by settting the DSPN bit in MODE SELECT page 0.

E4	Reserved
E5/OE5	Disable Spin on Power-on
E6	Spin delay by SCSI ID
E7	Disable SCSI Bus Parity



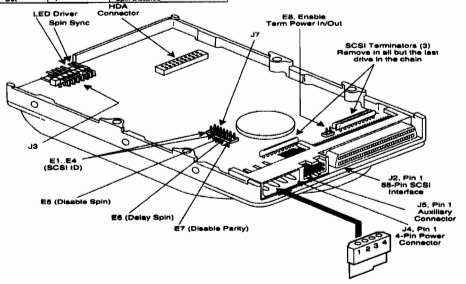
CONNER CFP1060W

SCSI Bus Address
There are four jumpers available for configuration of SCSI ID: E1, E2, E3, and E4 or alternatively pins 1,3,5, and 7 or J5. The following table defines the the relationship between the jumpers or the pins on J5 and the SCSI ID:

SCSI ID	E1/Pin 1	E2/Pin 3	E3/Pin 5	E4/Pin 7
0	Out/open	Out/open	Out/open	Out/open
1	In/Ground	Out/open	Out/open	Out/open
2	Out/open	In/Ground	Out/open	Out/open
3	In/Ground	In/Ground	Out/open	Out/open
4	Out/open	Out/open	In/Ground	Out/open
5	In/Ground	Out/open	In/Ground	Out/open
6	Out/open	In/Ground	In/Ground	Out/open
7	In/Ground	In/Ground	In/Ground	Out/open
8	Out/open	Out/open	Out/open	In/Ground
9	In/Ground	Out/open	Out/open	In/Ground
10	Out/open	In/Ground	Out/open	In/Ground
11	In/Ground	In/Ground	Out/open	In/Ground
12	Out/open	Out/open	In/Ground	In/Ground
13	In/Ground	Out/open	In/Ground	In/Ground
14	Out/open	In/Ground	In/Ground	In/Ground
15	In/Ground	In/Ground	In/Ground	In/Ground

Disable Spin: A jumper in the E5 location, disables spin up on power-on. Disabling spin up on application of power can also be enabled by settting the DSPN bit in MODE SELECT page 00H.

E5	DSPN	Result
In	0	Spin Disabled
In	1	Spin Disabled
Out	0	Spin up on Power On
Out	1	Spin Disabled



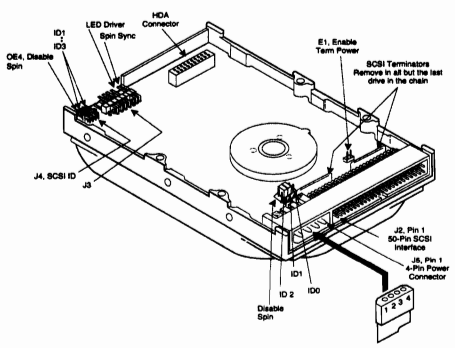
CONNER CFP1080S

SCSI Bus Address
There are three jumpers available for configuration of SCSI ID: E1, E2, and E3. The following table defines the settings:

SCSI Bus Addresses*			
E1/0E1	E2/0E2	E3/0E3	SCSI ID
OUT	OUT	OUT	0
IN	OUT	OUT	1
OUT	IN	OUT	2
IN	IN	OUT	3
OUT	OUT	IN	4
IN	OUT	IN	5
OUT	IN	IN	6
IN	IN	IN	7

*Use either but not both : E1 to E3 or 0E1 to 0E3. The 0E header is not installed on drive configurations with a LED on the PCBA.

Disable Spin: A jumper in the E4 location, disables spin up on power-on. Disabling spin up on application of power can also be enabled by settting the DSPN bit in MODE SELECT page 0.



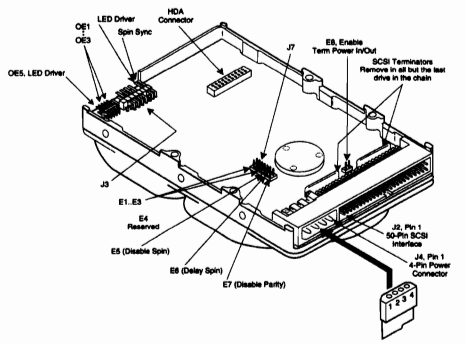
CONNER CFP2105S

SCSI Bus Address
There are three jumpers available for configuration of SCSI ID: E1, E2, and E3. The following table defines the settings:

SCSI Bus Addresses*			
E1/OE1	E2/OE2	E3/OE3	SCSI ID
OUT	OUT	OUT	0
IN	OUT	OUT	1
OUT	IN	OUT	2
IN	IN	OUT	3
OUT	OUT	IN	4
IN	OUT	IN	5
OUT	IN	IN	6
IN	IN	IN	7

*Use either but not both : E1 to E3 or 0E1 to 0E3. The 0E header is not installed on drive configurations with a LED on the PCBA.

Disable Spin: A jumper in the E5 location, disables spin up on power-on. Disabling spin up on application of power can also be enabled by settting the DSPN bit in MODE SELECT page 00H.



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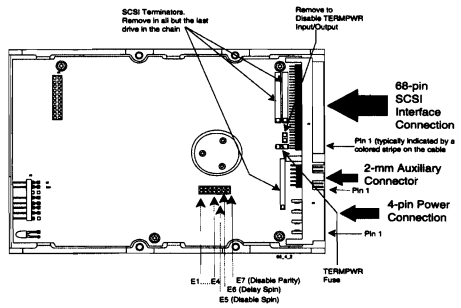
CONNER CFP2107W

SCSI Bus Address

There are four jumpers available for configuration of SCSI ID: E1, E2, and E3, and E4. The following table defines the settings:

SCSI Bus Addresses*				
E1/Pin 1	E2/Pin 3	E3/Pin 5	E4/pin 7	SCSI ID
OUT/OPEN	OUT/OPEN	OUT/OPEN	OUT/OPEN	0
IN/GROUND	OUT/OPEN	OUT/OPEN	OUT/OPEN	1
OUT/OPEN	IN/GROUND	OUT/OPEN	OUT/OPEN	2
IN/GROUND	IN/GROUND	OUT/OPEN	OUT/OPEN	3
OUT/OPEN	OUT/OPEN	IN/GROUND	OUT/OPEN	4
IN/GROUND	OUT/OPEN	IN/GROUND	OUT/OPEN	5
OUT/OPEN	IN/GROUND	IN/GROUND	OUT/OPEN	6
IN/GROUND	IN/GROUND	IN/GROUND	OUT/OPEN	7
OUT/OPEN	OUT/OPEN	OUT/OPEN	IN/GROUND	8
IN/GROUND	OUT/OPEN	OUT/OPEN	IN/GROUND	9
OUT/OPEN	IN/GROUND	OUT/OPEN	IN/GROUND	10
IN/GROUND	IN/GROUND	OUT/OPEN	IN/GROUND	11
OUT/OPEN	OUT/OPEN	IN/GROUND	IN/GROUND	12
IN/GROUND	OUT/OPEN	IN/GROUND	IN/GROUND	13
OUT/OPEN	IN/GROUND	IN/GROUND	IN/GROUND	14
IN/GROUND	IN/GROUND	IN/GROUND	IN/GROUND	15

Disable Spin: A jumper in the E5 location, disables spin up on power-on. Disabling spin up on application of power can also be enabled by setting the DSPN bit in MODE SELECT page 00H.



CONNER CFP2107S

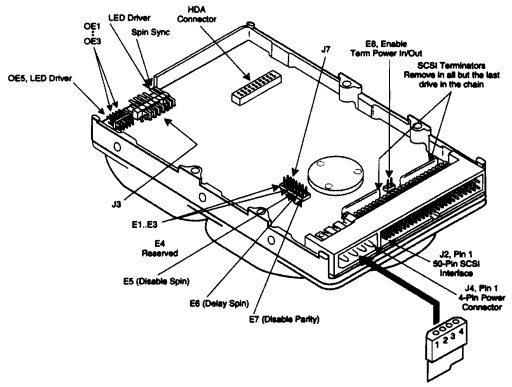
SCSI Bus Address

There are three jumpers available for configuration of SCSI ID: E1, E2, and E3. The following table defines the settings:

SCSI Bus Addresses*			
E1/OE1	E2/OE2	E3/OE3	SCSI ID
OUT	OUT	OUT	0
IN	OUT	OUT	1
OUT	IN	OUT	2
IN	IN	OUT	3
OUT	OUT	IN	4
IN	OUT	IN	5
OUT	IN	IN	6
IN	IN	IN	7

*Use either but not both : E1 to E3 or 0E1 to 0E3. The 0E header is not installed on drive configurations with a LED on the PCBA.

Disable Spin: A jumper in the E5 location, disables spin up on power-on. Disabling spin up on application of power can also be enabled by settting the DSPN bit in MODE SELECT page 00H.



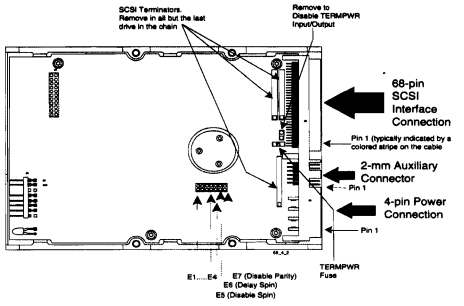
CONNER CFP4207W

SCSI Bus Address

There are four jumpers available for configuration of SCSI ID: E1, E2, and E3, and E4. The following table defines the settings:

SCSI Bus Addresses*				
E1/Pin 1	E2/Pin 3	E3/Pin 5	E4/pin 7	SCSI ID
OUT/OPEN	OUT/OPEN	OUT/OPEN	OUT/OPEN	0
IN/GROUND	OUT/OPEN	OUT/OPEN	OUT/OPEN	1
OUT/OPEN	IN/GROUND	OUT/OPEN	OUT/OPEN	2
IN/GROUND	IN/GROUND	OUT/OPEN	OUT/OPEN	3
OUT/OPEN	OUT/OPEN	IN/GROUND	OUT/OPEN	4
IN/GROUND	OUT/OPEN	IN/GROUND	OUT/OPEN	5
OUT/OPEN	IN/GROUND	IN/GROUND	OUT/OPEN	6
IN/GROUND	IN/GROUND	IN/GROUND	OUT/OPEN	7
OUT/OPEN	OUT/OPEN	OUT/OPEN	IN/GROUND	8
IN/GROUND	OUT/OPEN	OUT/OPEN	IN/GROUND	9
OUT/OPEN	IN/GROUND	OUT/OPEN	IN/GROUND	10
IN/GROUND	IN/GROUND	OUT/OPEN	IN/GROUND	11
OUT/OPEN	OUT/OPEN	IN/GROUND	IN/GROUND	12
IN/GROUND	OUT/OPEN	IN/GROUND	IN/GROUND	13
OUT/OPEN	IN/GROUND	IN/GROUND	IN/GROUND	14
IN/GROUND	IN/GROUND	IN/GROUND	IN/GROUND	15

Disable Spin: A jumper in the E5 location, disables spin up on power-on. Disabling spin up on application of power can also be enabled by settting the DSPN bit in MODE SELECT page 00H.



CONNER CFP4207S

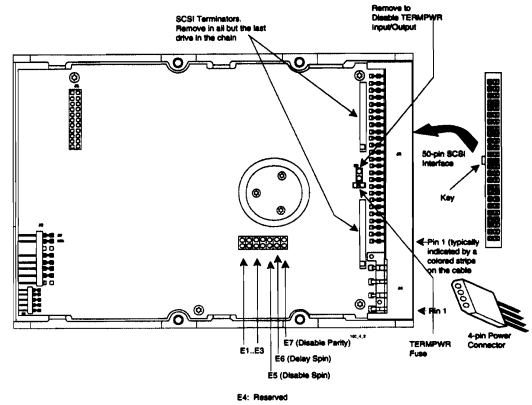
SCSI Bus Address

There are three jumpers available for configuration of SCSI ID: E1, E2, and E3. The following table defines the settings:

SCSI Bus Addresses*			
E1/OE1	E2/OE2	E3/OE3	SCSI ID
OUT	OUT	OUT	0
IN	OUT	OUT	1
OUT	IN	OUT	2
IN	IN	OUT	3
OUT	OUT	IN	4
IN	OUT	IN	5
OUT	IN	IN	6
IN	IN	IN	7

*Use either but not both : E1 to E3 or 0E1 to 0E3. The 0E header is not installed on drive configurations with a LED on the PCBA.

Disable Spin: A jumper in the E5 location, disables spin up on power-on. Disabling spin up on application of power can also be enabled by settting the DSPN bit in MODE SELECT page 00H.



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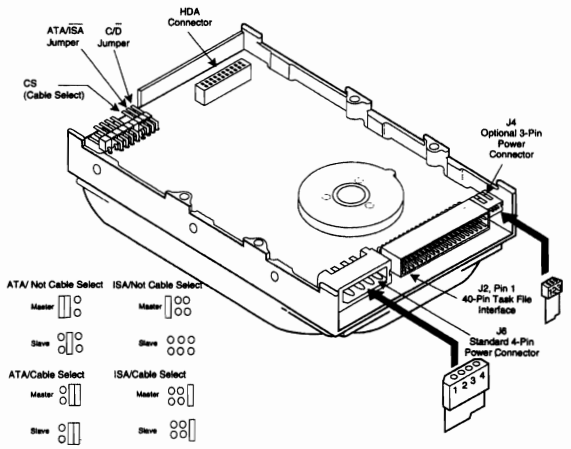
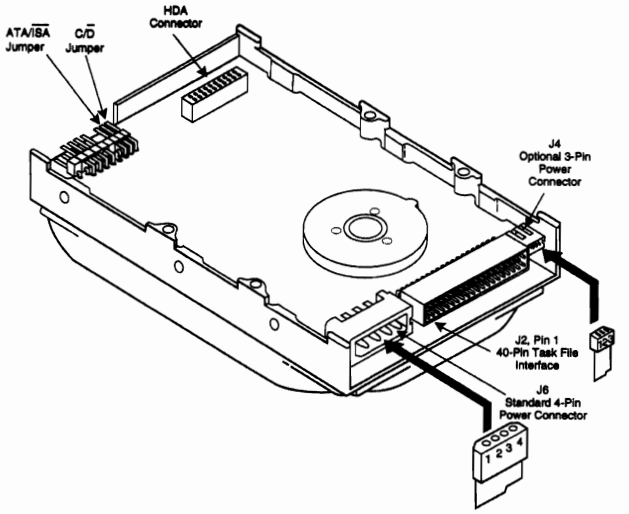
CONNER CFS1275A

The C/D jumper is used to determine whether the drive is a master (drive C) or a slave (drive D). The drive is configured as a master, when jumpered, and a slave when not jumpered. The ATA/ISA jumper is used when when daisy-chaining two drives. This jumper may have to be removed when this drive is used together with older (Pre-ATA) drives.



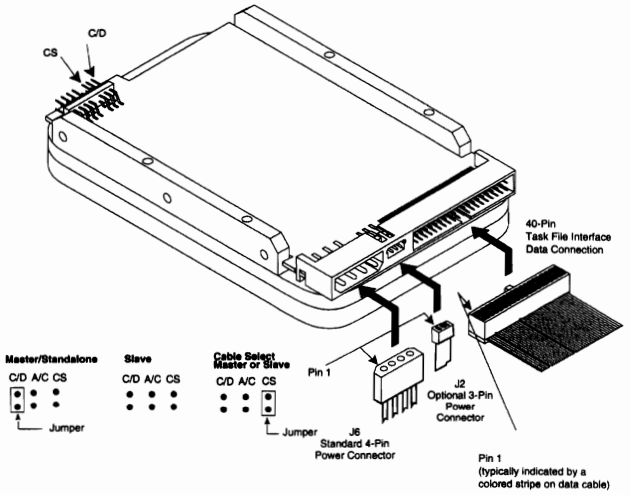
CONNER CFS210A

The C/D jumper is used to determine whether the drive is a master (drive C) or a slave (drive D). The drive is configured as a master, when jumpered, and a slave when not jumpered. The ATA/ISA jumper is used when when daisy-chaining two drives. This jumper may have to be removed when this drive is used together with older (Pre-ATA) drives.



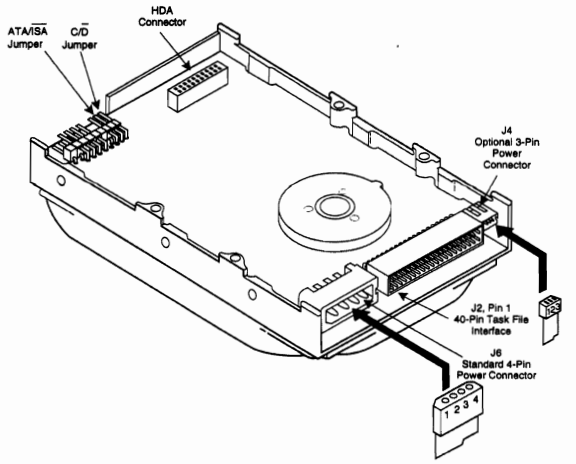
CONNER CFS270A

The C/D jumper is used to determine whether the drive is a master (drive C) or a slave (drive D). The drive is configured as a master, when jumpered, and a slave when not jumpered.



CONNER CFS420A

The C/D jumper is used to determine whether the drive is a master (drive C) or a slave (drive D). The drive is configured as a master, when jumpered, and a slave when not jumpered. The ATA/ISA jumper is used when when daisy-chaining two drives. This jumper may have to be removed when this drive is used together with older (Pre-ATA) drives.



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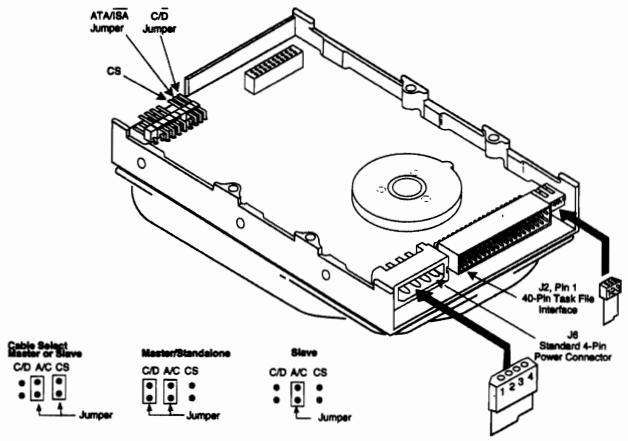
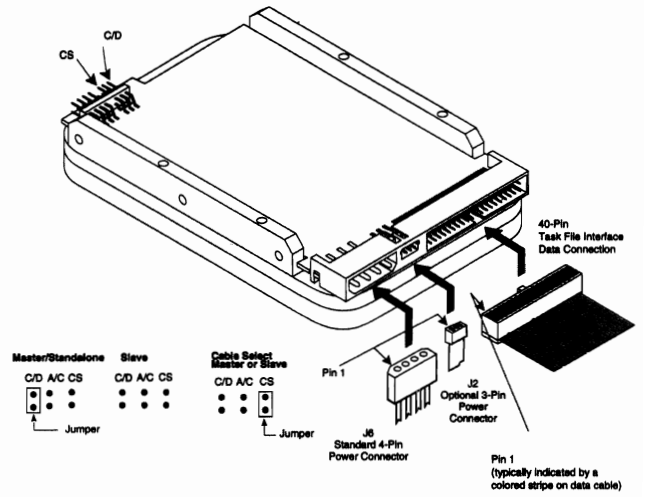
CONNER CFS540A

The C/D jumper is used to determine whether the drive is a master (drive C) or a slave (drive D). The drive is configured as a master, when jumpered, and a slave when not jumpered. The ATA/ISA jumper is used when when daisy-chaining two drives. This jumper may have to be removed when this drive is used together with older (Pre-ATA) drives.



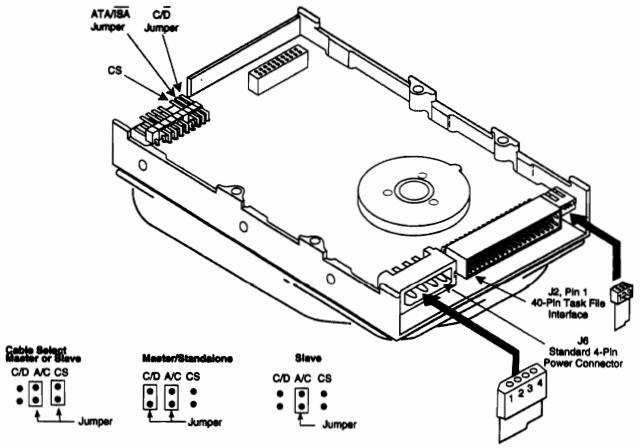
CONNER CFS425A

The C/D jumper is used to determine whether the drive is a master (drive C) or a slave (drive D). The drive is configured as a master, when jumpered, and a slave when not jumpered.



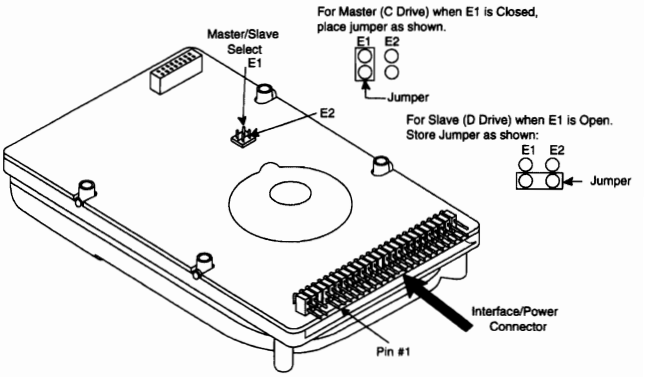
CONNER CFS850A

The C/D jumper is used to determine whether the drive is a master (drive C) or a slave (drive D). The drive is configured as a master, when jumpered, and a slave when not jumpered.



CONNER CP2034

The CP2034 is designed to operate as a master (Drive C) or as a Slave (Drive D). This feature is dependent on two settings; Jumper E1 and the firmware setting of a feature bit. E1 closed and the feature bit is set, the drive will be the Master. E1 open the drive will be the Slave. As a single drive, E1 should be closed.



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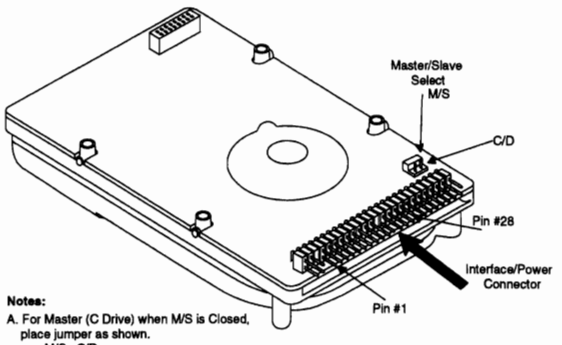
CONNER CP2044/CP2044P

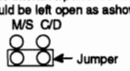
The CP2124 drive is designed to operate either as a Master drive (C Drive) or a Slave Drive (D Drive). This feature is dependent on two drive settings; the status of hardware Jumper M/S and the firmware setting of a feature bit. When (M/S) is closed, and the feature bit is set, the drive will assume the role of a Master Drive. When (M/S) is open, and the feature bit reset, the drive will act as the Slave. In single drive configurations M/S must remain in the closed position.



Notes:

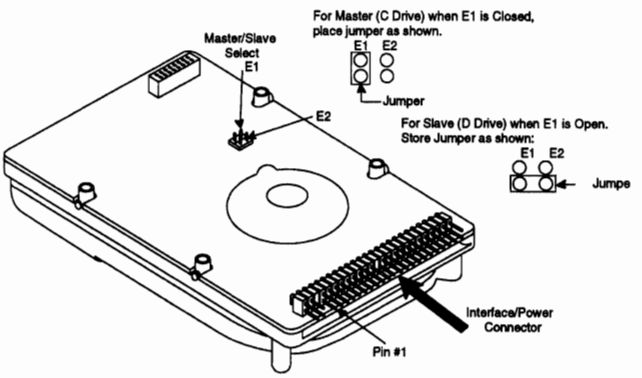
A. For Master (C Drive) when M/S is Closed, place jumper as shown.

B. If Master/Slave feature is selected at Pin 28 of the interface/power connector, jumper M/S should be left open as ashown:



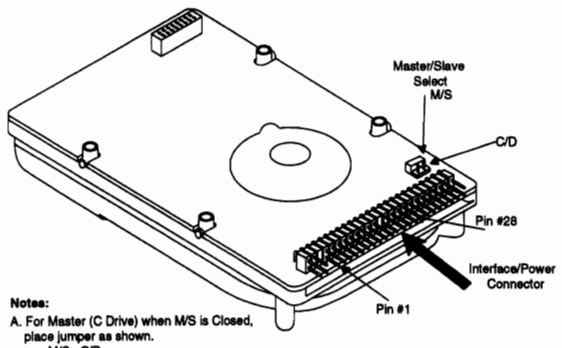
CONNER CP2064

The CP2064 is designed to operate as a master (Drive C) or as a Slave (Drive D). This feature is dependent on two settings; Jumper E1 and the firmware setting of a feature bit. E1 closed and the feature bit is set, the drive will be the Master. E1 open the drive will be the Slave. As a single drive, E1 should be closed.



CONNER CP2084

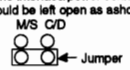
The CP2084 drive is designed to operate either as a Master drive (C Drive) or a Slave Drive (D Drive). This feature is dependent on two drive settings; the status of hardware Jumper M/S and the firmware setting of a feature bit. When (M/S) is closed, and the feature bit is set, the drive will assume the role of a Master Drive. When (M/S) is open, and the feature bit reset, the drive will act as the Slave. In single drive configurations M/S must remain in the closed position.



Notes:

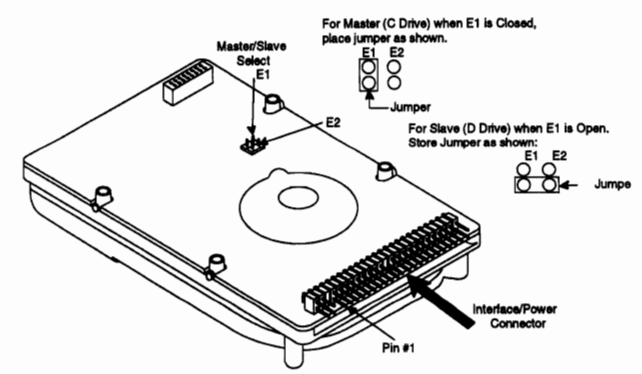
A. For Master (C Drive) when M/S is Closed, place jumper as shown.

B. If Master/Slave feature is selected at Pin 28 of the interface/power connector, jumper M/S should be left open as ashown:



CONNER CP2088

The CP2088 is designed to operate as a master (Drive C) or as a Slave (Drive D). This feature is dependent on two settings; Jumper E1 and the firmware setting of a feature bit. E1 closed and the feature bit is set, the drive will be the Master. E1 open the drive will be the Slave. As a single drive, E1 should be closed.



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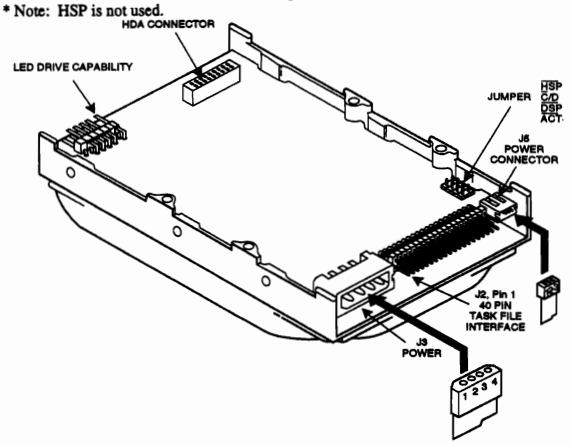
CONNER CP3000

There are four jumper options available for configuration: *HSP, C/D, DSP, and ACT.
The following table shows what the jumper settings should be for various system configurations.

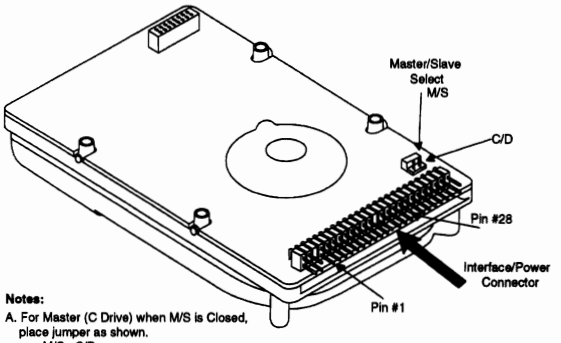
Single Drive = ACT and C/D Jumpered
Master Drive = C/D and DSP Jumpered
Slave Drive = No Jumpers installed

* Note: HSP is not used.



CONNER CP2124

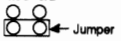
The CP2124 drive is designed to operate either as a Master drive (C Drive) or a Slave Drive (D Drive). This feature is dependent on two drive settings; the status of hardware Jumper M/S and the firmware setting of a feature bit. When (M/S) is closed, and the feature bit is set, the drive will assume the role of a Master Drive. When (M/S) is open, and the feature bit reset, the drive will act as the Slave. In single drive configurations M/S must remain in the closed position.



Notes:

A. For Master (C Drive) when M/S is Closed, place jumper as shown.

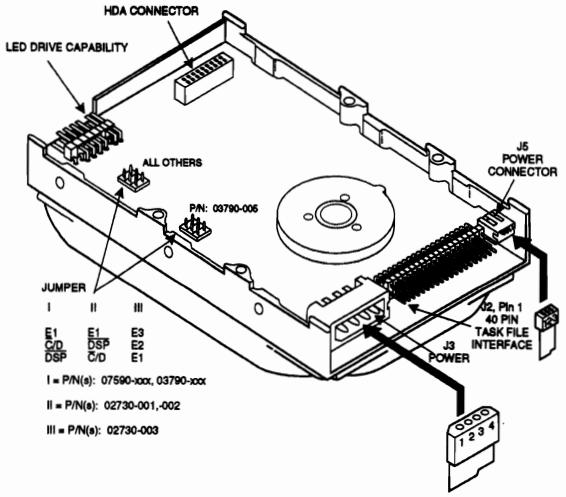
B. If Master/Slave feature is selected at Pin 28 of the interface/power connector, jumper M/S should be left open as ashown:



CONNER 30064

The drive has one set of jumpers labeled C/D, DSP, E1.

Single Drive = C/D Jumpered
Master = C/D and DSP Jumpered
Slave = No Jumpers Installed
E1 = Not used.



I = P/N(s): 07590-xxx, 03790-xxx

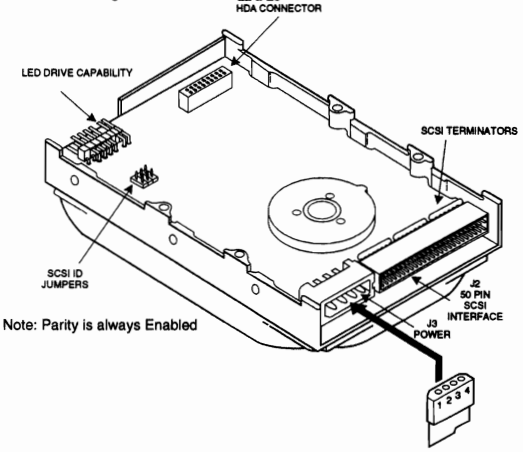
II = P/N(s): 02730-001,-002

III = P/N(s): 02730-003

CONNER CP 30060 SCSI

There are three jumpers available for configuration: E1, E2, and E3. These jumpers are used to select the drive's SCSI ID. The following table defines the settings:

SCSI ID	Jumper
0	None
1	E1
2	E2
3	E1 & E2
4	E3
5	E1 & E3
6	E2 & E3



Note: Parity is always Enabled

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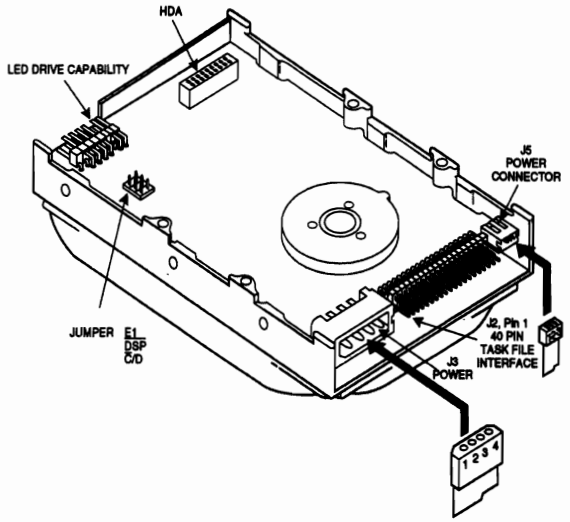
CONNER CP30064H

The drive has one set of jumpers labeled C/D, DSP, E1.

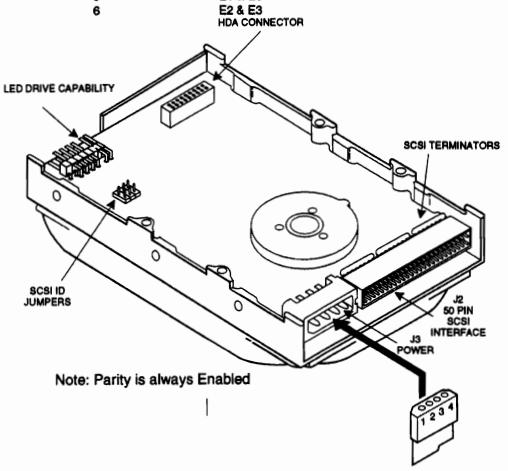
Single Drive = C/D Jumpered
Master = C/D and DSP Jumpered
Slave = No Jumpers Installed
E1 = Not used.



CONNER CP30080

There are three jumpers available for configuration: E1, E2, and E3. These jumpers are used to select the drive's SCSI ID. The following table defines the settings:

SCSI ID	Jumper
0	None
1	E1
2	E2
3	E1 & E2
4	E3
5	E1 & E3
6	E2 & E3

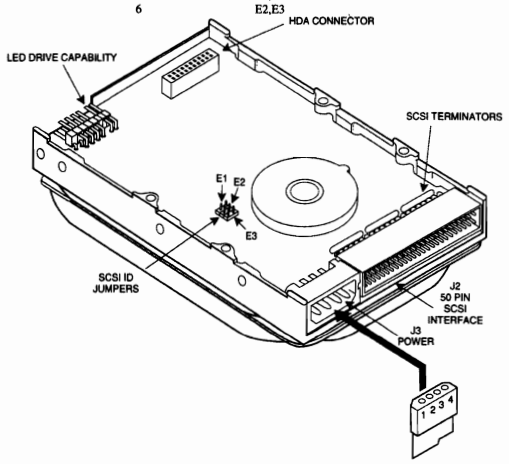


Note: Parity is always Enabled

CONNER CP30080E

E1, E2 and E3 are used to select the SCSI ID. The drive is shipped as ID 7, with all three jumpers installed.
The following table describes the SCSI ID:

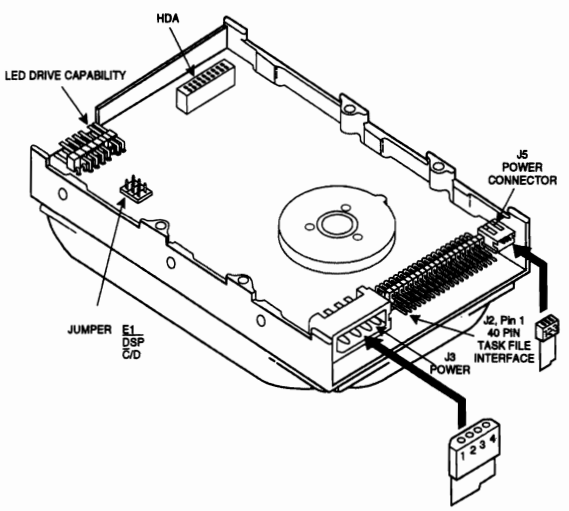
SCSI ID	Jumpers installed
0	None
1	E1
2	E2
3	E1,E2
4	E3
5	E1, E3
6	E2,E3



CONNER CP30084

The drive has one set of jumpers labeled C/D, DSP, E1.

Single Drive = C/D Jumpered
Master = C/D and DSP Jumpered
Slave = No Jumpers Installed
E1 = Not used.



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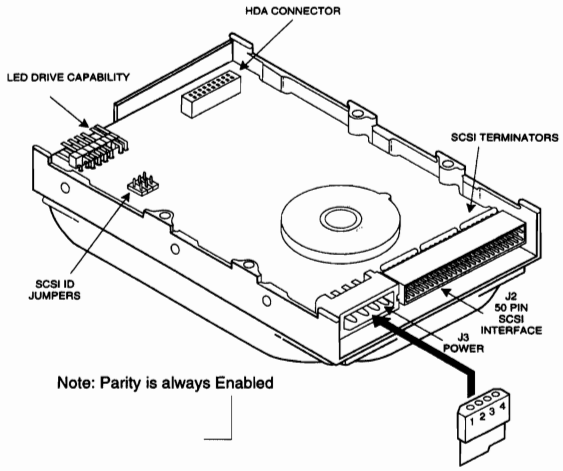
CONNER CP30100 SCSI

There are three jumpers available for configuration: E1, E2, and E3. These jumpers are used to select the drive's SCSI ID. The following table defines the settings:

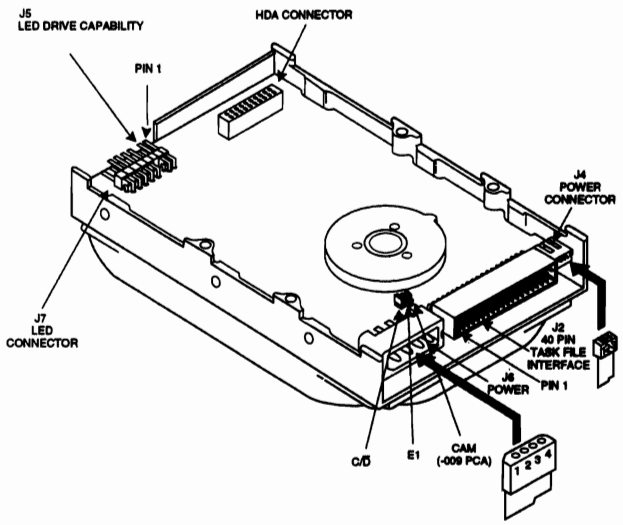
SCSI ID	Jumper
0	None
1	E1
2	E2
3	E1 & E2
4	E3
5	E1 & E3
6	E2 & E3



Note: Parity is always Enabled

CONNER CP30084E

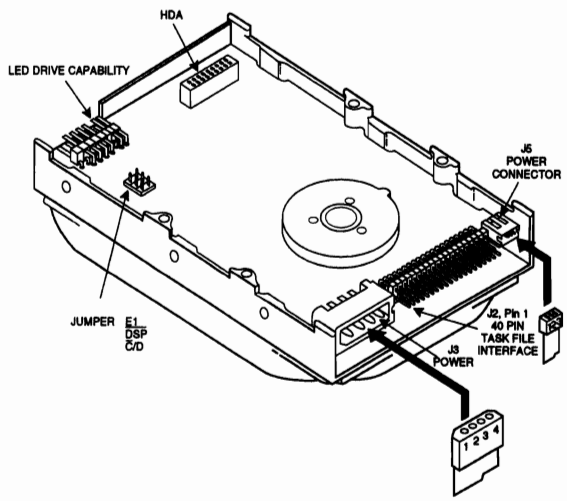
The C/D jumper is used to determine whether the drive is a master (drive C) or slave (drive D). The drive is configured as a master (drive C) when jumpered and as a slave drive (D drive) when not jumpered.



CONNER CP30104H

The drive has one set of jumpers labeled C/D, DSP, E1.

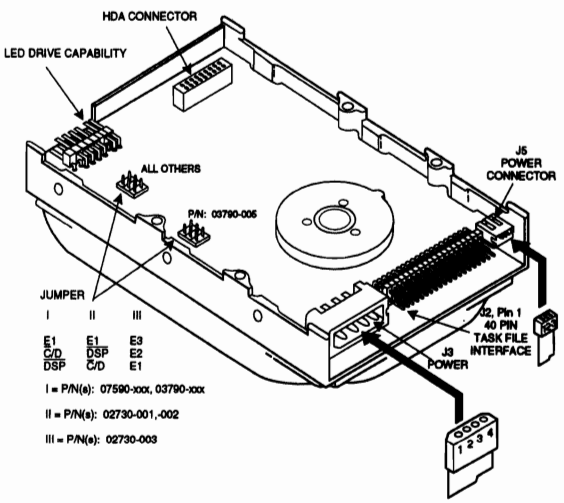
Single Drive = C/D Jumpered
Master = C/D and DSP Jumpered
Slave = No Jumpers Installed
E1 = Not used.



CONNER CP30104

The drive has one set of jumpers labeled C/D, DSP, E1.

Single Drive = C/D Jumpered
Master = C/D and DSP Jumpered
Slave = No Jumpers Installed
E1 = Not used.



I = P/N(s): 07590-xxx, 03790-xxx

II = P/N(s): 02730-001,-002

III = P/N(s): 02730-003

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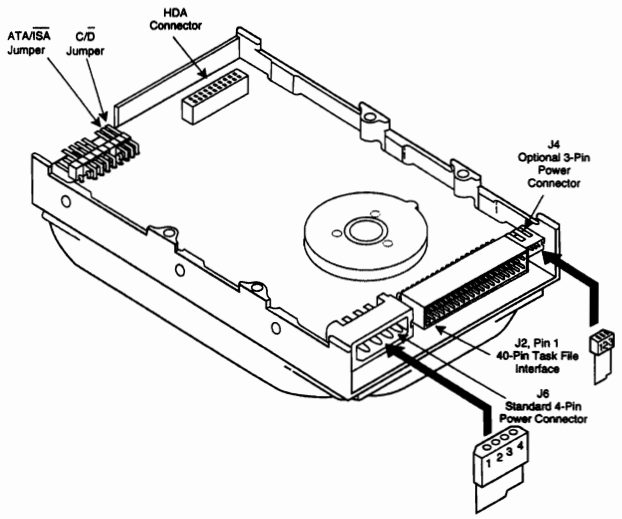
CONNER CP30124

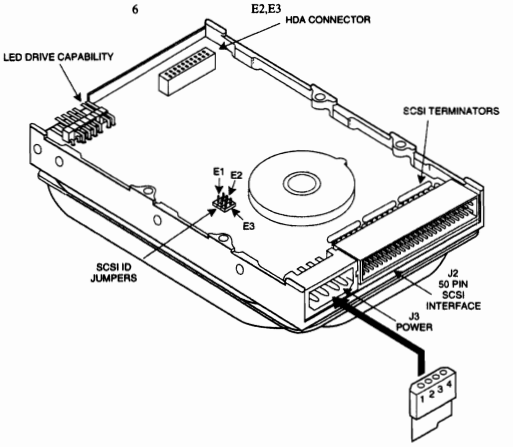
The C/D jumper is used to determine whether the drive is a master (drive C) or a slave (drive D). The drive is configured as a master, when jumpered, and a slave when not jumpered. The ATA/ISA jumper is used when when daisy-chaining two drives. If another manufacturers drive is being connected to the conner drive, you may need to install this jumper.



CONNER CP30170E

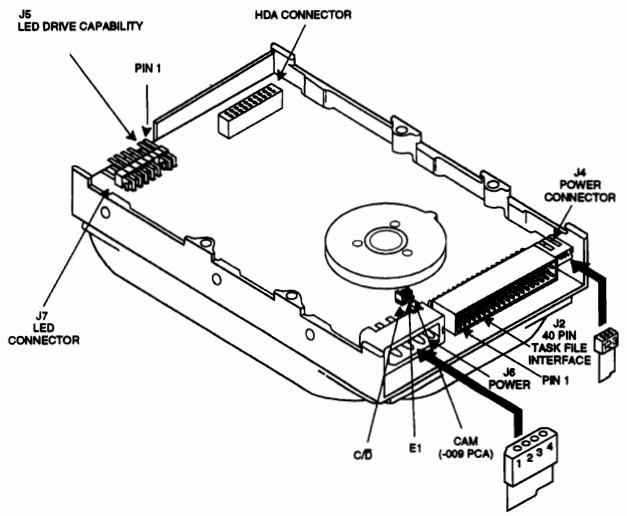
E1, E2 and E3 are used to select the SCSI ID. The drive is shipped as ID 7, with all three jumpers installed.
The following table describes the SCSI ID:

SCSI ID	Jumpers installed
0	None
1	E1
2	E2
3	E1,E2
4	E3
5	E1, E3
6	E2,E3



CONNER CP30174E

The C/D jumper is used to determine whether the drive is a master (drive C) or slave (drive D). The drive is configured as a master (drive C) when jumpered and as a slave drive (D drive) when not jumpered.



CONNER CP30200

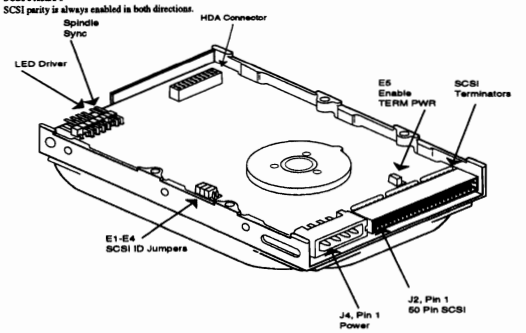
There are three jumpers availabel for configuration; E1,E2, and E3 are used to select the drive SCSI ID. The following table defines the settings. Note: SCSI parity is always enabled.
The following table defines the settings for jumpers E1, E2, and E3:

Jumper Options			
E1	E2	E3	SCSI ID
OUT	OUT	OUT	0
IN	OUT	OUT	1
OUT	IN	OUT	2
IN	IN	OUT	3
OUT	OUT	IN	4
IN	OUT	IN	5
OUT	IN	IN	6
IN	IN	IN	7

Delay Spin: A jumper in the E4 location, disables spin up on power-on. Disabling spin up on application of power can also be enabled by setting the DSPN bit in MODE SELECT page 0.

E4	DSPN	Result
IN	0	Spin Disabled
IN	1	Spin Disabled
OUT	0	Spin up onpower on
OUT	1	Spin Disabled

SCSI PARITY
SCSI parity is always enabled in both directions.



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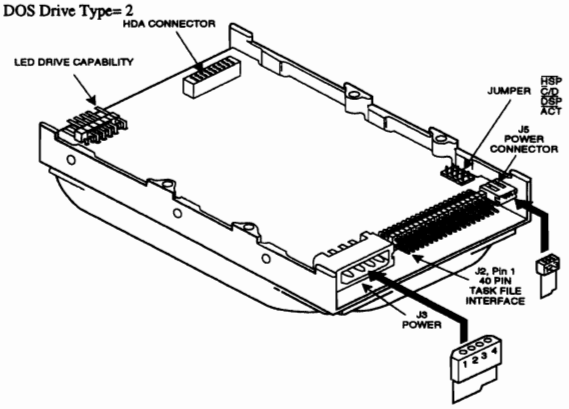
CONNER CP3024

There are four jumper options available for configuration: *HSP, C/D, DSP, and ACT.
The following table shows what the jumper settings should be for various system configurations.

Single Drive = ACT and C/D Jumpered
Master Drive = C/D and DSP Jumpered
Slave Drive = No Jumpers installed

* Note: HSP is not used.
DOS Drive Type= 2

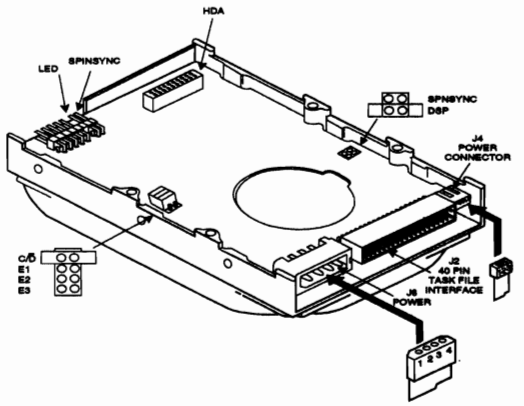


CONNER CP30204

The C/D jumper is used to determine whether the drive is a master (drive C) or slave (drive D). The drive is configured as a master (drive C) when jumpered and as a slave drive (D drive) when not jumpered.
DSP & SS:This pair of jumpers determines the signals on pin 39 of the interface connector.

Jumper		Action
DSP	SS	
X		- spindle synchronization signal disabled on pin 39. - activity LED signal available on pin 39. - Must be in place for CAM /ATA drives.
	X	- spindle synchronization signal enabled on pin 39. - activity LED signal disabled from pin 39.
		- pin 39 floating.

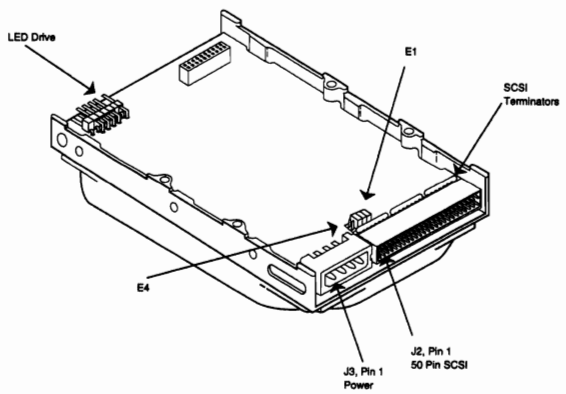
Jumper	
E1	Disable Spin Up until command received
E2	Not used
E3	Not used



CONNER CP3040

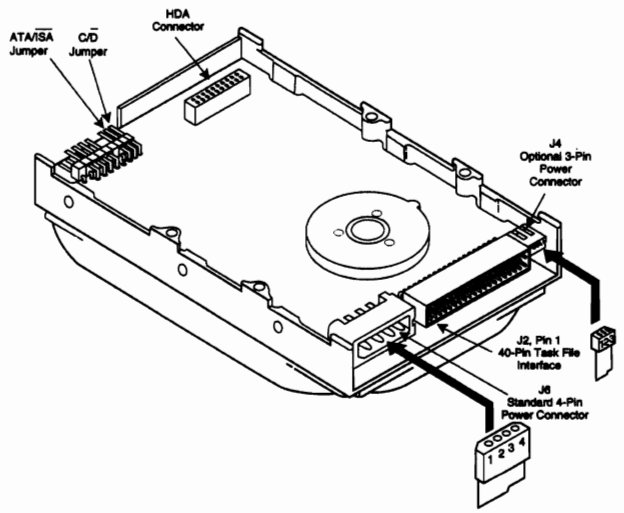
There are four jumpers available for configuration. Three of these jumpers, E1, E2, and E3 are used to select the drive's SCSI ID, installing E4 disables parity.The following table defines the settings for jumpers E1, E2, and E3:

E1	E2	E3	SCSI ID
OUT	OUT	OUT	0
IN	OUT	OUT	1
OUT	IN	OUT	2
IN	IN	OUT	3
OUT	OUT	IN	4
IN	OUT	IN	5
OUT	IN	IN	6
IN	IN	IN	7



CONNER CP30254

The C/D jumper is used to determine whether the drive is a master (drive C) or a slave (drive D). The drive is configured as a master, when jumpered, and a slave when not jumpered. The ATA/ISA jumper is used when daisy-chaining two drives. This jumper may have to be removed when this drive is used together with older (Pre-ATA) drives.



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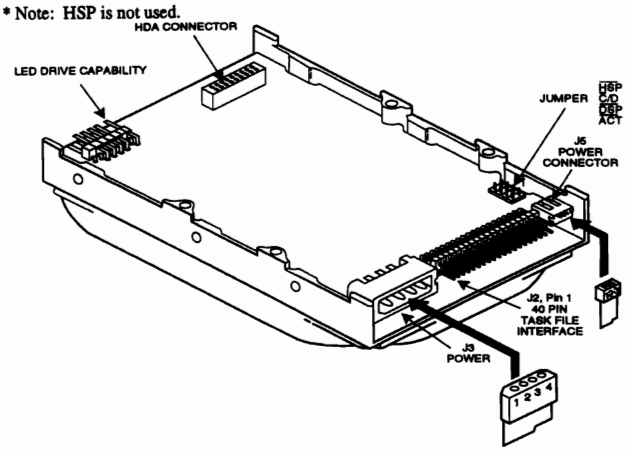
CONNER CP3044

There are four jumper options available for configuration: *HSP, C/D, DSP, and ACT.
The following table shows what the jumper settings should be for various system configurations.

Single Drive = ACT and C/D Jumpered
Master Drive = C/D and DSP Jumpered
Slave Drive = No Jumpers installed

* Note: HSP is not used.



CONNER CP30540

SCSI Bus Address

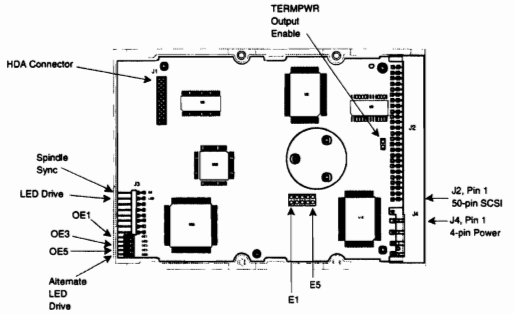
There are three jumpers available for configuration of SCSI ID: E1, E2, and E3. The following table defines the settings:

SCSI Bus Addresses*			
E1/0E1	E2/0E2	E3/0E3	SCSI ID
OUT	OUT	OUT	0
IN	OUT	OUT	1
OUT	IN	OUT	2
IN	IN	OUT	3
OUT	OUT	IN	4
IN	OUT	IN	5
OUT	IN	IN	6
IN	IN	IN	7

*Use either but not both : E1 to E3 or 0E1 to 0E3. The 0E header is not installed on drive configurations with a LED on the PCBA.

Disable Spin: A jumper in the E4 location, disables spin up on power-on. Disabling spin up on application of power can also be enabled by settting the DSPN bit in MODE SELECT page 0.

E4	Disable Spin on Power on	
E5	Terminators on	0E5



CONNER CP30544

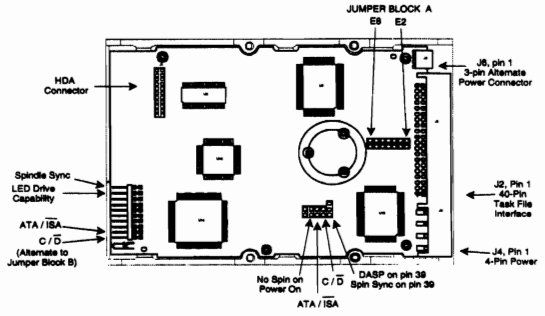
C/D

Up to two drives may be daisy chained together utilizing the 40 pin Task File connector. The maximum cable length is 18 inches. In order to install more than one drive, it is necessary to set a jumper option. The C/D jumper is used to determine whether the drive is master (drive C) or slave (drive D). The drive is configured as a master (drive C) when jumpered and as a slave drive (D drive) when not jumpered.

DSP & SS This pair of jumpers determines the signals on pin 39 of the interface connector.

Jumper		
DSP	SS	Action
		-Spindle synchronization signal disable on pin 39
X		-Activity LED signal available on pin 39.
		-Spindle synchronization signal enable on pin 39
	X	-Activity LED signal disabled from pin 39.
		-Pin 39 floating.

Jumper		Function	
		ATA/CAM	Non-CAM
Block A	E2	OUT	IN
Block A	E3	OUT	IN
Block A	E4	OUT	IN
Block A	E5	IN	OUT
Block A	E6	IN	OUT
Block A	E7	IN	OUT
Block A	E8	IN	OUT
Block B	ATA/ISA	IN	OUT



CONNER CP3100

There are six jumpers available for connfiguration. Three of these jumpers, E1, E2, and E3 are used to select the drive's SCSI ID, while E4 (installed) disables parity. Jumpers E5 and E6 are used to enable either the spindle synchronization signal, or LED, respectively.
The following table defines the settings for jumpers E1, E2, and E3

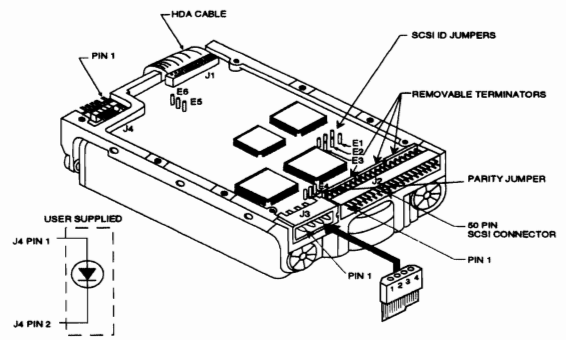
E1	E2	E3	SCSI ID
OUT	OUT	OUT	0
IN	OUT	OUT	1
OUT	IN	OUT	2
IN	IN	OUT	3
OUT	OUT	IN	4
IN	OUT	IN	5
OUT	IN	IN	6
IN	IN	IN	7

J3 POWER PIN ASSIGNMENTS

SIGNAL	PIN NO.
+12V	1
GND	2
GND	3
+5V	4

J4 FACTORY TEST PORT

SIGNAL	PIN NO.
+5V	1
LED/SYNC	2
UNUSED	3-14



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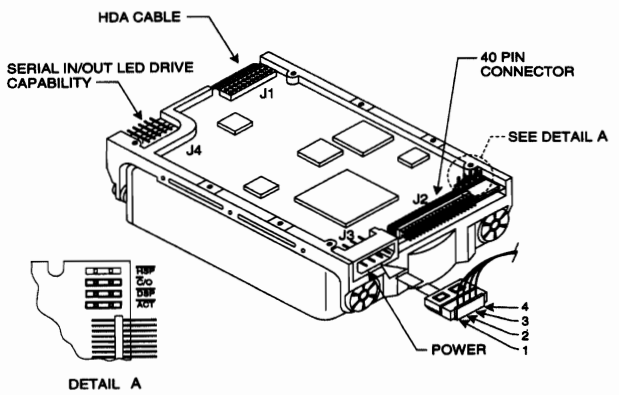
CONNER CP3104

The jumper options available are:

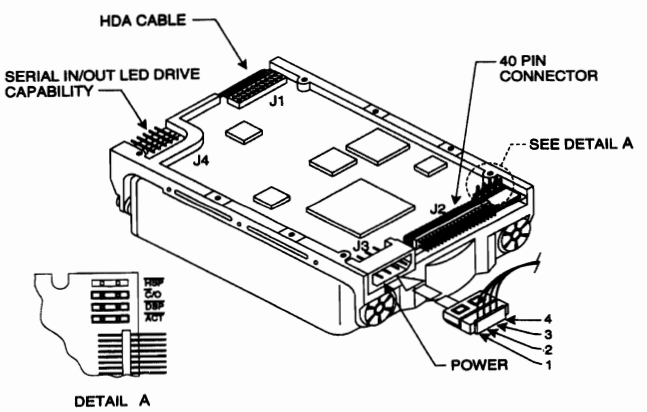
Single Drive = ACT and C/D are Jumpered
Master Drive = C/D and DSP are Jumpered
Slave Drive = No Jumpers Installed
-HSP, is not used.



CONNER CP3184

The jumper options available are:

Single Drive = ACT and C/D are Jumpered
Master Drive = C/D and DSP are Jumpered
Slave Drive = No Jumpers Installed
-HSP, is not used.



CONNER CP31370 BAJA SCSI

SCSI Bus Address

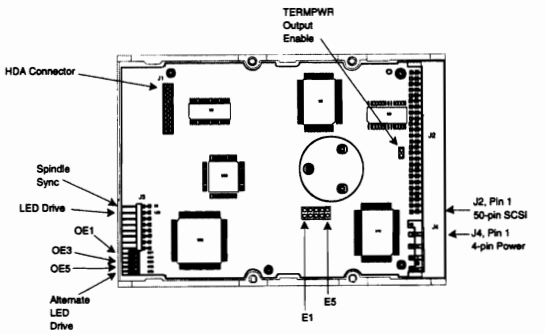
There are three jumpers available for configuration of SCSI ID: E1, E2, and E3. The following table defines the settings:

SCSI Bus Addresses*			
E1/0E1	E2/0E2	E3/0E3	SCSI ID
OUT	OUT	OUT	0
IN	OUT	OUT	1
OUT	IN	OUT	2
IN	IN	OUT	3
OUT	OUT	IN	4
IN	OUT	IN	5
OUT	IN	IN	6
IN	IN	IN	7

*Use either but not both : E1 to E3 or 0E1 to 0E3. The 0E header is not installed on drive configurations with a LED on the PCBA.

Disable Spin: A jumper in the E4 location, disables spin up on power-on. Disabling spin up on application of power can also be enabled by settting the DSPN bit in MODE SELECT page 0.

E4	Disable Spin on Power on	
E5	Terminators on	0E5

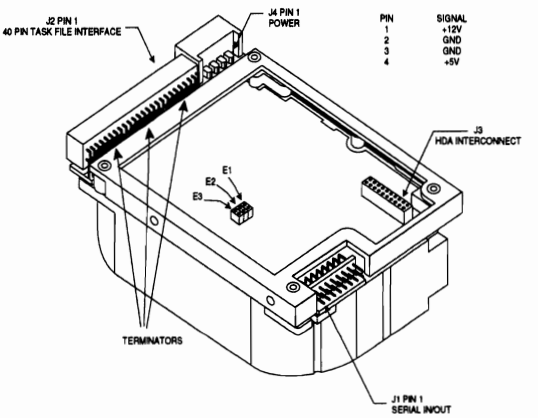


CONNER CP3200F

There are three jumpers availabel for configuration; E1,E2, and E3 are used to select the drive SCSI ID. The following table defines the settings. Note: SCSI parity is always enabled

The following table defines the settings for jumpers E1, E2, and E3:

Jumper Options			
E1	E2	E3	SCSI ID
OUT	OUT	OUT	0
IN	OUT	OUT	1
OUT	IN	OUT	2
IN	IN	OUT	3
OUT	OUT	IN	4
IN	OUT	IN	5
OUT	IN	IN	6
IN	IN	IN	7



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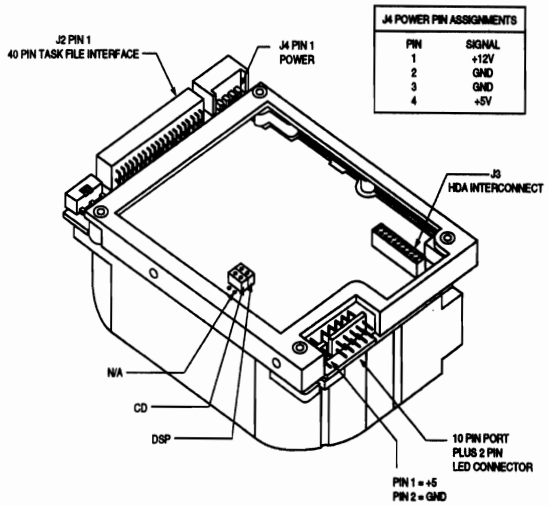
CONNER CP3204F

The CP3204F has two jumper options, DSP and C/D The jumper configuration is as follows.

Single Drive=Jumper C/D only
Master Drive=Jumper C/D and DSP jumpered
Slave Drive=No Jumpers installed.



J4 POWER PIN ASSIGNMENTS	
PIN	SIGNAL
1	+12V
2	GND
3	GND
4	+5V

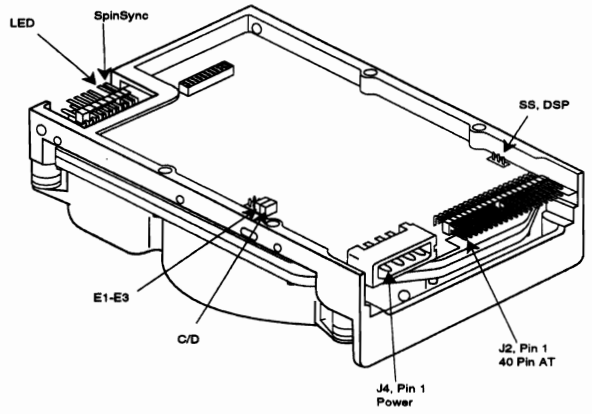
CONNER CP3304

C/D
The C/D jumper is used to determine whether the drive is a master (drive C) or slave (drive D). The drive is configured as a master (drive C) when jumpered and as a slave drive (D drive) when not jumpered.

DSP & SS This pair of jumpers determines the signals on pin 39 of the interface connector.

Jumper DSP	Jumper SS	Action
X		- spindle synchronization signal disabled on pin 39. - activity LED signal available on pin 39. - Must be in place for CAM /ATA drives.
	X	- spindle synchronization signal enabled on pin 39. - activity LED signal disabled from pin 39.
		- pin 39 floating.

Jumper	
E1	Disable Spin Up until command received
E2	Not used
E3	Not used



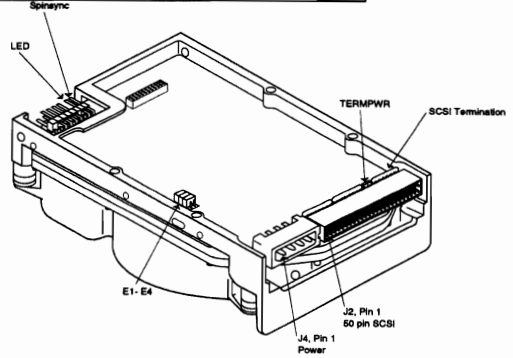
CONNER CP3360/CP3540

There are three jumpers available for configuration of SCSI ID: E1, E2, and E3. The following table defines the settings:

ID	Jumper
0	None
1	E1
2	E2
3	E1 & E2
4	E3
5	E1 & E3
6	E2 & E3

Delay Spin A jumper in the E4 location, disables spin up on power-on. Disabling spin up on application of power can also be enabled by setting the DSPN bit in MODE SELECT page 0.

E4	DSPN	Result
In	0	Spin Disabled
In	1	Spin Disabled
Out	0	Spin up on Power On
Out	1	Spin Disabled



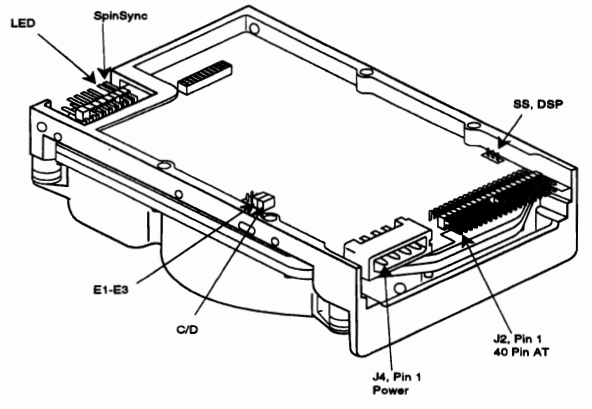
CONNER CP3364

C/D
The C/D jumper is used to determine whether the drive is a master (drive C) or slave (drive D). The drive is configured as a master (drive C) when jumpered and as a slave drive (D drive) when not jumpered.

DSP & SS This pair of jumpers determines the signals on pin 39 of the interface connector.

Jumper DSP	Jumper SS	Action
X		- spindle synchronization signal disabled on pin 39. - activity LED signal available on pin 39. - Must be in place for CAM /ATA drives.
	X	- spindle synchronization signal enabled on pin 39. - activity LED signal disabled from pin 39.
		- pin 39 floating.

Jumper	
E1	Disable Spin Up until command received
E2	Not used
E3	Not used



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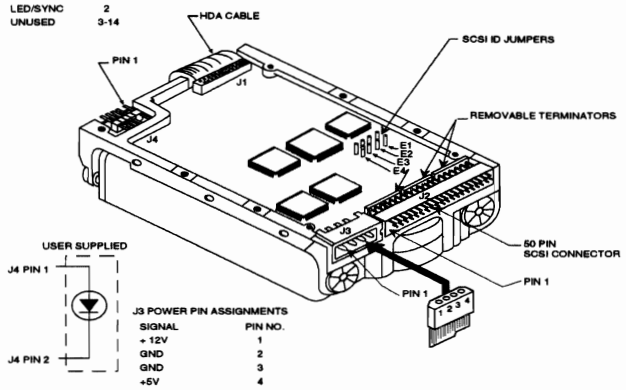
CONNER CP340

There are four jumpers available for configuration; three of the jumpers, E2, E3, and E4 are used to select the drive's SCSI ID, while E1 (installed) disables parity. The following table defines the settings for these jumpers.

E2	E3	E4	Device
OUT	OUT	OUT	0
IN	OUT	OUT	1
OUT	IN	OUT	2
IN	IN	OUT	3
OUT	OUT	IN	4
IN	OUT	IN	5
OUT	IN	IN	6
IN	IN	IN	7

J4 FACTORY TEST PORT

SIGNAL	PIN NO.
+ 5V	1
LED/SYNC	2
UNUSED	3-14



J3 POWER PIN ASSIGNMENTS

SIGNAL	PIN NO.
+ 12V	1
GND	2
GND	3
+5V	4

CONNER CP3504

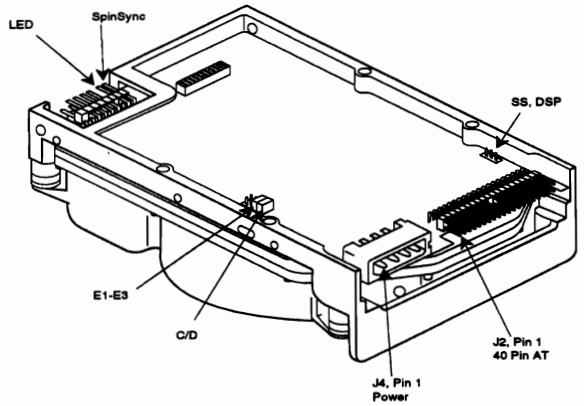
C/D

The C/D jumper is used to determine whether the drive is a master (drive C) or slave (drive D). The drive is configured as a master (drive C) when jumpered and as a slave drive (D drive) when not jumpered.

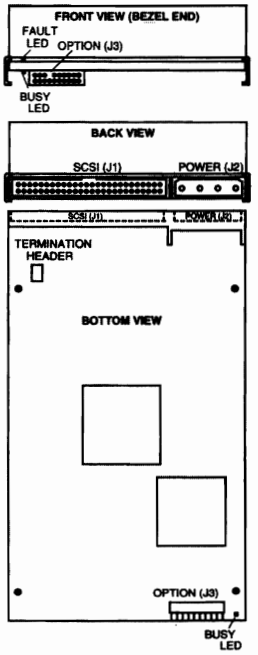
DSP & SS This pair of jumpers determines the signals on pin 39 of the interface connector.

Jumper DSP	Jumper SS	Action
X		- spindle synchronization signal disabled on pin 39. - activity LED signal available on pin 39. - Must be in place for CAM /ATA drives.
	X	- spindle synchronization signal enabled on pin 39. - activity LED signal disabled from pin 39.
		- pin 39 floating.

Jumper	
E1	Disable Spin Up until command received
E2	Not used
E3	Not used



DIGITAL DSP3000 SERIES



CONNER CP3544

C/D

The C/D jumper is used to determine whether the drive is a master (drive C) or slave (drive D). The drive is configured as a master (drive C) when jumpered and as a slave drive (D drive) when not jumpered.

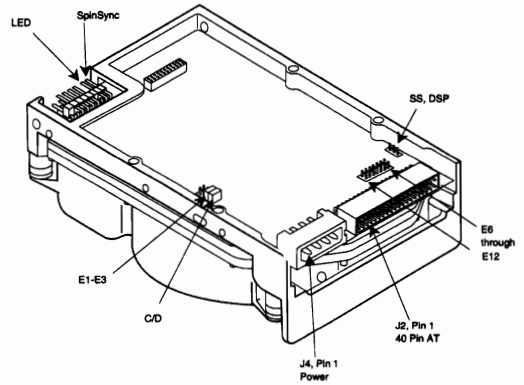
DSP & SS This pair of jumpers determines the signals on pin 39 of the interface connector.

Jumper DSP	Jumper SS	Action on pin 39
X		- DASP signal available - activity LED available
	X	- spindle synchronization output - activity LED disabled
		open

Jumper	
E1	Disable spin-up until command received
E2	Not used
E3	Not used (spare jumper retainer)

These jumpers only apply to PCB P/N 09400-001

Jumper	
E6	ISA - DMAEN on J2, pin 21
E7	ISA - DMARQ on J2, pin 29
E8	ISA - DMACK on J2, pin 27
E9	ATA - IORDY on J2, pin 27
E10	ATA - Spin Sync on J2, pin 28 (remove unless spin sync is used)
E11	ATA - DMACK on J2, pin 29
E12	ATA - DMARQ on J2, pin 21



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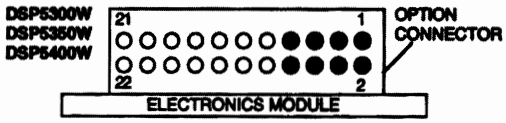
DIGITAL DSP5000 SERIES

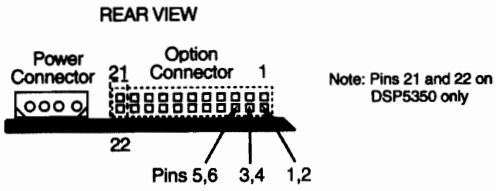
SCSI ID – DSP5300W/5350W/5400W



SCSI ID	JUMPER LOCATION			
	PINS 7-8	PINS 5-6	PINS 3-4	PINS 1-2
0	0	0	0	0
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1
6	0	1	1	0
7	0	1	1	1
8	1	0	0	0
9	1	0	0	1
10	1	0	1	0
11	1	0	1	1
12	1	1	0	0
13	1	1	0	1
14	1	1	1	0
15	1	1	1	1

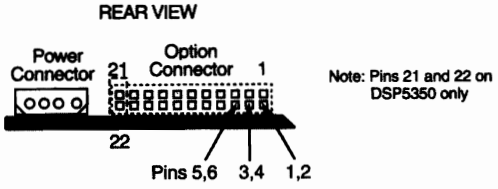
0 = JUMPER NOT INSTALLED
1 = JUMPER INSTALLED

DIGITAL DSP5200



ID JUMPER SETTINGS			
SCSI ID	Pins 5,6	3,4	1,2
0	□	□	□
1	□	□	■
2	□	■	□
3	□	■	■
4	■	□	□
5	■	□	■
6	■	■	□
7	■	■	■

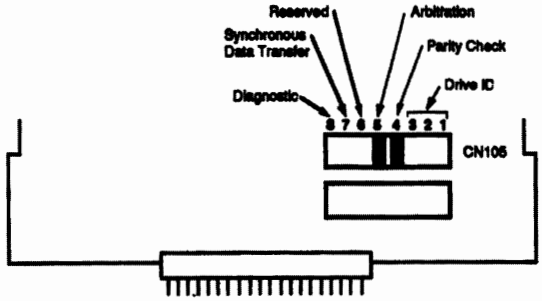
DIGITAL DSP5350



ID JUMPER SETTINGS			
SCSI ID	Pins 5,6	3,4	1,2
0	□	□	□
1	□	□	■
2	□	■	□
3	□	■	■
4	■	□	□
5	■	□	■
6	■	■	□
7	■	■	■

FUJITSU M2246SA

On the M2246SA model, parameter settings are made with jumpers between pairs of pins on terminal strip CN105. The figure below shows the location of CN105 as you see it when you flip over the drive, identifies the purpose of each pin pair, and shows whether a shorting plug is installed at the factory. Read the descriptions to determine whether the factory settings are correct for your system.



Terminal strip CN105-M2246SA

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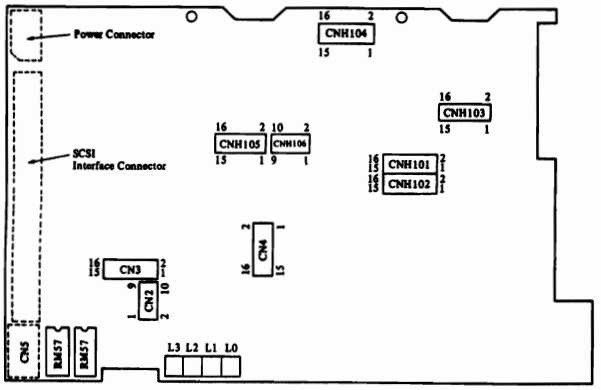
FUJITSU M2247/M2248/M2249SA

Short plugs are inserted as follows when shipped from the factory.

CN3: Between 11 and 12, 13 and 14
CNH104: Between 3 and 4
CNH105: Between 15 and 16

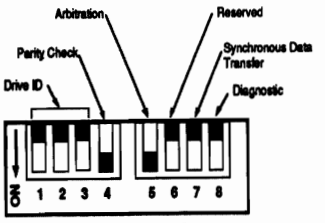
The following settings are model specific.

CNH105: Between 13 and 14 : M2249
Between 11 and 12 : M2248
No short plugs between 11 and 12 or 13 and 14 : M2247



Location of check terminals and setting circuits

FUJITSU M2249SA



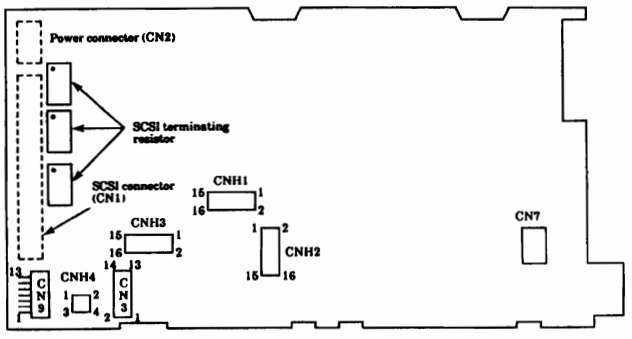
DIP switch-M2249SA

Drive ID

This setting determines the ID by which the host adaptor identifies the drive. You make the setting with the first three pin pairs on terminal strip CN105 (M2246SA) or with the first three toggles on the DIP switch (M2249SA). The table shows the settings and the corresponding IDs.

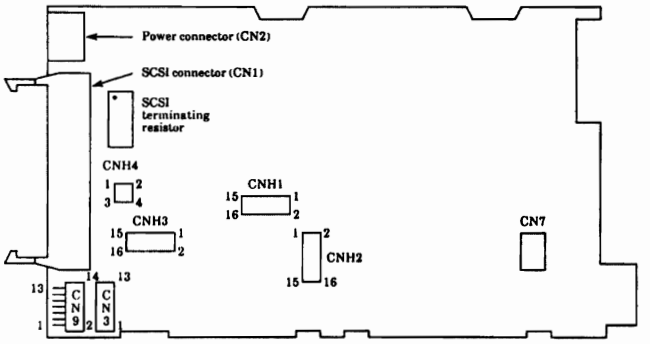
Drive ID	Pin pair/toggle 1	2	3
0	OPEN	OPEN	OPEN
1	SHORT	OPEN	OPEN
2	OPEN	SHORT	OPEN
3	SHORT	SHORT	OPEN
4	OPEN	OPEN	SHORT
5	SHORT	OPEN	SHORT
6	OPEN	SHORT	SHORT
7	SHORT	SHORT	SHORT

FUJITSU M226xH



The Setting Terminals and Terminating Resistor (M226xH)

FUJITSU M226xS



The Setting Terminals and Terminating Resistor (M226xS)

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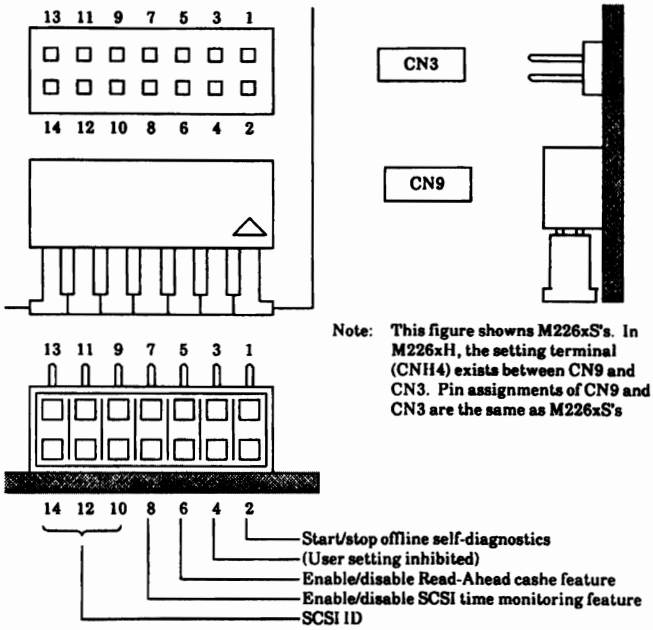
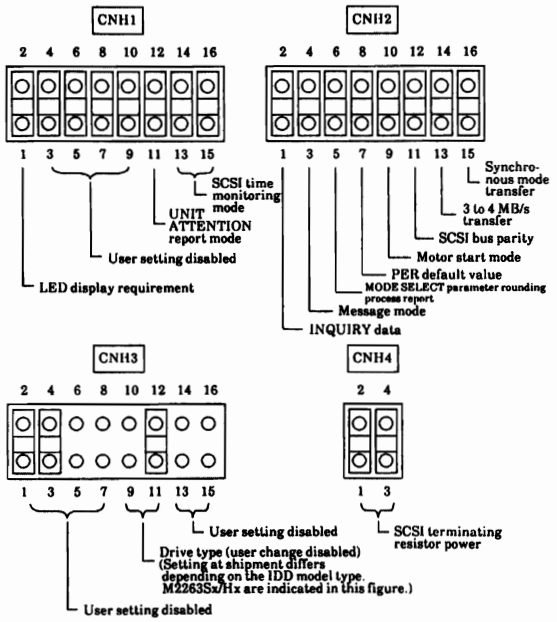
FUJITSU M226xS/H



Note: This figure showns M226xS's. In M226xH, the setting terminal (CNH4) exists between CN9 and CN3. Pin assignments of CN9 and CN3 are the same as M226xS's

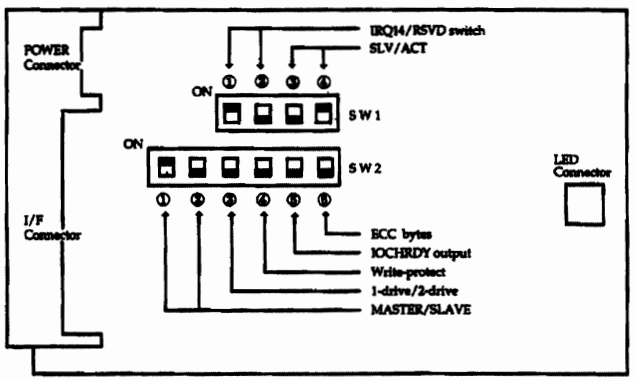
Setting Terminals CN3/CN9

FUJITSU M226xS/H

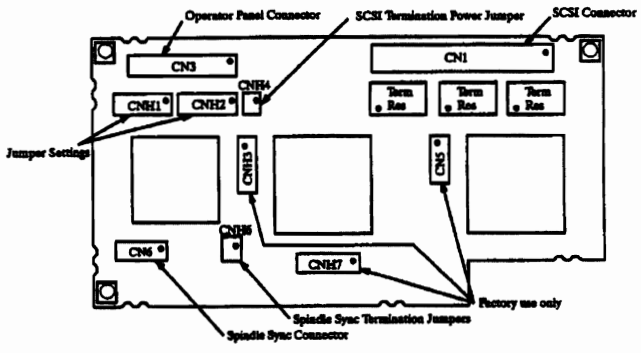


Setting Terminals CNH1, CNH2, CNH3, and CNH4

FUJITSU M2611T/M2612T



FUJITSU M265xH (REV. 02)



M265xH interface PCA (Revision 02)

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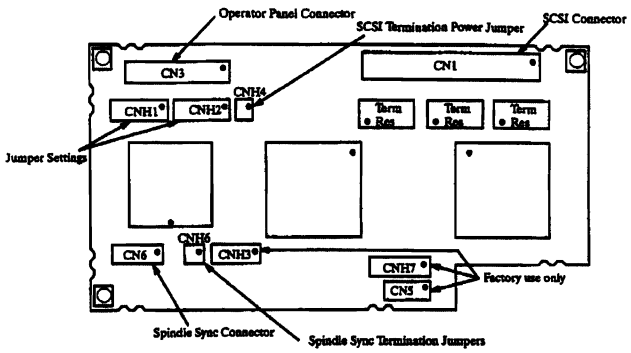
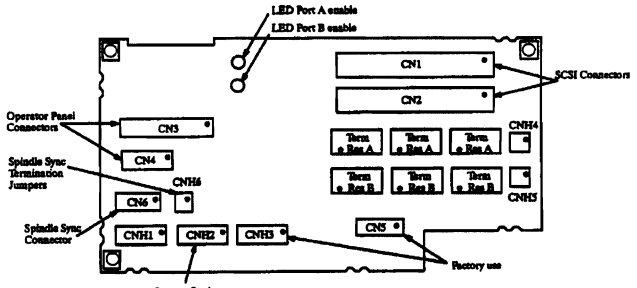
FUJITSU M265xH (REV. 03)



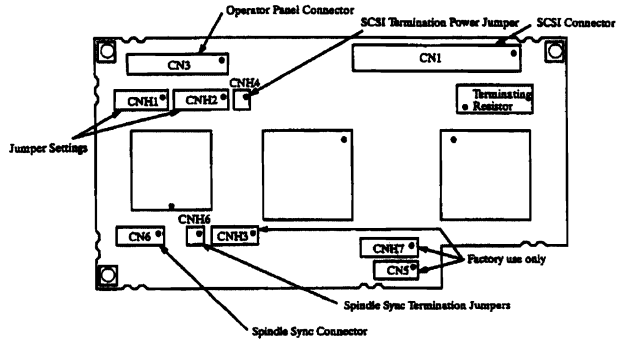
M265xH interface PCA (Revision 03—)

FUJITSU M265xHD



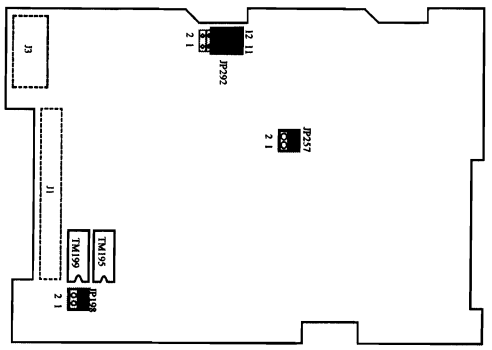
M265xHD interface PCA

FUJITSU M265xS (REV. 03)



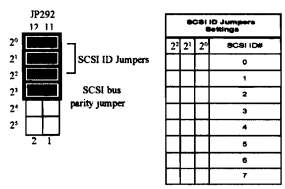
M265xS interface PCA (Revision 03—)

HITACHI DK514C



The terminator of the DK514C must be removed except for the last drive of the daisy-chain

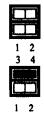
1) SCSI ID setting jumper (JP292 Bits 2^0 - 2^5)



Shipped with ID# = 0

2) SCSI bus parity jumper (JP292 bit 2^5) Note: 0 = Jumper plug installed, 1 = Jumper plug removed
1 Disables SCSI bus parity
0 Enables SCSI bus parity

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)

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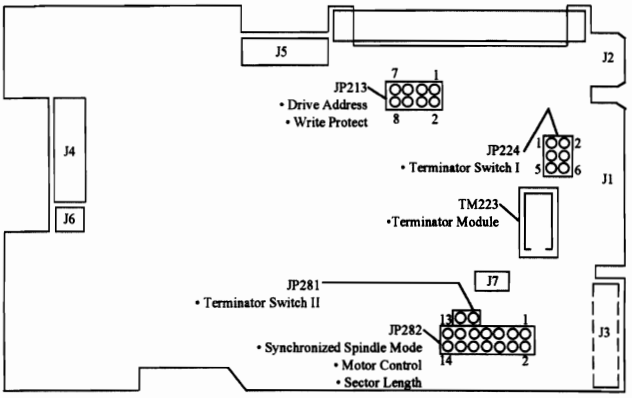
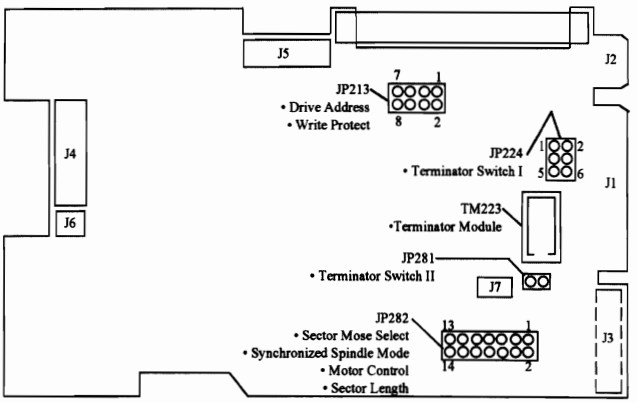
HITACHI DK515 (PCB REV.0)

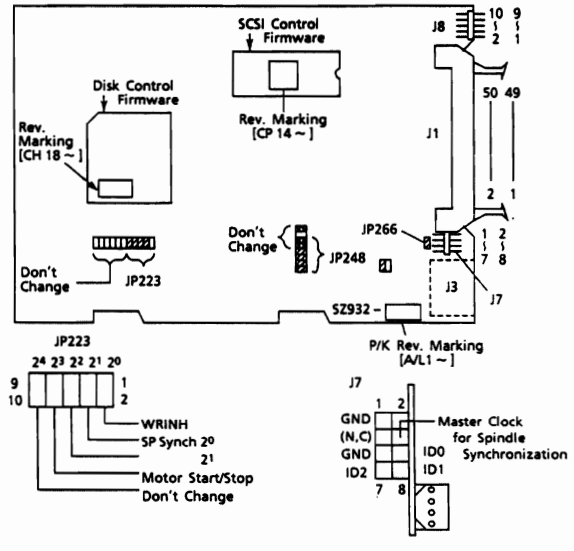


HITACHI DK515 (PCB REV.1+)

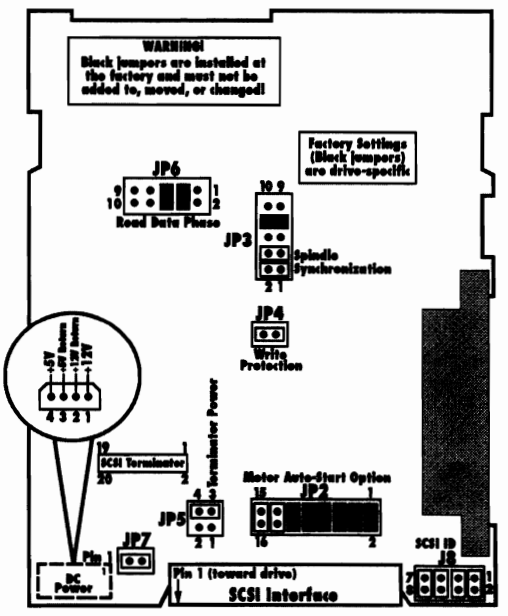


HITACHI DK515C

Spindle Synchronization J7 – Pin 1 ~ 4 (Signal connector)
JP266 (Signal termination)
JP223 – 2^1~2^2 (Mode Setting Jumper)



HITACHI DK516C



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HITACHI DK517C-37

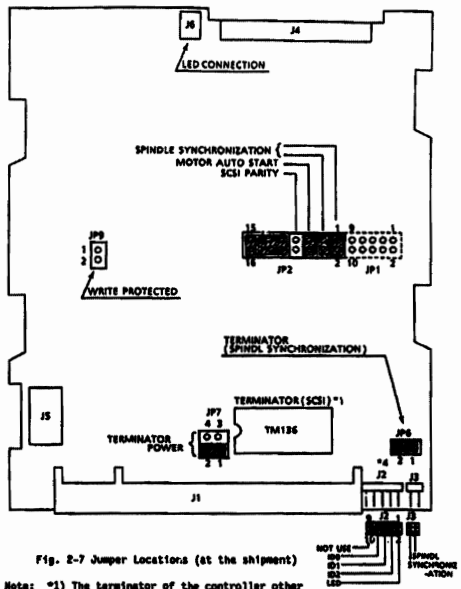
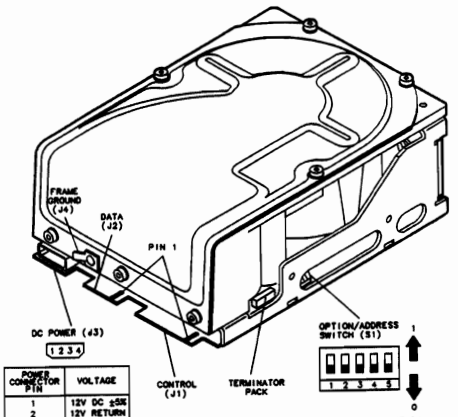


Fig. 2-7 Jumper Locations (at the shipment)

Note: *1) The terminator of the controller other than the last drive of SCSI Daisy Chain must be removed.
*2) The terminator for Synchronized Spindle option.
*3) ■ : Jumper at the shipment
□ : User changeable (Green Jumper)
*4) See Sheet No.24-2.

HEWLETT PACKARD 9753xE ESDI



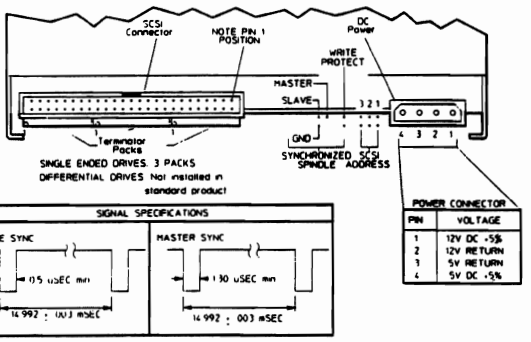
POWER CONNECTOR PIN	VOLTAGE
1	12V DC ±5%
2	12V RETURN
3	5V RETURN
4	5V DC ±5%

SEGMENT 1: POWER-UP OPTION
0 = SPIN-UP AT POWER ON
1 = SPIN-UP ON COMMAND
SEGMENT 2: AGGRESSIVE SEEKS OPTION
0 = OFF
1 = ON
SEGMENTS 3-5: ESDI ADDRESS

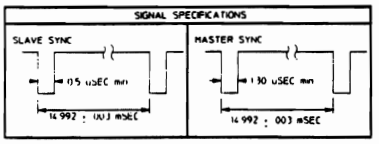
SEGMENTS 3	4	5	DRIVE ADDRESS
0	0	0	ILLEGAL*
0	0	1	1
0	1	0	2
0	1	1	3
1	0	0	4
1	0	1	5
1	1	0	6
1	1	1	7

* DRIVE RESPONDS AS ADDRESS 1. THIS POSITION IS USED FOR MANUFACTURING.

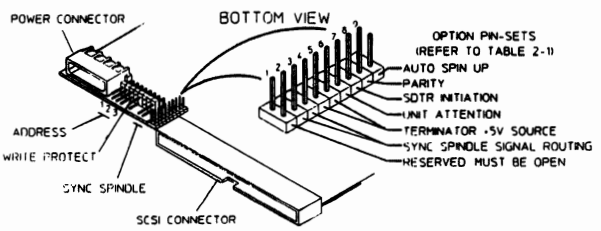
HEWLETT PACKARD 97556/97558/97560



SIGNAL SPECIFICATIONS

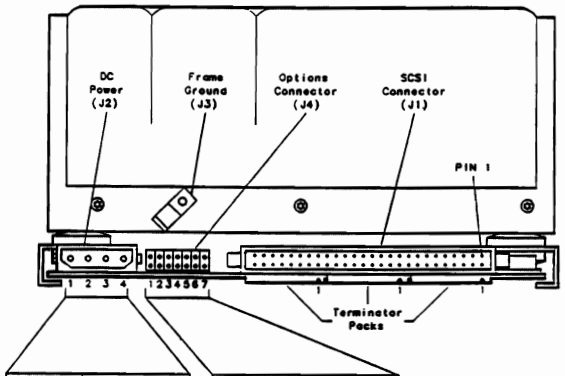


POWER CONNECTOR PIN	VOLTAGE
1	12V DC +5%
2	12V RETURN
3	5V RETURN
4	5V DC +5%



Interface Connectors and Option Pin-Set Settings

HEWLETT PACKARD 9753xS/T/D



POWER CONNECTOR PIN	VOLTAGE
1	12V DC ±5%
2	12V RETURN
3	5V RETURN
4	5V DC ±5%

OPTION SETTINGS
0 = Open, 1 = Short

PINS 5	6	7	DRIVE ADDRESS
0	0	0	0
0	0	1	1
0	1	0	2
0	1	1	3
1	0	0	4
1	0	1	5
1	1	0	6
1	1	1	7

PIN 1: Reserved (Normally shorted)
PIN 2: Drive initiation of SDTR message
0 = Inhibit initiation of SDTR message
1 = Enable initiation at Power On and RESET
PIN 3: Parity
0 = Parity checking is disabled
1 = Parity checking is enabled
PIN 4: Auto spin up
0 = Drive will not spin up until host sends start unit command
1 = Drive will automatically spin up on power on
PINS 5-7: SCSI address

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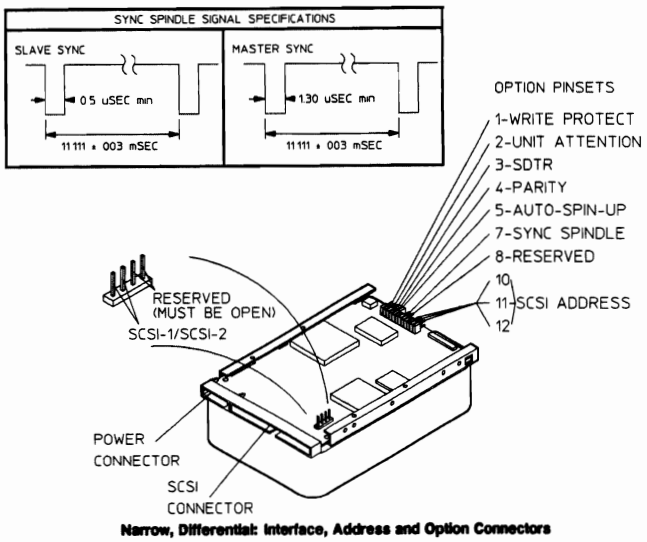
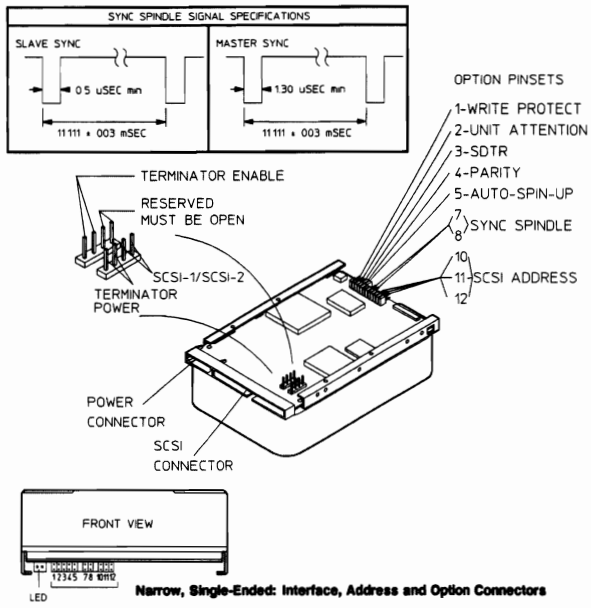
HEWLETT PACKARD C2244/45/46/47 NARROW DIFFERENTIAL



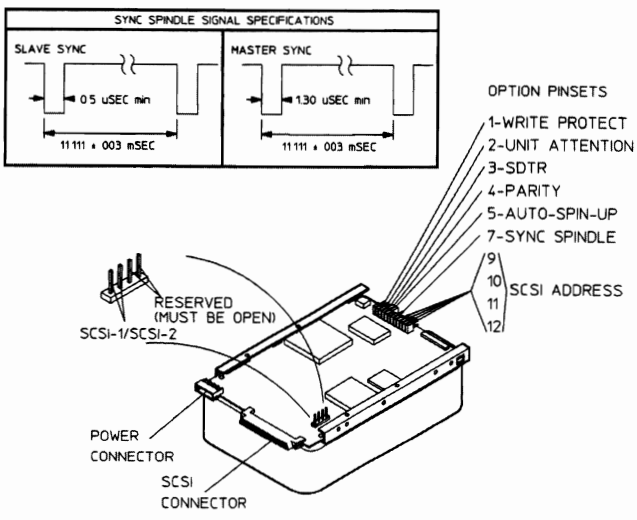
Narrow, Differential: Interface, Address and Option Connectors

HEWLETT PACKARD C2244/45/46/47 NARROW SINGLE ENDED



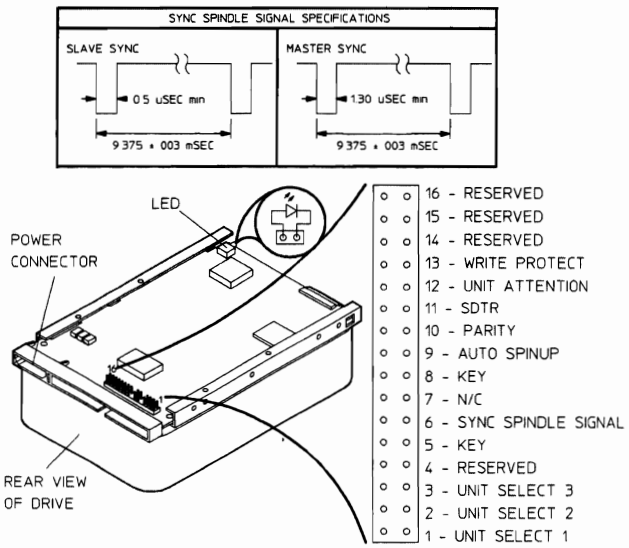
Narrow, Single-Ended: Interface, Address and Option Connectors

HEWLETT PACKARD C2244/45/46/47 WIDE DIFFERENTIAL



Wide, Differential: Interface, Address and Option Connectors

HEWLETT PACKARD C2490A NARROW DIFFERENTIAL



Narrow, Differential: Interface, Address and Option Configurations

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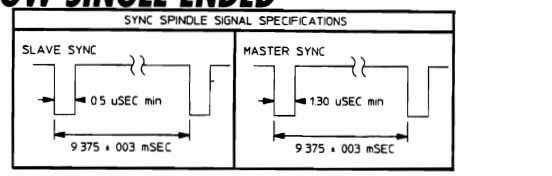
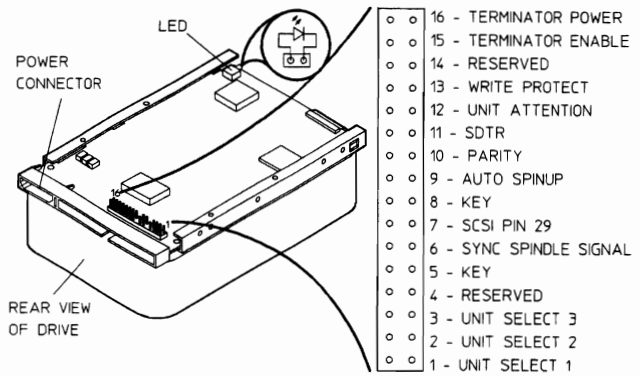
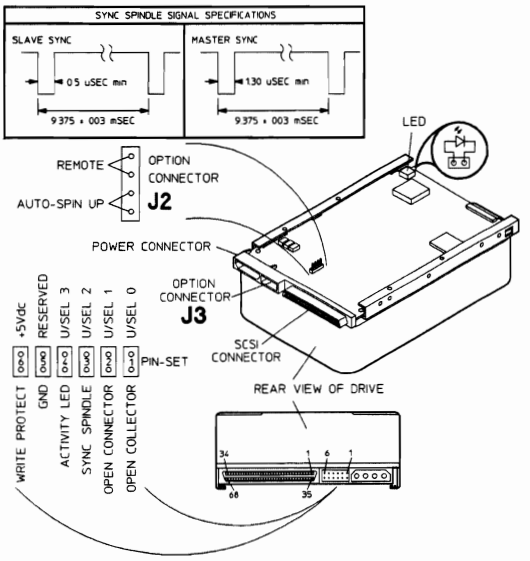
HEWLETT PACKARD C2490A NARROW SINGLE ENDED





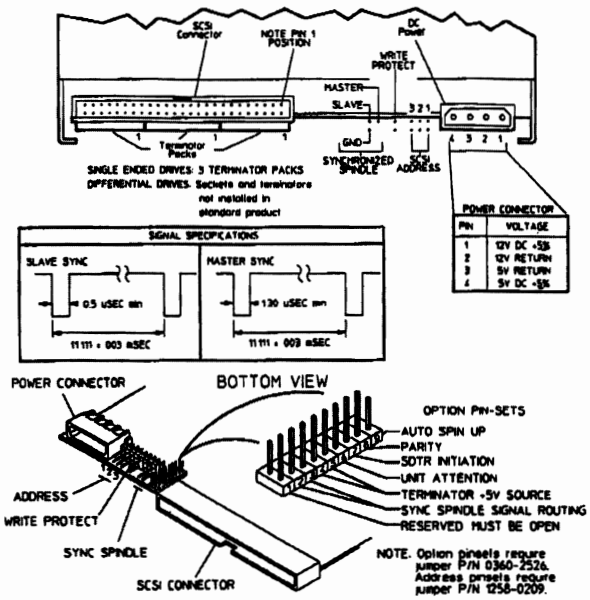
Narrow, Single-Ended: Interface, Address and Option Configurations

HEWLETT PACKARD C2490A WIDE DIFFERENTIAL



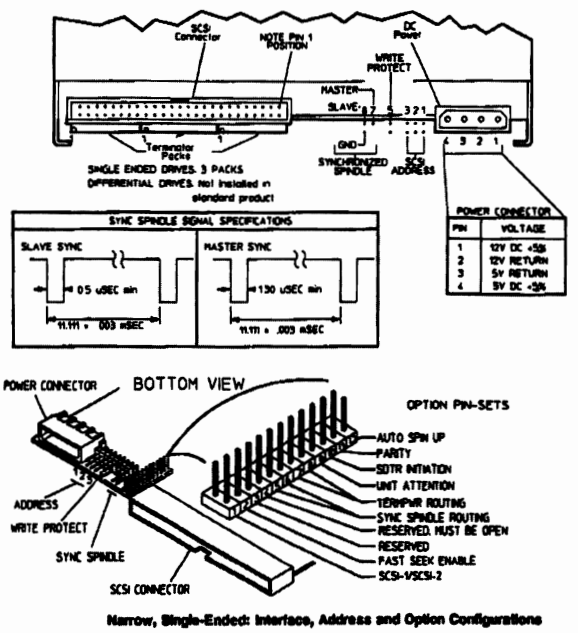
Wide, Differential: Interface, Address and Option Configurations

HEWLETT PACKARD 9-Pin Version



Narrow, Single-Ended, Interface, Address, and Option Connectors (9-Pin-set Version)

HEWLETT PACKARD C3010 12-Pin Version



Narrow, Single-Ended: Interface, Address and Option Configurations

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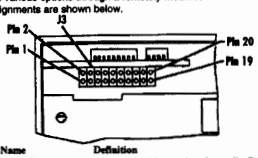
IBM 0632

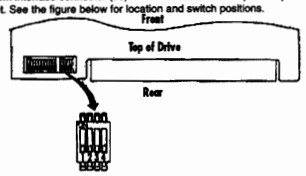
Subsystem Interface Connector (J3)
The subsystem interface connector (J3)* allows direct communications between a library autochanger and the drive subassembly. The subsystem interface connector (J3) also allows setting of various options through a remotely mounted switch cabled to the connector. The pin assignments are shown below.



Pin	Signal Name	Definition
1	LIB Interface Eject	Instructs the drive to eject the media. Driven active low by the subsystem and pulled up to 5 volts by the drive.
2	* LED Pipe	Represents the drive front panel activity indicator LED. Active low signal.
3	PWRDNREQ	Instructs the drive to synchronous the cache immediately (transfer data from the write cache to the media). Driven active low by the subsystem and pulled up to 5 volts by the drive.
4	LIB Interface Busy	Indicates drive activity during cartridge insertion, spin-down, and removal. Driven active low by the drive and pulled up to 5 volts by the sussystem (220-ohm resistor).
5	SCSI TERMPWR	Connects to the same pin as the SCSI connector TERMPWR signal.
6	SCSI TERMPWR SRC	Supplies +5V AC source voltage throught isolation diode for TERMPWR. Connecting Pin 6 to Pin 5 enables the SCSI TERMPWR signal.
7	Not Connected	Not connected to the drive electronics
8	Reserved for Mfg.	Reserved for manufacturer's use. Should not be connected.
9	Reserved for Mfg.	Reserved for manufacturer's use. Should not be connected.
10	CART_IN_DRIVE	Indicates a cartridge has been inserted into the drive. Driven by active low by the drive and pulled up to 5 volts by the subsystem (220 ohm resistor).
11	Sub Reset	Instructs the drive to perform a hard reset.
12	Reserved for Mfg.	Reserved for manufacturer's use. Should not be connected.
13	SCSI Parity Disabled	Disables SCSI parity on the drive. Driven by active low by the subsystem and pulled up to 5 volts by the drive.
14	LIB Interface Spin-down	Instructs the drive to spin-down the media. Driven active low by the subsystem and pulled up to 5 volts by the drive.
15	SCSI ID2	SCSI ID select bit 2. Driven active low by the subsystem and pulled up to 5 volts by the drive.
16	Reserved for Mfg.	Reserved for manufacturer's use. Should not be connected.
17	SCSI ID1	SCSI ID select bit 1. Driven active low by the subsystem and pulled up to 5 volts by the drive.
18	SCSI Termination Disable	Disables SCSI termination by the drive.
19	SCSI ID0	SCSI ID select bit 0. Driven active low by the subsystem and pulled up to 5 volts by the drive.
20	Ground	Ground.

IBM 0632 (Continued)

SCSI Address Switch (J4)
The SCSI address of the drive can be selected using the 4-position address switch (J4) or the subsystem interface connector (J3). The address is read at power up and when the drive is reset. See the figure below for location and switch positions.



SCSI Adress Switch Settings

SCSI Drive Address	Switch 1 (ID0)	Switch 2 (ID1)	Switch 3 (ID2)	Switch 4
0	Off (inactive)	Off (inactive)	Off (inactive)	Not connected
1	On (active)	Off (inactive)	Off (inactive)	Not connected
2	Off (inactive)	On (active)	Off (inactive)	Not connected
3	On (active)	On (active)	Off (inactive)	Not connected
4	Off (inactive)	Off (inactive)	On (active)	Not connected
5	On (active)	Off (inactive)	On (active)	Not connected
6	Off (inactive)	On (active)	On (active)	Not connected
7	On (active)	On (active)	On (active)	Not connected

The correct SCSI address must be applied to the SCSI address switch or subsystem interface connector while the address is read by the drive. The SCSI address is read by the drive approximately 1.75 seconds after the power is applied to the drive or after a SCSI reset condition is initiated. The address setting must be applied to the switch or connector at least 1.5 seconds after applying drive power until the drive is powered off.
The user should only use one SCSI address source, either the SCSI address switch OR the subsystem interface connector. The other (unused) source must be set to an address of 0.
The SCSI address switch is preset in the factory to SCSI address 1.

Feature Switches (J5 and J6)

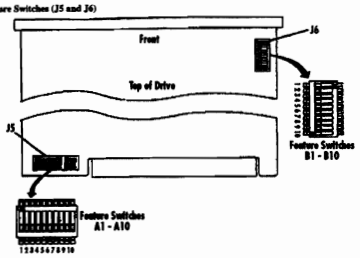
J5

Switch	Setting	Description
A1	**Off***	Enable Unit Attention on POR/SCSI Reset.
	On	Feature Switch 2 Off: Disable Unit Attention on POR/SCSI Reset for Apple-attach. Feature Switch 2 On: Support Mode Sense/Select pages for DEC-attach.
A2	**Off***	Peripheral Device Type in Inquiry data is X'07', Optical Memory Device.
	On	Peripheral Device Type in Inquiry data is X'00', Direct Address Device.
A3	**Off***	Spin automatically on power-up or cartridge insert.
	On	No spin-up on power-up but spin-up on cartridge insert.
A4	**Off***	Force verify on Write command is default mode.
	On	Inhibit verify on Write command is default mode.
A5	**Off***	Enable SCSI termination.
	On	Disable SCSI termination.

Bold* = Default

IBM 0632 (Continued)

Feature Switches (J5 and J6)



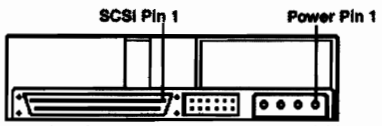
A6	Off	SCSI TERMPWR signal is disabled.
	On*	SCSI TERMPWR signal is enabled.
A7	Off	Reserved for Manufacturer's Use (SCSI reset causes drive self-test–long reset).
	On*	Required setting (SCSI reset does not cause drive self-test–long reset).
A8	Off*	SCSI Parity is enabled.
	On	SCSI Parity is disabled.
A9	Off*	Reserved.
	On	Reserved.
A10	Off*	Reserved.
	On	Reserved.

J6

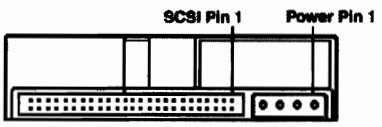
Switch	Setting	Description
B1	Off*	Write Cache disabled (WCE=0) is default mode.
	On	Write Cache enabled (WCE=1) is default mode.
B2	Off*	Drive internal trace is enabled.
	On	Drive internal trace is disabled.
B3	Off	Permit SCSI eject request.
	On	Inhibit SCSI eject request.
B4	Off*	Write Cache is supported for Write commands only.
	On	Write Cache is supported for Write and Write Verify commands.
B5	Off*	Write Reordering is enabled when Write Cache is enabled (when WCE=1).
	On	Write Reordering is disabled.
B6	Off*	Reserved.
	On	Reserved.
B7	Off*	Reserved.
	On	Reserved.
B8	Off*	Reserved.
	On	Reserved.
B9	Off*	Reserved.
	On	Reserved.
B10	Off*	Reserved.
	On	Reserved.

IBM 0662

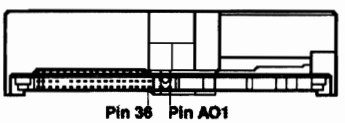
Electrical Connector Locations - The electrical connectors are shown below, consisting of an option block, a SCSI connector and a power connector.



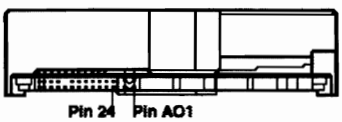
Electrical Connectors (rear view) 68 Pin SCSI



Electrical Connectors (rear view) 50 Pin SCSI



SMD Jumper Pin Locations (front view)



SMP Jumper Pin Locations (front view)

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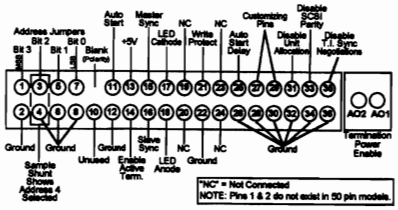
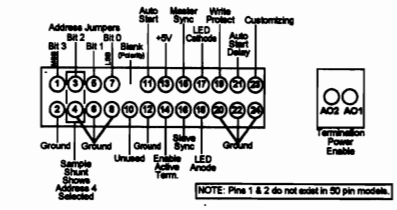
IBM 0662 (Continued)



Front Options Jumper Block for SMD Versions

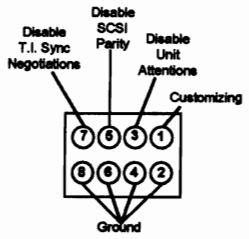
Bit 0	Bit 1	Bit 2	Address
off	off	off	0
on	off	off	1
off	on	off	2
on	on	off	3
off	off	on	4
on	off	on	5
off	on	on	6
on	on	on	7

Address Determination for 50 Pin SCSI Models.*

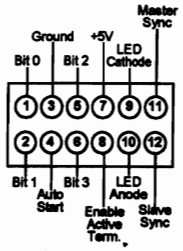


Front Options Jumper Block for SMP Versions

IBM 0662 (Continued)



Bottom Options Jumper Block for SMP Versions

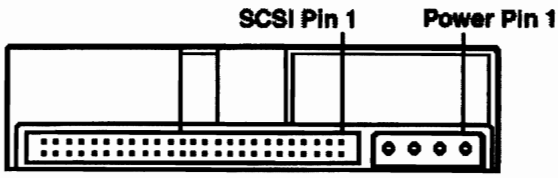


Rear Options Jumper Block for 68 pin models

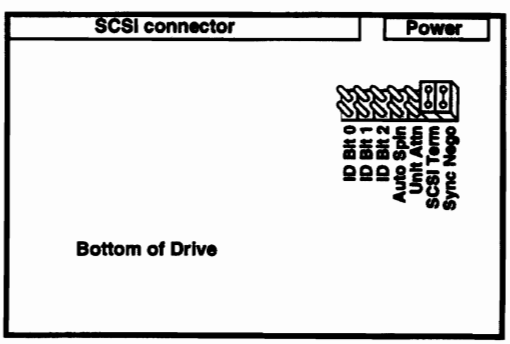
Bit 0	Bit 1	Bit 2	Bit 3	Address
off	off	off	off	0
on	off	off	off	1
off	on	off	off	2
on	on	off	off	3
off	off	on	off	4
on	off	on	off	5
off	on	on	off	6
on	on	on	off	7
off	off	off	on	8
on	off	off	on	9
off	on	off	on	10
on	on	off	on	11
off	off	on	on	12
on	off	on	on	13
off	on	on	on	14
on	on	on	on	15

Address Determination for 50 Pin SCSI Models.*

IBM 31080



Electrical Connectors (rear view) 50 Pin SCSI

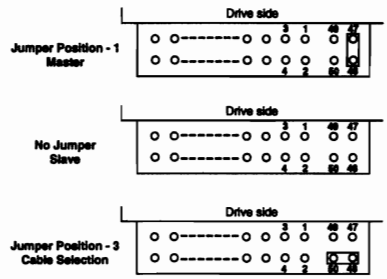


IBM DBOA 2360

Drive Address

A jumper cable is available at the interface connector to determine the drive address.

Using Cable Selection, the drive address depends on the condition of pin 28 of the AT interface cable. In the case when pin 28 is ground or low, the drive is a Master. If pin 28 is open or high level, the drive is a Slave.

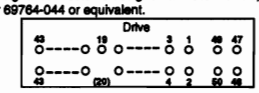


Cabling

The maximum cable length from the host system to the HDD plus circuit pattern length in the host system shall not exceed 18 inches.

AT Signal Connector

The AT signal connector is designed to mate with Dupont part number 69764-044 or equivalent.



NOTES: Pin position 20 is left blank for secure connector insertion.
Pin position 47 through 50 are used for drive address setting.

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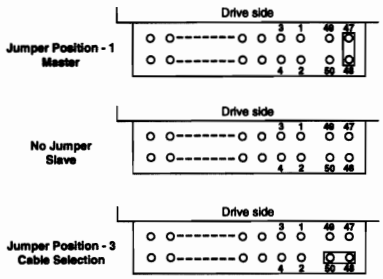
IBM DBOA 2528

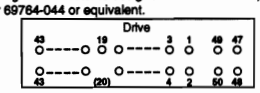
Drive Address
A jumper cable is available at the interface connector to determine the drive address.

Using Cable Selection, the drive address depends on the condition of pin 28 of the AT interface cable. In the case when pin 28 is ground or low, the drive is a Master. If pin 28 is open or high level, the drive is a Slave.



Cabling
The maximum cable length from the host system to the HDD plus circuit pattern length in the host system shall not exceed 18 inches.

AT Signal Connector
The AT signal connector is designed to mate with Dupont part number 69764-044 or equivalent.

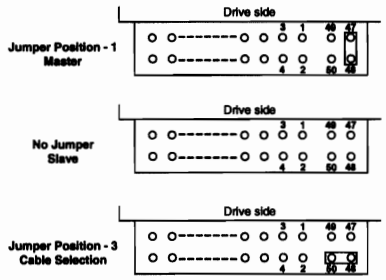


NOTES: Pin position 20 is left blank for secure connector insertion.
Pin position 47 through 50 are used for drive address setting.

IBM DBOA 2540

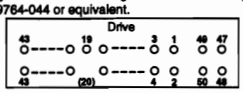
Drive Address
A jumper cable is available at the interface connector to determine the drive address.

Using Cable Selection, the drive address depends on the condition of pin 28 of the AT interface cable. In the case when pin 28 is ground or low, the drive is a Master. If pin 28 is open or high level, the drive is a Slave.



Cabling
The maximum cable length from the host system to the HDD plus circuit pattern length in the host system shall not exceed 18 inches.

AT Signal Connector
The AT signal connector is designed to mate with Dupont part number 69764-044 or equivalent.

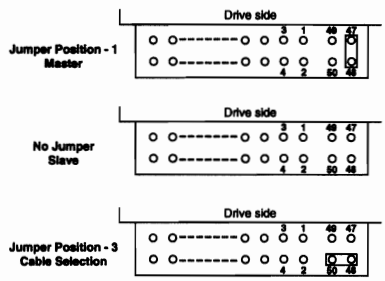


NOTES: Pin position 20 is left blank for secure connector insertion.
Pin position 47 through 50 are used for drive address setting.

IBM DBOA 2720

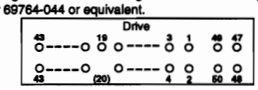
Drive Address
A jumper cable is available at the interface connector to determine the drive address.

Using Cable Selection, the drive address depends on the condition of pin 28 of the AT interface cable. In the case when pin 28 is ground or low, the drive is a Master. If pin 28 is open or high level, the drive is a Slave.



Cabling
The maximum cable length from the host system to the HDD plus circuit pattern length in the host system shall not exceed 18 inches.

AT Signal Connector
The AT signal connector is designed to mate with Dupont part number 69764-044 or equivalent.

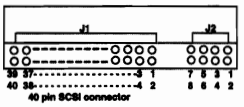


NOTES: Pin position 20 is left blank for secure connector insertion.
Pin position 47 through 50 are used for drive address setting.

IBM DHAS 2270

Driver/Receiver
The drives support single ended drivers and receivers.

Connector
The SCSI signal connectors is designed to mate with AMP part number 6-176135 or equivalent. Size and location of the mounting holes comply with MCC.



J2 Pin No.	-ID1 5	-ID2 6	-ID4 7	Device Address
	open	open	open	0
	gnd	open	open	1
	open	gnd	open	2
	gnd	gnd	open	3
	open	open	gnd	4
	gnd	open	gnd	5
	open	gnd	gnd	6
	gnd	gnd	gnd	7

Cabling
The maximum cable length from the host system to the drive is limited to 6 inches with external 1K-ohm pull up resistors.
In case that appropriate termination resistors are externally equipped to the interface lines, the cable length can be extended. The maximum cable length depends on the condition of the various electrical parameters of the interface.

Device Address
The drive recognizes its device address, namely SCSI ID, with the condition of -ID1, -ID2, and -ID4. The signal condition and the device address are shown above.

Signal Termination
The drive does not ahve termination nor pull up resistors for SCSI interface.

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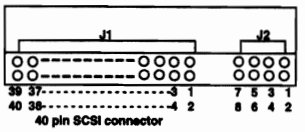
IBM DHAS 2405

Connector
The SCSI signal connectors is designed to mate with AMP part number 6-176135 or equivalent. Size and location of the mounting holes compkly with MCC.



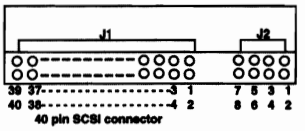
J2 Pin No.	-ID1 5	-ID2 6	-ID4 7	Device Address
	open	open	open	0
	gnd	open	open	1
	open	gnd	open	2
	gnd	gnd	open	3
	open	open	gnd	4
	gnd	open	gnd	5
	open	gnd	gnd	6
	gnd	gnd	gnd	7

Cabling
The maximum cable length from the host system to the drive is limited to 6 inches with external 1K-ohm pull up resistors.
In case that appropriate termination resistors are externally equipped to the interface lines, the cable length can be extended. The maximum cable length depends on the condition of the various electrical parameters of the interface.

Device Address
The drive recognizes its device address, namely SCSI ID, with the condition of -ID1, -ID2, and -ID4. The signal condition and the device address are shown above.

IBM DHAS 2540

Connector
The SCSI signal connectors is designed to mate with AMP part number 6-176135 or equivalent. Size and location of the mounting holes compkly with MCC.



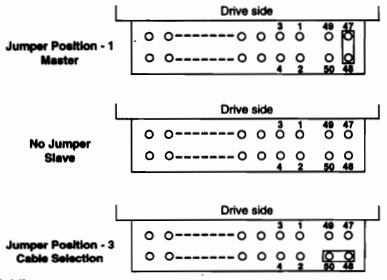
J2 Pin No.	-ID1 5	-ID2 6	-ID4 7	Device Address
	open	open	open	0
	gnd	open	open	1
	open	gnd	open	2
	gnd	gnd	open	3
	open	open	gnd	4
	gnd	open	gnd	5
	open	gnd	gnd	6
	gnd	gnd	gnd	7

Cabling
The maximum cable length from the host system to the drive is limited to 6 inches with external 1K-ohm pull up resistors.
In case that appropriate termination resistors are externally equipped to the interface lines, the cable length can be extended. The maximum cable length depends on the condition of the various electrical parameters of the interface.

Device Address
The drive recognizes its device address, namely SCSI ID, with the condition of -ID1, -ID2, and -ID4. The signal condition and the device address are shown above.

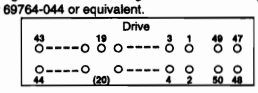
IBM DPRA 21215

Drive Address
A jumper cable is available at the interface connector to determine the drive address.
Using Cable Selection, the drive address depends on the condition of pin 28 of the AT interface cable. In the case when pin 28 is ground or low, the drive is a Master. If pin 28 is open or high level, the drive is a Slave.



Cabling
The maximum cable length from the host system to the HDD plus circuit pattern length in the host system shall not exceed 18 inches.

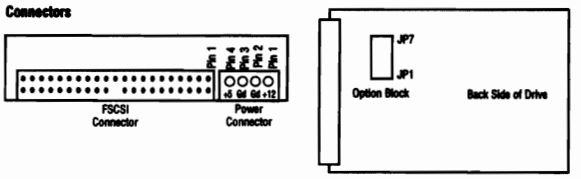
AT Signal Connector
The AT signal connector is designed to mate with Dupont part number 69764-044 or equivalent.



NOTES: Pin position 20 is left blank for secure connector insertion.
Pin position 47 through 50 are used for drive address setting.

IBM DSAS 3270

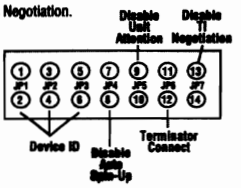
Connectors



The DC power connector is designed to mate with AMP part 1-480424 (using AMP pins P/N 350078-4). Equivalent connectors may be used. Pin assignments are shown above as viewed from the end of the drive.

SCSI Signal Connector
The SCSI Signal Connector is a 50 pin connector meeting the ANSI SCSI specification.
NOTE: It is intended that the hard disk drive should only be in electrical contact with the chassis of the PC at a designated set of mounting holes. Other electrical contact may degrade error rate performance. As a result of this it is recommended that there should be no metal contact to the hard disk drive except at the mounting holes or the side rails into which holes are taped.

Option Block
Jumper position and function are as shown below. Pin pitch is 2mm.
The jumpers control SCSI Device ID, Auto Spin-Up, Unit Attention, SCSI Terminator Connection and Target Initiated Synchronous Negotiation.



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IBM DSAS 3270 (Continued)

NOTE:

1. The jumper of JP1, 2, and 3, define SCSI ID of the drive.
   If JP1, JP2, JP3 are Off, Off, Off, the SCSI ID is 0 - default
   If JP1, JP2, JP3 are On, Off, Off, the SCSI ID is 1
   If JP1, JP2, JP3 are Off, On, Off, the SCSI ID is 2
   If JP1, JP2, JP3 are On, On, Off, the SCSI ID is 3
   If JP1, JP2, JP3 are Off, Off, On, the SCSI ID is 4
   If JP1, JP2, JP3 are On, Off, On, the SCSI ID is 5
   If JP1, JP2, JP3 are Off, On, On, the SCSI ID is 6
   If JP1, JP2, JP3 are On, On, On, the SCSI ID is 7
2. If JP4 is Off, the drive will spin up automatically after power on reset.
   If JP4 is On, the drive will not spin up unless the host system issues a start command to the drive.
3. If JP5 is On, Unit Attention after power on reset or SCSI bus reset is disabled.
4. If JP6 is On, the internal SCSI terminator works.
5. If JP7 is On, Target Initiated Synchronous Negotiation is disabled, and then the Initiator is required to start a negotiation handshake if Synchronous SCSI transfers are desired.

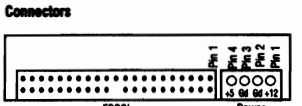
Default Setting

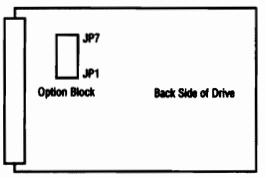
JP1	JP2	JP3	JP4	JP5	JP6	JP7	Position
1-2	3-4	5-6	7-8	9-10	11-12	13-14	Pin
OFF	OFF	OFF	OFF	OFF	ON	OFF	Jumper

TI Sync Nego Enabled
SCSI Terminator ON
Unit Attention Enabled
Auto Spin-Up Enabled
SCSI Device ID = 0

IBM DSAS 3360

Connectors





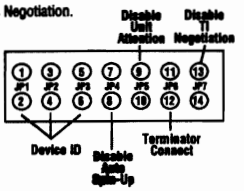
The DC power connector is designed to mate with AMP part 1-480424 (using AMP pins P/N 350078-4). Equivalent connectors may be used. Pin assignments are shown above as viewed from the end of the drive.

SCSI Signal Connector

The SCSI Signal Connector is a 50 pin connector meeting the ANSI SCSI specification.
NOTE: It is intended that the hard disk drive should only be in electrical contact with the chassis of the PC at a designated set of mounting holes. Other electrical contact may degrade error rate performance. As a result of this it is recommended that there should be no metal contact to the hard disk drive except at the mounting holes or the side rails into which holes are taped.

Option Block

Jumper position and function are as shown below. Pin pitch is 2mm.
The jumpers control SCSI Device ID, Auto Spin-Up, Unit Attention, SCSI Terminator Connection and Target Initiated Synchronous Negotiation.



IBM DSAS 3360 (Continued)

NOTE:

1. The jumper of JP1, 2, and 3, define SCSI ID of the drive.
   If JP1, JP2, JP3 are Off, Off, Off, the SCSI ID is 0 - default
   If JP1, JP2, JP3 are On, Off, Off, the SCSI ID is 1
   If JP1, JP2, JP3 are Off, On, Off, the SCSI ID is 2
   If JP1, JP2, JP3 are On, On, Off, the SCSI ID is 3
   If JP1, JP2, JP3 are Off, Off, On, the SCSI ID is 4
   If JP1, JP2, JP3 are On, Off, On, the SCSI ID is 5
   If JP1, JP2, JP3 are Off, On, On, the SCSI ID is 6
   If JP1, JP2, JP3 are On, On, On, the SCSI ID is 7
2. If JP4 is Off, the drive will spin up automatically after power on reset.
   If JP4 is On, the drive will not spin up unless the host system issues a start command to the drive.
3. If JP5 is On, Unit Attention after power on reset or SCSI bus reset is disabled.
4. If JP6 is On, the internal SCSI terminator works.
5. If JP7 is On, Target Initiated Synchronous Negotiation is disabled, and then the Initiator is required to start a negotiation handshake if Synchronous SCSI transfers are desired.

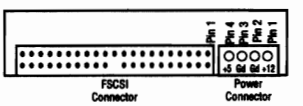
Default Setting

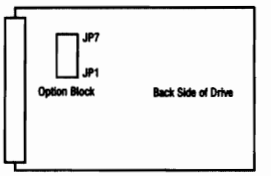
JP1	JP2	JP3	JP4	JP5	JP6	JP7	Position
1-2	3-4	5-6	7-8	9-10	11-12	13-14	Pin
OFF	OFF	OFF	OFF	OFF	ON	OFF	Jumper

TI Sync Nego Enabled
SCSI Terminator ON
Unit Attention Enabled
Auto Spin-Up Enabled
SCSI Device ID = 0

IBM DSAS 3540

Connectors





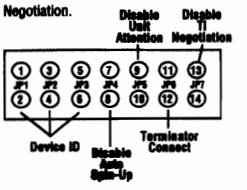
The DC power connector is designed to mate with AMP part 1-480424 (using AMP pins P/N 350078-4). Equivalent connectors may be used. Pin assignments are shown above as viewed from the end of the drive.

SCSI Signal Connector

The SCSI Signal Connector is a 50 pin connector meeting the ANSI SCSI specification.
NOTE: It is intended that the hard disk drive should only be in electrical contact with the chassis of the PC at a designated set of mounting holes. Other electrical contact may degrade error rate performance. As a result of this it is recommended that there should be no metal contact to the hard disk drive except at the mounting holes or the side rails into which holes are taped.

Option Block

Jumper position and function are as shown below. Pin pitch is 2mm.
The jumpers control SCSI Device ID, Auto Spin-Up, Unit Attention, SCSI Terminator Connection and Target Initiated Synchronous Negotiation.



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IBM DSAS 3540 (Continued)

If JP1, JP2, JP3 are Off, Off, Off, the SCSI ID is 0 - default
If JP1, JP2, JP3 are On, Off, Off, the SCSI ID is 1
If JP1, JP2, JP3 are Off, On, Off, the SCSI ID is 2
If JP1, JP2, JP3 are On, On, Off, the SCSI ID is 3
If JP1, JP2, JP3 are Off, Off, On, the SCSI ID is 4
If JP1, JP2, JP3 are On, Off, On, the SCSI ID is 5
If JP1, JP2, JP3 are Off, On, On, the SCSI ID is 6
If JP1, JP2, JP3 are On, On, On, the SCSI ID is 7

2. If JP4 is Off, the drive will spin up automatically after power on reset.
   If JP4 is On, the drive will not spin up unless the host system issues a start command to the drive.
3. If JP5 is On, Unit Attention after power on reset or SCSI bus reset is disabled.
4. If JP6 is On, the internal SCSI terminator works.
5. If JP7 is On, Target Initiated Synchronous Negotiation is disabled, and then the Initiator is required to start a negotiation handshake if Synchronous SCSI transfers are desired.

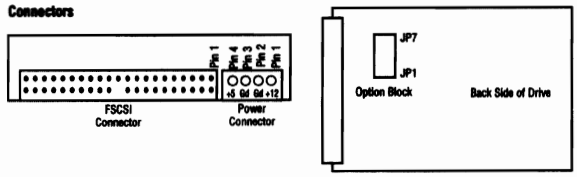
Default Setting

JP1	JP2	JP3	JP4	JP5	JP6	JP7	Position
1-2	3-4	5-6	7-8	9-10	11-12	13-14	Pin
OFF	OFF	OFF	OFF	OFF	ON	OFF	Jumper

TI Sync Nego Enabled
SCSI Terminator ON
Unit Attention Enabled
Auto Spin-Up Enabled
SCSI Device ID = 0

IBM DSAS 3720

Connectors



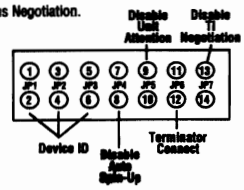
The DC power connector is designed to mate with AMP part 1-480424 (using AMP pins P/N 350078-4). Equivalent connectors may be used. Pin assignments are shown above as viewed from the end of the drive.

SCSI Signal Connector

The SCSI Signal Connector is a 50 pin connector meeting the ANSI SCSI specification.
NOTE: It is intended that the hard disk drive should only be in electrical contact with the chassis of the PC at a designated set of mounting holes. Other electrical contact may degrade error rate performance. As a result of this it is recommended that there should be no metal contact to the hard disk drive except at the mounting holes or the side rails into which holes are taped.

Option Block

Jumper position and function are as shown below. Pin pitch is 2mm.
The jumpers control SCSI Device ID, Auto Spin-Up, Unit Attention, SCSI Terminator Connection and Target Initiated Synchronous Negotiation.



IBM DSAS 3720 (Continued)

NOTE:

1. The jumper of JP1, 2, and 3, define SCSI ID of the drive.
   If JP1, JP2, JP3 are Off, Off, Off, the SCSI ID is 0 - default
   If JP1, JP2, JP3 are On, Off, Off, the SCSI ID is 1
   If JP1, JP2, JP3 are Off, On, Off, the SCSI ID is 2
   If JP1, JP2, JP3 are On, On, Off, the SCSI ID is 3
   If JP1, JP2, JP3 are Off, Off, On, the SCSI ID is 4
   If JP1, JP2, JP3 are On, Off, On, the SCSI ID is 5
   If JP1, JP2, JP3 are Off, On, On, the SCSI ID is 6
   If JP1, JP2, JP3 are On, On, On, the SCSI ID is 7
2. If JP4 is Off, the drive will spin up automatically after power on reset.
   If JP4 is On, the drive will not spin up unless the host system issues a start command to the drive.
3. If JP5 is On, Unit Attention after power on reset or SCSI bus reset is disabled.
4. If JP6 is On, the internal SCSI terminator works.
5. If JP7 is On, Target Initiated Synchronous Negotiation is disabled, and then the Initiator is required to start a negotiation handshake if Synchronous SCSI transfers are desired.

Default Setting

JP1	JP2	JP3	JP4	JP5	JP6	JP7	Position
1-2	3-4	5-6	7-8	9-10	11-12	13-14	Pin
OFF	OFF	OFF	OFF	OFF	ON	OFF	Jumper

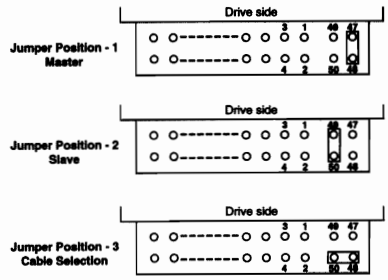
TI Sync Nego Enabled
SCSI Terminator ON
Unit Attention Enabled
Auto Spin-Up Enabled
SCSI Device ID = 0

IBM DVAA 2810

Drive Address

A jumper cable is available at the interface connector to determine the drive address.

Using Cable Selection, the drive address depends on the condition of pin 28 of the AT interface cable. In the case when pin 28 is ground or low, the drive is a Master. If pin 28 is open or high level, the drive is a Slave.

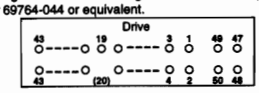


Cabling

The maximum cable length from the host system to the HDD plus circuit pattern length in the host system shall not exceed 18 inches.

AT Signal Connector

The AT signal connector is designed to mate with Dupont part number 69764-044 or equivalent.



NOTES: Pin position 20 is left blank for secure connector insertion.
Pin position 47 through 50 are used for drive address setting.

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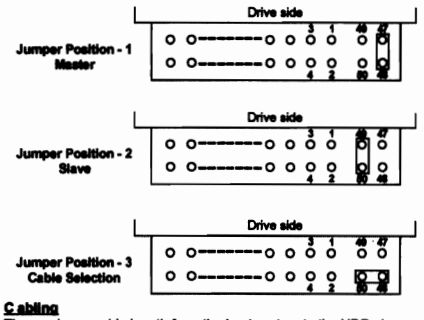
IBM H2172-A2

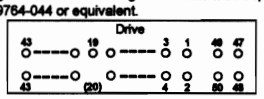
Drive Address
A jumper cable is available at the interface connector to determine the drive address.

Using Cable Selection, the drive address depends on the condition of pin 28 of the AT interface cable. In the case when pin 28 is ground or low, the drive is a Master. If pin 28 is open or high level, the drive is a Slave.



Cabling
The maximum cable length from the host system to the HDD plus circuit pattern length in the host system shall not exceed 18 inches.

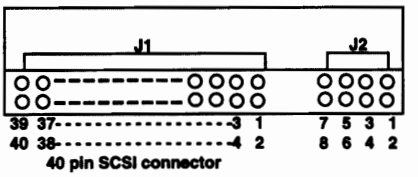
AT Signal Connector
The AT signal connector is designed to mate with Dupont part number 69764-044 or equivalent.



NOTES: Pin position 20 is left blank for secure connector insertion.
Pin position 47 through 50 are used for drive address setting.

IBM H2172-S2

Connector
The SCSI signal connectors is designed to mate with AMP part number 6-176135 or equivalent. Size and location of the mounting holes comply with MCC.

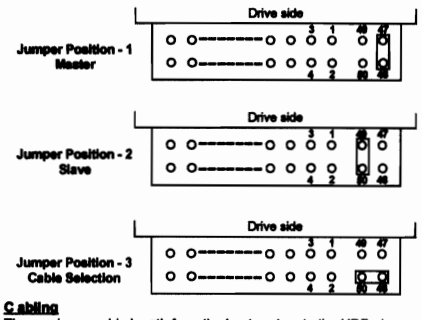


J2 Pin No.	-ID1 5	-ID2 6	-ID4 7	Device Address
	open	open	open	0
	gnd	open	open	1
	open	gnd	open	2
	gnd	gnd	open	3
	open	open	gnd	4
	gnd	open	gnd	5
	open	gnd	gnd	6
	gnd	gnd	gnd	7

IBM 2258-A3

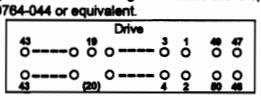
Drive Address
A jumper cable is available at the interface connector to determine the drive address.

Using Cable Selection, the drive address depends on the condition of pin 28 of the AT interface cable. In the case when pin 28 is ground or low, the drive is a Master. If pin 28 is open or high level, the drive is a Slave.



Cabling
The maximum cable length from the host system to the HDD plus circuit pattern length in the host system shall not exceed 18 inches.

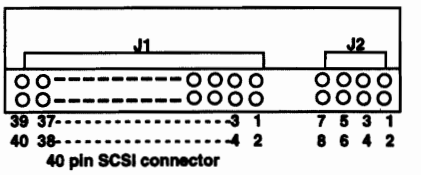
AT Signal Connector
The AT signal connector is designed to mate with Dupont part number 69764-044 or equivalent.



NOTES: Pin position 20 is left blank for secure connector insertion.
Pin position 47 through 50 are used for drive address setting.

IBM H2258-S3

Connector
The SCSI signal connectors is designed to mate with AMP part number 6-176135 or equivalent. Size and location of the mounting holes comply with MCC.



J2 Pin No.	-ID1 5	-ID2 6	-ID4 7	Device Address
	open	open	open	0
	gnd	open	open	1
	open	gnd	open	2
	gnd	gnd	open	3
	open	open	gnd	4
	gnd	open	gnd	5
	open	gnd	gnd	6
	gnd	gnd	gnd	7

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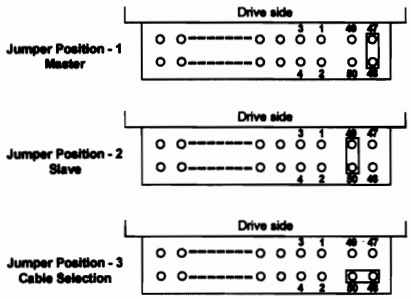
IBM H2344-A4

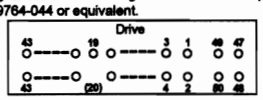
Drive Address
A jumper cable is available at the interface connector to determine the drive address.

Using Cable Selection, the drive address depends on the condition of pin 28 of the AT interface cable. In the case when pin 28 is ground or low, the drive is a Master. If pin 28 is open or high level, the drive is a Slave.



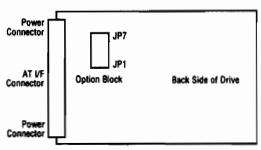
Cabling
The maximum cable length from the host system to the HDD plus circuit pattern length in the host system shall not exceed 18 inches.

AT Signal Connector
The AT signal connector is designed to mate with Dupont part number 69764-044 or equivalent.



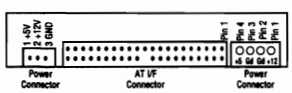
NOTES: Pin position 20 is left blank for secure connector insertion.
Pin position 47 through 50 are used for drive address setting.

IBM H3133-A2



Shipping Default Settings
MASTER is set to on (i.e. jumper on pins 1 and 2). No other jumpers are fitted.
NOTE: *LED connections, pin 13 can source up to 18mA. Pin 14 can sink up to 100mA.*
The jumper positions JP1, JP2, and JP3 must not be selected concurrently.

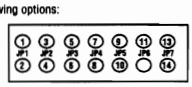
Connectors
There is a choice of 2 power connections to this drive. One DC power connector is designed to mate with AMP part 1-480424 (using AMP pins P/N 350078-4). The other (3 pin) DC power connector is designed to mate with MOLEX 5480-03 (using MOLEX pins 5479). Equivalent connectors may be used. Pin assignments are shown below, as viewed from the end of the drive.



AT Signal Connector
The drive uses single-ended drivers and receivers. The connector is designed to mate with 3M part 3417-7000 or equivalent.
NOTE: *It is intended that the hard disk drive should only be in electrical contact with the chassis of the PC at a disignated set of mounting holes. Other electrical contact may degrade error rate performance. As a result of this it is recommended that there should be no metal contact to the hard disk drive except at the mounting holes or the side rails into which the mounting holes are tapped.*

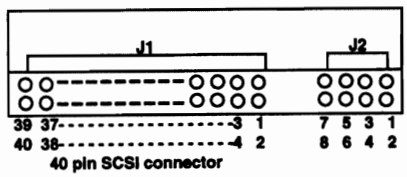
Option Block
Jumper Settings - Jumpers may be fitted to select the following options:

MASTER active	Pin Numbers 1 and 2
SLAVE activbe	Pin Numbers 3 and 4
Cable Select	Pin Numbers 5 and 6
LED drive lines	Pin Numbers 13 and 14



IBM H2344-S4

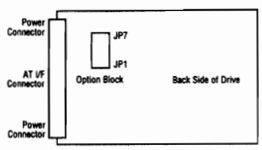
Connector
The SCSI signal connectors is designed to mate with AMP part number 6-176135 or equivalent. Size and location of the mounting holes comply with MCC.



40 pin SCSI connector

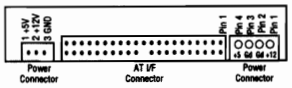
J2 Pin No.	-ID1 5	-ID2 6	-ID4 7	Device Address
	open	open	open	0
	gnd	open	open	1
	open	gnd	open	2
	gnd	gnd	open	3
	open	open	gnd	4
	gnd	open	gnd	5
	open	gnd	gnd	6
	gnd	gnd	gnd	7

IBM H3171-A2



Shipping Default Settings
MASTER is set to on (i.e. jumper on pins 1 and 2). No other jumpers are fitted.
NOTE: *LED connections, pin 13 can source up to 18mA. Pin 14 can sink up to 100mA.*
The jumper positions JP1, JP2, and JP3 must not be selected concurrently.

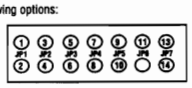
Connectors
There is a choice of 2 power connections to this drive. One DC power connector is designed to mate with AMP part 1-480424 (using AMP pins P/N 350078-4). The other (3 pin) DC power connector is designed to mate with MOLEX 5480-03 (using MOLEX pins 5479). Equivalent connectors may be used. Pin assignments are shown below, as viewed from the end of the drive.



AT Signal Connector
The drive uses single-ended drivers and receivers. The connector is designed to mate with 3M part 3417-7000 or equivalent.
NOTE: *It is intended that the hard disk drive should only be in electrical contact with the chassis of the PC at a disignated set of mounting holes. Other electrical contact may degrade error rate performance. As a result of this it is recommended that there should be no metal contact to the hard disk drive except at the mounting holes or the side rails into which the mounting holes are tapped.*

Option Block
Jumper Settings - Jumpers may be fitted to select the following options:

MASTER active	Pin Numbers 1 and 2
SLAVE activbe	Pin Numbers 3 and 4
Cable Select	Pin Numbers 5 and 6
LED drive lines	Pin Numbers 13 and 14



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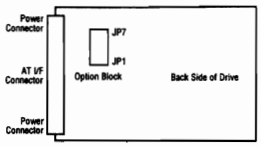
IBM H3256-A3



Shipping Default Settings

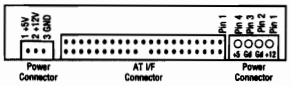
MASTER is set to on (i.e. jumper on pins 1 and 2). No other jumpers are fitted.

***NOTE:** LED connections, pin 13 can source up to 18mA. Pin 14 can sink up to 100mA.*

The jumper positions JP1, JP2, and JP3 must not be selected concurrently.

Connectors

There is a choice of 2 power connections to this drive. One DC power connector is designed to mate with AMP part 1-480424 (using AMP pins P/N 350078-4). The other (3 pin) DC power connector is designed to mate with MOLEX 5480-03 (using MOLEX pins 5479). Equivalent connectors may be used. Pin assignments are shown below, as viewed from the end of the drive.



AT Signal Connector

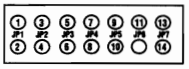
The drive uses single-ended drivers and receivers. The connector is designed to mate with 3M part 3417-7000 or equivalent.

***NOTE:** It is intended that the hard disk drive should only be in electrical contact with the chassis of the PC at a disignated set of mounting holes. Other electrical contact may degrade error rate performance. As a result of this it is recommended that there should be no metal contact to the hard disk drive except at the mounting holes or the side rails into which the mounting holes are tapped.*

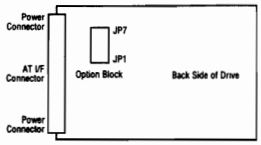
Option Block

Jumper Settings - Jumpers may be fitted to select the following options:

MASTER active	Pin Numbers 1 and 2
SLAVE activbe	Pin Numbers 3 and 4
Cable Select	Pin Numbers 5 and 6
LED drive lines	Pin Numbers 13 and 14



IBM H3342-A4



Shipping Default Settings

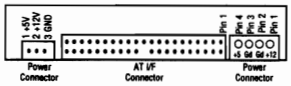
MASTER is set to on (i.e. jumper on pins 1 and 2). No other jumpers are fitted.

***NOTE:** LED connections, pin 13 can source up to 18mA. Pin 14 can sink up to 100mA.*

The jumper positions JP1, JP2, and JP3 must not be selected concurrently.

Connectors

There is a choice of 2 power connections to this drive. One DC power connector is designed to mate with AMP part 1-480424 (using AMP pins P/N 350078-4). The other (3 pin) DC power connector is designed to mate with MOLEX 5480-03 (using MOLEX pins 5479). Equivalent connectors may be used. Pin assignments are shown below, as viewed from the end of the drive.



AT Signal Connector

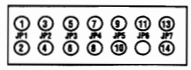
The drive uses single-ended drivers and receivers. The connector is designed to mate with 3M part 3417-7000 or equivalent.

***NOTE:** It is intended that the hard disk drive should only be in electrical contact with the chassis of the PC at a disignated set of mounting holes. Other electrical contact may degrade error rate performance. As a result of this it is recommended that there should be no metal contact to the hard disk drive except at the mounting holes or the side rails into which the mounting holes are tapped.*

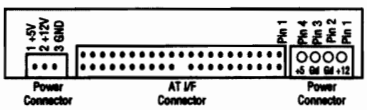
Option Block

Jumper Settings - Jumpers may be fitted to select the following options:

MASTER active	Pin Numbers 1 and 2
SLAVE activbe	Pin Numbers 3 and 4
Cable Select	Pin Numbers 5 and 6
LED drive lines	Pin Numbers 13 and 14



IBM WDA-L160



AT Signal Connector

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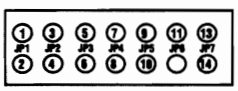
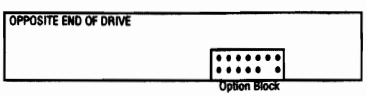
Option Block

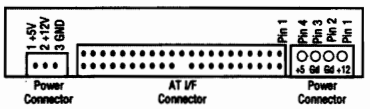
Jumper Settings - Jumpers may be fitted to select the following options:

IOCHRDY active	Pin Numbers 1 and 2
MASTER active	Pin Numbers 3 and 4
LED drive lines	Pin Numbers 13 and 14





IBM WDA-L80



AT Signal Connector

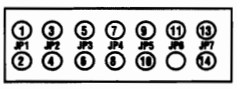
The drive uses single-ended drivers and receivers. The connector is designed to mate with 3M part 3417-7000 or equivalent.

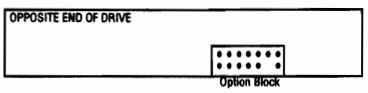
***NOTE:** It is intended that the hard disk drive should only be in electrical contact with the chassis of the PC at a disignated set of mounting holes. Other electrical contact may degrade error rate performance. As a result of this it is recommended that there should be no metal contact to the hard disk drive except at the mounting holes or the side rails into which the mounting holes are tapped.*

Option Block

Jumper Settings - Jumpers may be fitted to select the following options:

IOCHRDY active	Pin Numbers 1 and 2
MASTER active	Pin Numbers 3 and 4
LED drive lines	Pin Numbers 13 and 14





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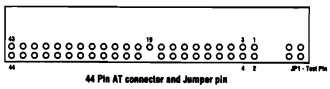
IBM WDA-240



44 Pin AT connector and Jumper pin

Electrical Interface

Drive Address - A jumper fitted to position JP1 will select drive address 0 (Master). If no jumper is installed the drive address is 1 (Slave).

Interface Connector - The drive connector is 2mm pitch. AMP, DuPont and Hirose all make suitable mating connector.

Cabling - Maximum cable length from host system to HDD shall not exceed 18 inches (45.7 cm).

Operating Modes

Description

Spin-Up - The time taken for the motor to reach full speed from a stopped or power down condition.

Seek, Read, Write - Seek, read or write operating modes.

Idle - Spindle motor and servo system working, all modules (except servo control and interface) are 'sleeping'. Commands can be received and processed immediately.

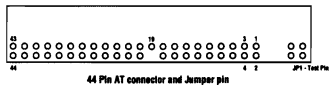
Standby - Spindle motor is stopped, all modules (except interface) are 'sleeping'. The drive is waiting for an interrupt and commands can be processed immediately. This is the lowest power dissipation mode.

Command Description

The following Commands are supported by the Drive:

Commands	(Hex)	Commands	(Hex)
Check Power Mode	(E5)	Recalibrate	(1X)
Execute Drive Diagnostics	(90)	Seek	(7X)
Format Track	(50)	Set Features	(EF)
Identify Drive	(EC)	Set Multiple	(C6)
Idle	(E3)	Sleep	(E6)
Idle Immediate	(E1)	Standby	(E2)
Initialize Drive Parameters	(91)	Standby Immediate	(E0)
Read Buffer	(E4)	Write Buffer	(E8)
Read Long (retry)	(22)	Write Long (retry)	(32)
Read Long (no retry)	(23)	Write Long (no retry)	(33)
Read Multiple	(C4)	Write Multiple	(C5)
Read Sectors (retry)	(20)	Write Sectors (retry)	(30)
Read Sectors (no retry)	(21)	Write Sectors (no retry)	(31)
Read Verify Sectors (retry)	(40)	Write Verify	(3C)
Read Verify Sectors (no retry)	(41)		

IBM WDA-280



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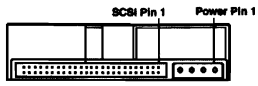
Command Description

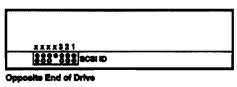
The following Commands are supported by the Drive:

Commands	(Hex)	Commands	(Hex)
Check Power Mode	(E5)	Recalibrate	(1X)
Execute Drive Diagnostics	(90)	Seek	(7X)
Format Track	(50)	Set Features	(EF)
Identify Drive	(EC)	Set Multiple	(C6)
Idle	(E3)	Sleep	(E6)
Idle Immediate	(E1)	Standby	(E2)
Initialize Drive Parameters	(91)	Standby Immediate	(E0)
Read Buffer	(E4)	Write Buffer	(E8)
Read Long (retry)	(22)	Write Long (retry)	(32)
Read Long (no retry)	(23)	Write Long (no retry)	(33)
Read Multiple	(C4)	Write Multiple	(C5)
Read Sectors (retry)	(20)	Write Sectors (retry)	(30)
Read Sectors (no retry)	(21)	Write Sectors (no retry)	(31)
Read Verify Sectors (retry)	(40)	Write Verify	(3C)
Read Verify Sectors (no retry)	(41)		

IBM WDS-380



Electrical Connectors (rear view) 50 Pin SCSI



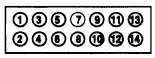
Opposite End of Drive

Jumper Settings

This section describes jumper settings.

A14 pin connector is populated on the card as illustrated below. These pins are used to select SCSI ID or for other optional features.

Pin pitch is 2mm.



Device ID and LED portion pin assignment.

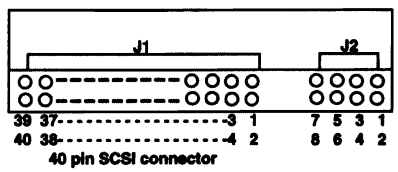
Pin #	Status	Description	Signal Name
1	In	–Device Address Select Line #0	–DAS0
2	–	Ground	GND
3	In	–Device Address Select Line #1	–DAS1
4	–	Ground	GND
5	In	–Device Address Select Line #2	–DAS2
6	–	Ground	GND
7	–	Polarity KEY	KEY
8	Out	–LED (might be used as SPN READY)	–LED
9	In	–Motor Start	–M_START
10	–	Ground	GND
11	In	–Hard Reset Input	–H_RESET
12	–	Ground	GND
13	Out	+LED	+LED
14	Out	–LED	–LED

IBM WDS-2120

Interface Connectors

The drive connector is 2mm pitch. AMP, DuPont and Hirose all make suitable mating connectors.

To select an address, the appropriate pin(s) must be connected to ground. The illustration below shows which pins to ground to select a particular drive address.



40 pin SCSI connector

J2

Pin: 1 unused
2 unused
3 INDEX
4 unused
5 Addr 0
6 Addr 1
7 Addr 2
8 LED

J2 Pin No.	Addr2	Addr1	Addr0	Device Address
	open	open	open	0
	gnd	open	open	1
	open	gnd	open	2
	gnd	gnd	open	3
	open	open	gnd	4
	gnd	open	gnd	5
	open	gnd	gnd	6
	gnd	gnd	gnd	7

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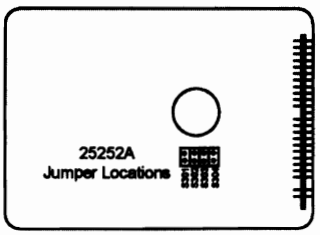
MAXTOR 25252A

25252A Jumper Designation

	S301	S302	S303	S304
Master/Slave				
Only drive in single drive system*	J			
Master in dual drive system	J			
Slave in dual drive system	O			
Reserved for Factory				
Normal operation*			O	O
Factory operatin			J	J
Idle Mode Latch				
Option Disabled		O		
Option Enabled*		J		

* = Default J = Jumpered O = Open



25252A
Physical Specifications

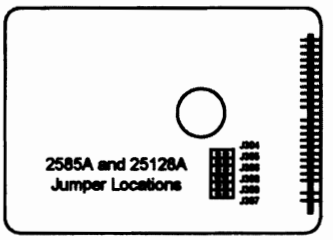
Height = 0.678" (17 mm)
Length = 4.00" (101.6 mm)
Width = 2.75" (69.84 mm)
Weight = 0.419 lbs. (190 gm)

MAXTOR 2585A/25128A

2585A and 25128A Jumper Designation

	J306	J307	J308	J309
Master/Slave				
Only drive in single drive system*			J	
Master in dual drive system			J	
Slave in dual drive system			O	
Reserved for Factory				
Normal operation*		O		O
Factory operatin		J		J
Idle Mode Latch				
Option Disabled*		O		
Option Enabled		J		

* = Default J = Jumpered O = Open
J304 and J305 reserved for future use.



2585A and 25128A
Physical Specifications

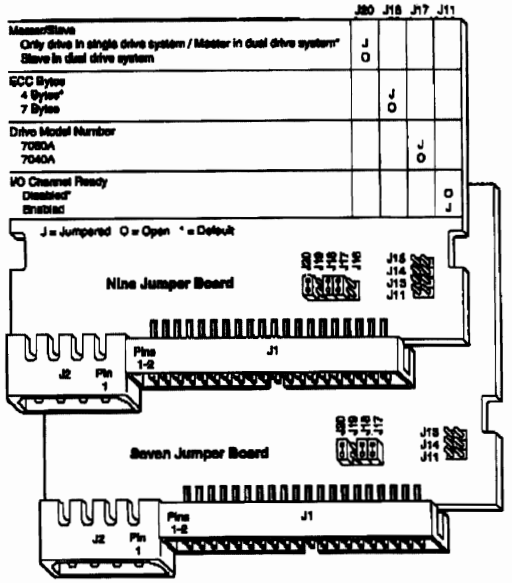
Height = 0.69" (17.5 mm)
Length = 4.00" (101.6 mm)
Width = 2.75" (69.84 mm)
Weight = 0.374 lbs. (170 gm)

MAXTOR 7040A

7080A/7040A Jumper Designation

	J20	J16	J17	J11
Master/Slave				
Only drive in single drive system / Master in dual drive system*	J			
Slave in dual drive system	O			
ECC Bytes				
4 Bytes*		J		
7 Bytes		O		
Drive Model Number				
7080A			J	
7040A			O	
I/O Channel Ready				
Disabled*				O
Enabled				J

J = Jumpered O = Open * = Default

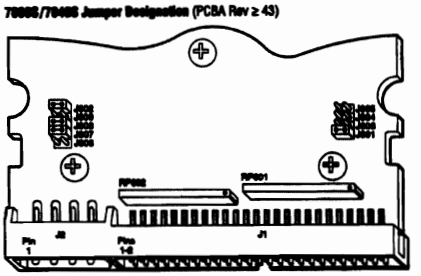


MAXTOR 7040S

7080S/7040S Jumper Positions (PCBA Rev ≥ 43)

Jumper	Position
J901	Terminator Power
J903	Diagnostic Mode (factory use only)
J905	Disable Parity
J904	reserved
J902	Power-up Option
J900	reserved
J908	Target ID Address (most significant bytes - MSB)
J907	Target ID Address
J906	Target ID Address (least significant bytes - LSB)

7080S/7040S Jumper Designation (PCBA Rev ≥ 43)



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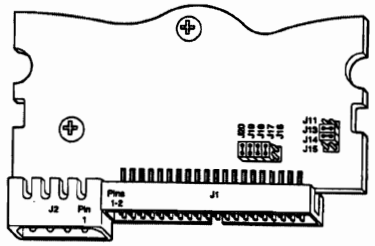
MAXTOR 7060A PCB<38

	J20	J19	J18	J17	J14	J13	J11
Master/Slave Only drive in single drive system Master in dual drive system Slave in dual drive system	J O	J O					
ECC Bytes 4 Bytes * 7 Bytes			J O				
Drive Model Number 7120A 7060A				J O			
Power-up Configuration 7120A Cyl Hds Sec MB 935 16 17 130.8 * 1024 14 17 124.8 762 8 39 121.7 900 15 17 117.5 7060A 457 16 17 65.0 * 1024 7 17 62.4 782 4 39 60.9 925 8 17 64.4					J O	J O	
I/O Channel Ready Disabled * Enabled							O J

*J= Jumpered O = Open * = Default*
Note: J15 and J16 are reserved. Abnormal operation may occur if altered.

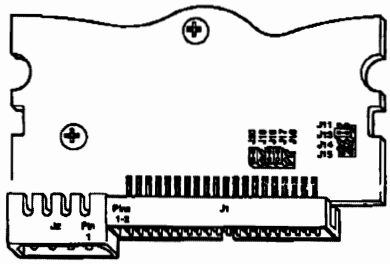


Jumper Locations: PCBA ≤ 38

MAXTOR 7060A PCB>48

	J20	J19	J18	J17	J14	J13	J11
Master in dual drive system Slave in dual drive system	J O						
ECC Bytes 4 Bytes * 7 Bytes			J O				
Drive Model Number 7120A 7060A				J O			
Power-up Configuration 7120A Cyl Hds Sec MB 935 16 17 130.8 * 1024 14 17 124.8 7060A 823 8 17 64.4 * 1024 7 17 62.4					J O J O		
I/O Channel Ready Disabled * Enabled							O J

*J = Jumpered O = Open * = Default*
Note: J14, J15, J16, and J19 are reserved. Abnormal operation may occur if altered.



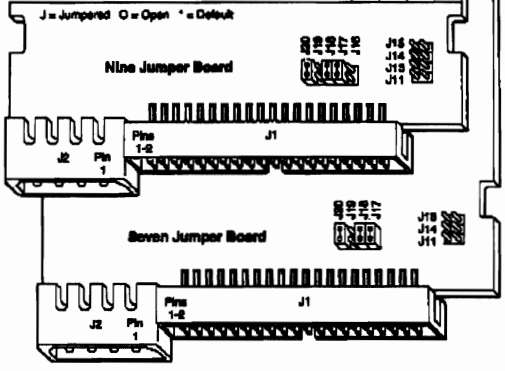
Jumper Locations: PCBA ≥ 48

MAXTOR 7080A

7080A/7040A Jumper Designation

	J20	J18	J17	J11
Master/Slave Only drive in single drive system / Master in dual drive system* Slave in dual drive system	J O			
ECC Bytes 4 Bytes* 7 Bytes		J O		
Drive Model Number 7080A 7040A			J O	
I/O Channel Ready Disabled* Enabled				O J

J = Jumpered O = Open * = Default

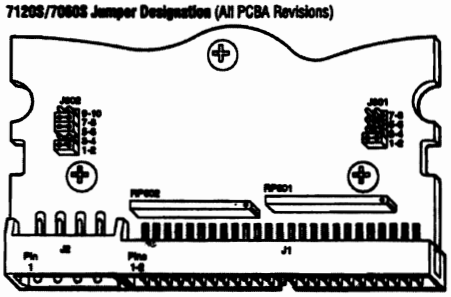


MAXTOR 7060S

7120S/7060S Jumper Functions (All PCBA Revisions)

Jumper Block	Pin Location	Function
J801	1 - 2	Terminator Power
J801	3 - 4	Diagnostic Mode (factory use only)
J801	5 - 6	Disable Parity
J801	7 - 8	reserved
J802	1 - 2	Power-up Option
J802	3 - 4	reserved
J802	5 - 6	Target ID Address (most significant bytes - MSB)
J802	7 - 8	Target ID Address
J802	9 - 10	Target ID Address (least significant bytes - LSB)

7120S/7060S Jumper Designation (All PCBA Revisions)



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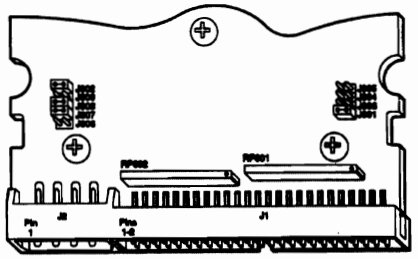
MAXTOR 7080S

7080S/7040S Jumper Functions (PCBA Rev ≥ 43)

Jumper	Function
J801	Terminator Power
J803	Diagnostic Mode (factory use only)
J805	Disable Parity
J804	reserved
J802	Power-up Option
J809	reserved
J808	Target ID Address (most significant bytes - MSB)
J807	Target ID Address
J806	Target ID Address (least significant bytes - LSB)

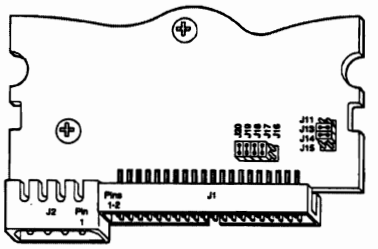
7080S/7040S Jumper Designation (PCBA Rev ≥ 43)



MAXTOR 7120A PCB<38

	J20	J19	J18	J17	J14	J13	J11
Master/Slave Only drive in single drive system Master in dual drive system Slave in dual drive system	J J O	J O J					
ECC Bytes 4 Bytes * 7 Bytes			J O				
Drive Model Number 7120A 7060A				J O			
Power-up Configuration 7120A Cyl Hds Sec MB 936 16 17 130.9 * 1024 14 17 124.8 762 8 39 121.7 900 15 17 117.5 7080A 457 16 17 65.0 * 1024 7 17 62.4 762 4 39 60.9 925 9 17 64.4					J O J O J O J O	J O O J O O O J	
I/O Channel Ready Disabled * Enabled							O J

*J = Jumpered O = Open * = Default*
Note: J15 and J16 are reserved. Abnormal operation may occur if altered.

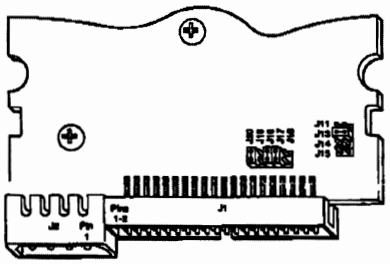


Jumper Locations: PCBA ≤ 38

MAXTOR 7120A PCB>48

	J20	J16	J17	J13	J11
Master/Slave Only drive in single drive system Master in dual drive system Slave in dual drive system	J J O				
ECC Bytes 4 Bytes * 7 Bytes		J O			
Drive Model Number 7120A 7060A			J O		
Power-up Configuration 7120A Cyl Hds Sec MB 936 16 17 130.9 * 1024 14 17 124.8 7060A 925 9 17 64.4 * 1024 7 17 62.4				J O J O	
I/O Channel Ready Disabled * Enabled					O J

*J = Jumpered O = Open * = Default*
Note: J14, J15, J16, and J19 are reserved. Abnormal operation may occur if altered.



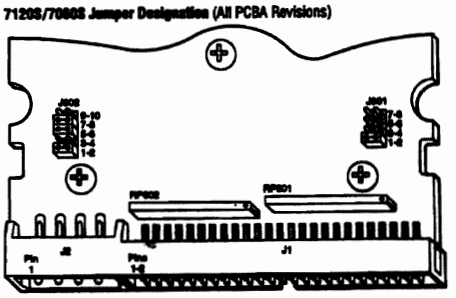
Jumper Locations: PCBA ≥ 48

MAXTOR 7120S

7120S/7060S Jumper Functions (All PCBA Revisions)

Jumper Block	Pin Location	Function
J801	1 - 2	Terminator Power
J801	3 - 4	Diagnostic Mode (factory use only)
J801	5 - 6	Disable Parity
J801	7 - 8	reserved
J802	1 - 2	Power-up Option
J802	3 - 4	reserved
J802	5 - 6	Target ID Address (most significant bytes - MSB)
J802	7 - 8	Target ID Address
J802	9 - 10	Target ID Address (least significant bytes - LSB)

7120S/7060S Jumper Designation (All PCBA Revisions)



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MAXTOR 7213S

JUMPER LOCATIONS and FUNCTIONS

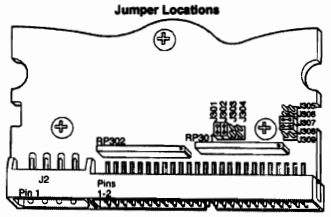
Jumper Functions		
Jumper	**Function**	**Factory Default**
J301/J26	Terminator Power	Installed
J302/J25	Power-up Option	Installed
J303/J24	Disable Parity	Removed
J304/J23	Reserved	Removed
J305/J22	Reserved	Removed
J306/J20	Reserved	Removed
J307/J19	Target ID Address (MSB)	Installed
J308/J18	Target ID Address	Installed
J309/J17	Target ID Address (LSB)	Removed

Jumper locations may have a 2-digit or 3-digit designator dependent on PCBA revision.

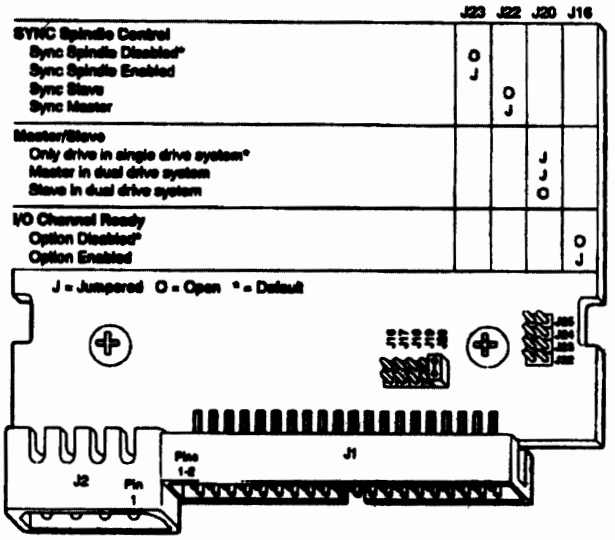
PHYSICAL SPECS
Height - 1.00" (2.54 cm)
Length - 5.75" (14.61 cm)
Width - 4.00" (10.16 cm)
Weight - 1.2 lbs. (.57 kg)

SCSI ID	PRIORITY	J307	J308	J309
0	Lowest	O	O	O
1		O	O	J
2		O	J	O
3		O	J	J
4		J	O	O
5		J	O	J
6		J	J	O
7	Highest	J	J	J

Jumper Locations



MAXTOR 7245A



MAXTOR 7245S

JUMPER LOCATIONS and FUNCTIONS

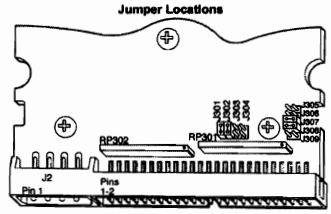
Jumper Functions		
Jumper	**Function**	**Factory Default**
J301/J26	Terminator Power	Installed
J302/J25	Power-up Option	Installed
J303/J24	Disable Parity	Removed
J304/J23	Reserved	Removed
J305/J22	Reserved	Removed
J306/J20	Reserved	Removed
J307/J19	Target ID Address (MSB)	Installed
J308/J18	Target ID Address	Installed
J309/J17	Target ID Address (LSB)	Removed

Jumper locations may have a 2-digit or 3-digit designator dependent on PCBA revision.

PHYSICAL SPECS
Height - 1.00" (2.54 cm)
Length - 5.75" (14.61 cm)
Width - 4.00" (10.16 cm)
Weight - 1.2 lbs. (.57 kg)

SCSI ID	PRIORITY	J307	J308	J309
0	Lowest	O	O	O
1		O	O	J
2		O	J	O
3		O	J	J
4		J	O	O
5		J	O	J
6		J	J	O
7	Highest	J	J	J

Jumper Locations



MAXTOR 7290S

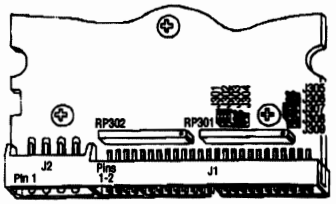
JUMPER LOCATIONS and FUNCTIONS

7290S Jumper Functions

Jumper	Function	As shipped
J301	Terminator Power	Installed
J302	Power-up Option	Installed
J303	Disable Parity	Removed
J304	Reserved	Removed
J305	Reserved	Removed
J306	Reserved	Removed
J307	Target ID Address (MSB)	Installed
J308	Target ID Address	Installed
J309	Target ID Address (LSB)	Removed

Drive Addressing

SCSI ID	Priority	J307	J308	J309
0	Lowest	O	O	O
1		O	O	J
2		O	J	O
3		O	J	J
4		J	O	O
5		J	O	J
6		J	J	O
7	Highest	J	J	J



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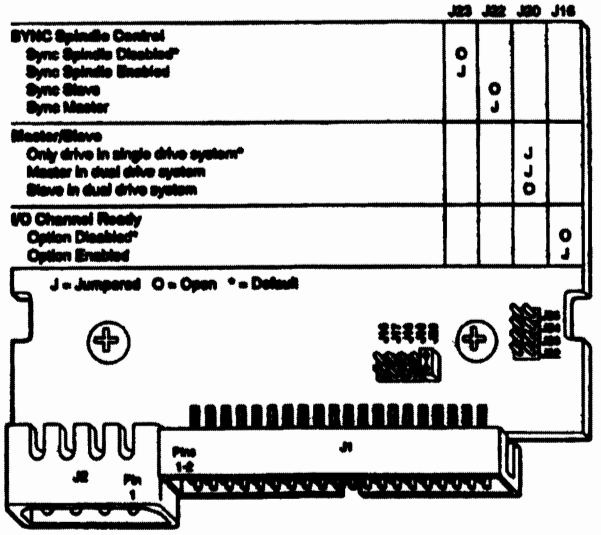
MAXTOR 7345A

7345A Jumper Designation



MAXTOR 7345S

JUMPER LOCATIONS and FUNCTIONS

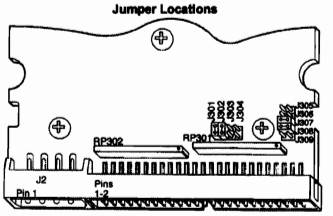
Jumper Functions		
Jumper	**Function**	**Factory Default**
J301/J26	Terminator Power	Installed
J302/J25	Power-up Option	Installed
J303/J24	Disable Parity	Removed
J304/J23	Reserved	Removed
J305/J22	Reserved	Removed
J306/J20	Reserved	Removed
J307/J19	Target ID Address (MSB)	Installed
J308/J18	Target ID Address	Installed
J309/J17	Target ID Address (LSB)	Removed

Jumper locations may have a 2-digit or 3-digit designator dependent on PCBA revision.

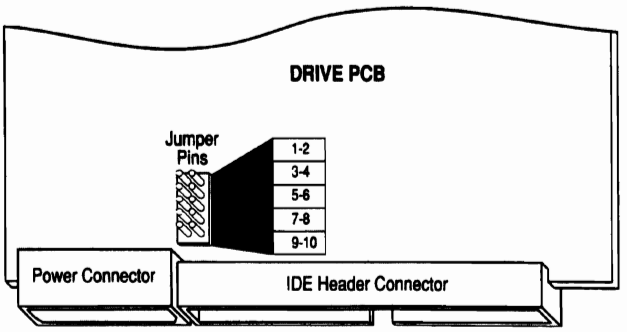
PHYSICAL SPECS
Height - 1.00" (2.54 cm)
Length - 5.75" (14.61 cm)
Width - 4.00" (10.16 cm)
Weight - 1.2 lbs. (.57 kg)

SCSI ID	PRIORITY	J307	J308	J309
0	Lowest	O	O	J
1		O	O	J
2		O	J	O
3		O	J	J
4		J	O	O
5		J	O	J
6		J	J	O
7	Highest	J	J	J

Jumper Locations



MAXTOR LXT DRIVES



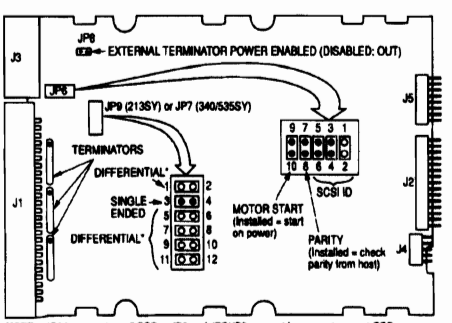
PIN NUMBERS		JUMPER	SINGLE DRIVE SYSTEM	DUAL DRIVE SYSTEM	
				MASTER	SLAVE
1	2	Slave Drive	Removed	Removed	Installed
3	4	Drive Active LED	Optional	Optional	Optional
5	6	Slave Present	Removed	Removed	Optional
7	8	Master Drive	Removed	Installed	Removed
9	10	Synchronous Spindle	Removed (N/A)	Optional*	Removed

* Only one drive (the master) in an array should have this jumper installed.

MAXTOR LXT-213SY

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: JP8 is present on all PCBs. JP6 and JP7/JP9 may not be present on your PCB.
** Optional differential operation requires a tailgate PCB to be installed.*

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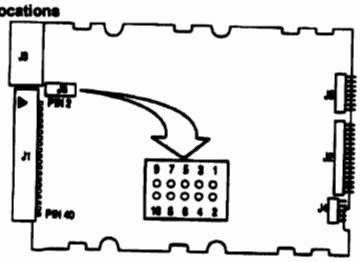
MAXTOR LXT-340A

Jumper Locations



Jumper Designation

Pins	1, 2	3, 4	5, 6	7, 8	9, 10
Master/Slave					
Only drive in single system*	R				
Master in dual drive system	R				
Slave in dual drive system	J				
Drive Active					
One drive in a single drive sys		O			
Master in dual drive system		O			
Slave in dual drive system		O			
Slave Present					
One drive in a single drive sys			R		
Master in dual drive system			R		
Slave in dual drive system			O		
Two Drive System					
One drive in a single drive sys				R	
Master in a dual drive system				J	
Slave in a dual drive system				R	
Sync Spindle Pulse Source					
If receiving the pulse					R
If transmitting a pulse*					J

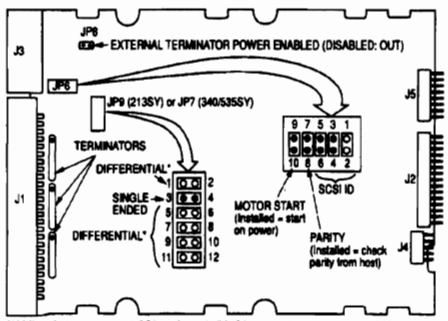
J = Jumpered R = Removed O = Optional

* This jumper may be installed in only one drive in an array!

MAXTOR LXT-340SY

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

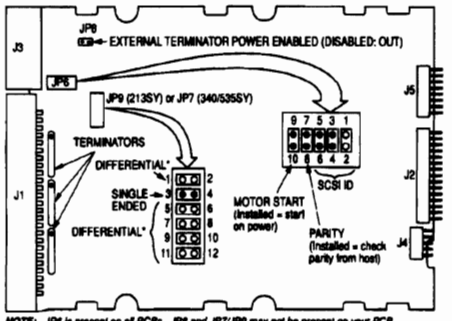


NOTE: JP6 is present on all PCBs. JP8 and JP7/JP9 may not be present on your PCB.
* Optional differential operation requires a tailgate PCB to be installed.

MAXTOR LXT-535SY

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

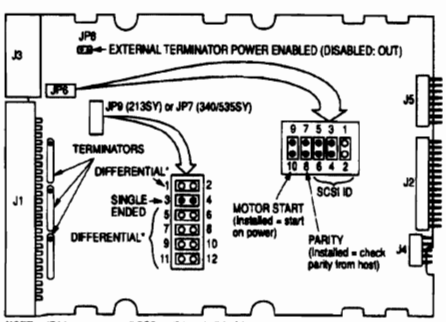


NOTE: JP6 is present on all PCBs. JP8 and JP7/JP9 may not be present on your PCB
* Optional differential operation requires a tailgate PCB to be installed.

MAXTOR LXT-437SY

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.

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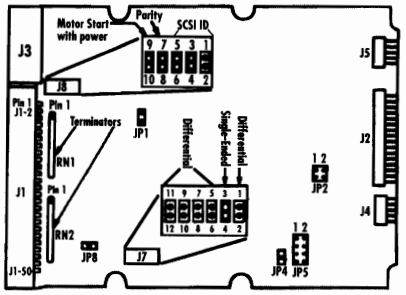
MAXTOR MXT-540SL



**SCSI ID 6 is shown in this figure.*
***Requires a tailgate differential PCB to be installed.*
All solid jumper blocks indicate that the drive is shipped with those jumpers installed.

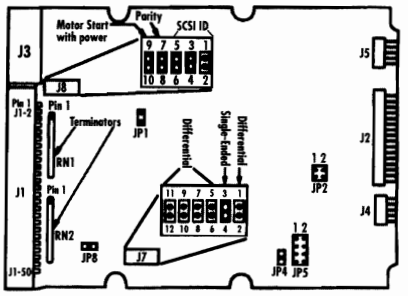
SCSI ID SELECTION

SCSI ID jumpers (pins one through six on JP6) are provided to configure each disk drive with a SCSI device ID for use in multiple SCSI device configurations.

The table below is a reference table for the SCSI ID jumper configuration, the ID, and the priority on the SCSI bus. An ID of seven is the highest priority in a multiple device configuration, and is usually used by the initiator.

SCSI ID	PRIORITY	PINS 5&6	PINS 3&4	PINS 1&2
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

MAXTOR MXT-1240A



**SCSI ID 6 is shown in this figure.*
***Requires a tailgate differential PCB to be installed.*
All solid jumper blocks indicate that the drive is shipped with those jumpers installed.

SCSI ID SELECTION

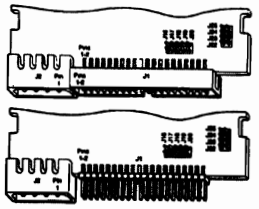
SCSI ID jumpers (pins one through six on JP6) are provided to configure each disk drive with a SCSI device ID for use in multiple SCSI device configurations.

The table below is a reference table for the SCSI ID jumper configuration, the ID, and the priority on the SCSI bus. An ID of seven is the highest priority in a multiple device configuration, and is usually used by the initiator.

SCSI ID	PRIORITY	PINS 5&6	PINS 3&4	PINS 1&2
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

MAXTOR MXT-7345A

Jumper Locations



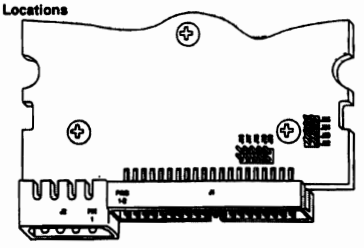
Jumper Designation

	J24	J23	J22	J20	J18	J17	J16
Cable Select							
Disabled*	O						
Enabled	J						
Write Cache							
Enabled*		O					
Disabled		J					
Drive Compatibility							
Disabled*			O				
Enabled			J				
Master/Slave							
Only drive in single system*				J			
Master in dual drive system				J			
Slave in dual drive system				O			
Low Power Spin Mode							
Disabled*					O		
Enabled					J		
ECC							
11-Byte*						O	
4-Byte emulation						J	
I/O Channel Ready							
Option Disabled*							O
Option Enabled							J

* = Default J = Jumpered O = Open
NOTE: Jumper J25 factory reserved. Jumper J19 is a spare shunt

MAXTOR MXT-7546A

Jumper Locations



Jumper Designation

	J24	J23	J20	J19	J18	J16
Cable Select						
Disabled*	O					
Enabled	J					
Write Cache						
Enabled*		O				
Disabled		J				
Master/Slave						
Only drive in single system*			J			
Master in dual drive system			J			
Slave in dual drive system			O			
Deferred Spin Up						
Disabled*				O		
Enabled				J		
Automatic Idle Mode						
Disabled*					O	
Enabled					J	
I/O Channel Ready						
Option Disabled*						O
Option Enabled						J

* = Default J = Jumpered O = Open
NOTE: Jumpers J25, J22 and J17 factory reserved. Do not use.

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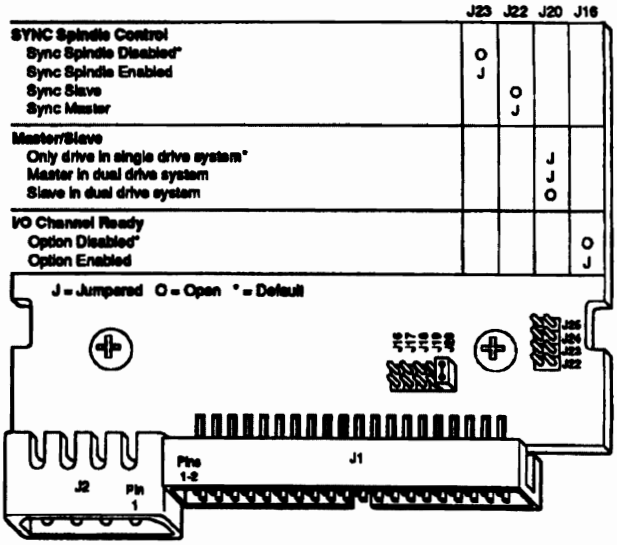
MAXTOR 7213A



MICROPOLIS 1598-15

Jumper Addressing and Interface Termination

ID0, ID1, ID2 - SCSI Address Jumpers

The SCSI ID (drive address) jumpers are identified as ID0, ID1, and ID2. ID selection is binary as shown in the table below.

For multiple drive installations, on one Host Adapter, each drive must have a unique address. Drives are configured as SCSI ID 7 at the factory.

RN9 Interface - Terminator

The Interface Terminator factory installed at RN9 provides proper termination for the interface lines. When daisy-chaining multiple drives, leave the terminator installed only in the last physical drive on the daisy chain cable; remove the terminator from each of the other drives.

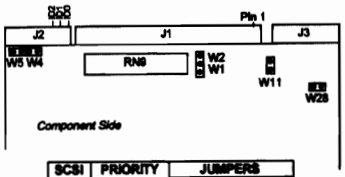
W1, W2 - Terminator Option

W1 and W2 select the source of terminator power (+5V) for the interface terminator. If a jumper is installed at W1 (the factory default configuration), and no jumper is installed at W2 the drive provides terminator power. This configuration is used for PC/AT applications. If a jumper is on W2 the host adapter will supply terminator power. If a jumper is installed at W2 and W11, and no jumper is installed at W1 the drive provides terminator power to it's on-board terminators and also to the SCSI bus via interface connector J1, pin 26.

W11 - Bus Option

W11 allows the drive to supply interface terminator power to the SCSI bus. If W11 is not installed and W1 is jumpered (the factory default configuration), the drive does supply SCSI bus interface terminator power. W11 should not be installed for PC/AT application.

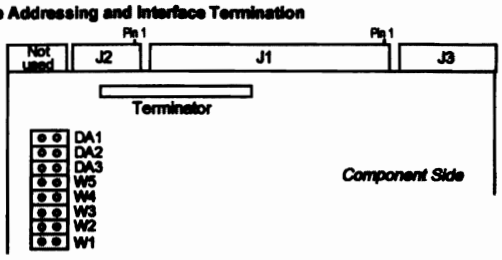
(Continued on reverse)



SCSI ID	PRIORITY	JUMPERS ID2	ID1	ID0
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

MICROPOLIS 1664-7

Drive Addressing and Interface Termination



RN1 - Interface Terminator.

The interface terminator factory installed at RN1 will provide proper termination for the interface lines. When daisy-chaining multiple drives, leave the terminator installed only in the last physical drive on the daisy chain; remove the terminator from each of the other drives. In most PC/AT installations, the C: drive is actually at the end of the cable and should retain the terminator.

DA1, DA2, DA3 - Drive Address Jumpers.

The drive address jumpers are identified as DA1, DA2, and DA3. Address selection is binary, as shown in the table below. The ESDI controller's documentation will specify the drive address to use.

Drive Address	Select Jumpers DA3	DA2	DA1
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	In	In	In

MICROPOLIS 1664-7 (Continued)

"Drive Address 0" (no jumper at DA1, DA2, or DA3) is a "deselect" (i.e., no drive selected). Drives are factory configured as Drive Address 1. For many multiple drive installations, each drive must have a unique address. An exception is that for every drive in a PC/AT installation, verify that the only Drive Address is at DA2; move the jumper if necessary (the special twisted interface cable that is generally used takes care of assigning a unique address to each drive). PC/AT controller can typically support a maximum of two drives.

W5 - Selects the Spindle Control Option.

W5 selects the spindle control option. If W5 is installed, the drive waits for a Start Spindle command (after power is applied) to start the spindle motor. If W5 is not installed (the factory default configuration), the drive automatically starts the spindle motor at power-on. W5 is not installed for PC/AT applications.

W1 - Selects the Sectoring Mode.

If W1 is installed, the drive operates in the soft-sectored mode. If W1 is not installed (the factory default configuration), the drive operates in the hard-sector mode. S1 is not installed for most PC/AT in applications.

W2, W3, and W4 - Sector Size and Number Options

The number of bytes per sector may be specified using the Set Bytes Per Sector command or by selecting a default sector configuration with jumpers W2, W3, and W4 as follows:

Jumpers W4	W3	W2	Sectors per track	Bytes/Sector Formatted	Unformatted
Out	Out	Out	53	512	588
Out	Out	In	54	512	576
Out	In	Out	28	1024	1116
Out	In	In	14	2048	2232
In	Out	Out	7	4096	4464
			Reserved		
In	In	Out	97	256	321
In	In	In	1	31,248	31,248

* This is the default (factory installed) configuration and is recommended for PC/AT applications.

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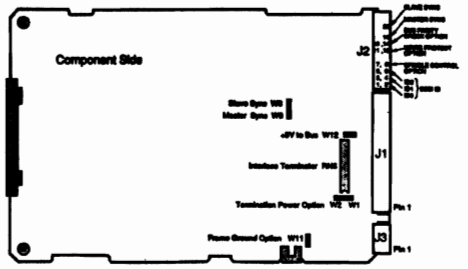
MICROPOLIS 1924

Device Addressing and Interface Termination

Up to eight devices (the host and seven targets) cn be attached to the SCSI bus. The 1924 drive has three id jumpers - ID0, ID1, and ID2. These jumpers are used to assign one of the eight SCSI ID bits (0 through 7) to the drive. *(see table)* In multiple-device systems, each drive must have it own unique ID.

SCSI ID	JUMPERS ID2	ID1	ID0
0*	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	in	in	in

*Factory default configuration



The electrical interface between the 1924 drive and the host system is accomplished via five connectors: J1, J2, J3, J4, and J5.

Signal Connector J1 is a 50-pin connector. The signals on J1 include the 8-bit SCSI bus and various control and handshaking lines.

J2 is a 24-pin, multi-function connector/jumper block.

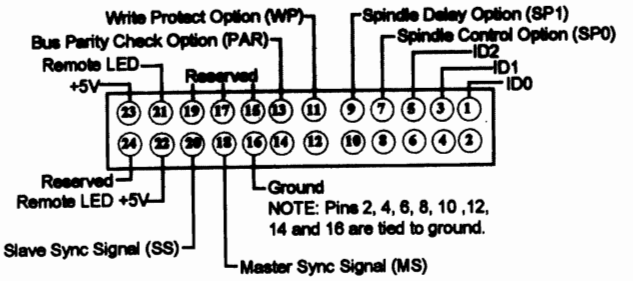
J3 is a 4-pin, keyed, AMP MATE-N-LOCK connector. Both +5V and +12V are supplied to the drive via this connector.

J4 and J5 are provided for grounding; J4 is located on the HDA, and J5 is located on the frame.

Drive Option Selection

Interface Terminator pack RN6 provides proper termination for the interface lines. For a multiple-drive system, the terminator pack is installed in the last drive on the cable.

MICROPOLIS 1991



J2 Multi-Function Connector

MICROPOLIS 1991 (Continued)

Configuration/Options

• **SCSI Address.** Jumpers at ID0, ID1, and ID2 select the SCSI address. Each SCSI device on one Host Adapter must have a unique address.

SCSI ID	PRIORITY	JUMPERS ID2	ID1	ID0
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

• **Interface Termination.** If terminators are installed at RN1 and RN2 (default), the drive provides termination for the SCSI interface. If the terminators are not installed, the drive does not provide interface termination.

SCSI terminators are installed only in the end devices on the SCSI cable; remove the terminators from each of the other devices. The SCSI Host Adapter card and the last drive in the chain should have terminators.

• **Terminator Power.** W1 and W2 select the source of terminator power (+5V) for interface terminators RN1 and RN2; W3 controls the drive supplying +5V to the bus.

W1	W2	W3	
Y	N	-	Drive provides terminator power. (Default)
N	Y	-	Host provides terminator per via J1 pin 26 to RN1 and RN2.
-	-	Y	Drive supplies +5V to the bus via J1 pin 26. (Default)

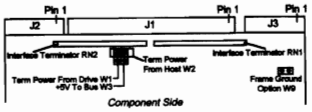
• **Frame Ground Option.** A jumper at W9 selects the frame ground option.

Jumper	Frame ground connected to logic ground.
No jumper	Frame ground not connected to logic ground. (Default)

• **Spindle Options.** Jumpers at SP0 (J2 pins 7 and 8) and SP1 (J2 pins 9 and 10) control the spindle options.

SP0	SP1	
N	N	The drive starts the spindle motor at power-on. (Default)
Y	N	The drive waits for a Start Unit SCSI command to start the spindle motor.
N	Y	Spindle start-up is delayed based on SCSI ID address. (12 seconds per ID)

(Continued on reverse)



Component Side

MICROPOLIS 1991 (Continued)

• **Write Protect.** A jumper at WP (J2 pins 11 and 12) selects the write protect option..

Jumper	The drive is write protected.
No jumper	The drive is not write protected. (Default)

• **Parity.** A jumper at PAR (J2 pins 13 and 14) selects the bus parity chech option. The drive **always generates** parity regardless of this option.

Jumper	SCSI interface parity checking disabled.
No jumper	SCSI interface parity checking on. (Default)

• **Spindle Sync Termination.** Jumpers at MS (Master Sync, J2 pin 18) and SS (Slave Sync, J2 pin 20) control spindle sync termination. This depends on system configuration; i.e. Master Mode or Master Controller Mode.

MS	SS	
Y	Y	Spindle sync is terminated. (Default)
N	N	Spindle sync not terminated.

• **Remote LED.** A user-supplied LED may be connected to Remote LED (J2 pin 21).

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MICROPOLIS 2112A

Drive emulates both Master and Slave: Specifies that one 2112A drive can emulate both the Master drive (Drive 0) and the Slave drive (Drive 1). This option allows for existing host systems to utilize the full capacity of the drive.
When the drive is configured as both the Master and the Slave, the Master's (Drive 0) capacity is set to 1024 logical cylinders, 16 logical heads, and 63 logical sectors. This setting yields 528,482,304 bytes. The Slave's (Drive 1) capacity is set to the remaining storage on the disk drive.
For this configuration, the recommended drive type setting in the computer's CMOS memory is as follows:

Drive 0: 1024 logical cylinders, 16 logical heads, 63 logical sectors
Drive 1: 1010 logical cylinders, 16 logical heads, 63 logical sectors

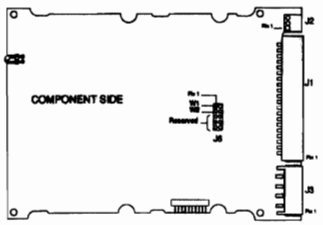
NOTE

The capacity of the 2112A drive may exceed the capacity that the host can access. This limitation stems from the communication link between the DOS and the BIOS. A typical limit is 1024 cylinders, 16 heads, and 63 sectors. For optimum use of the following options, the BIOS may need to be modified.

Drive is Master, Slave is present: Specifies the Master drive (Drive 0) when two 2112A drives are used in a system. The other drive is Slave.

Drive is Slave: Specifies the Slave drive (Drive 1) when two 2112A drives are used in a system. The other drive is Master.

Drive is Master: Specifies the Master drive (Drive 0) when one 2112A drive is used in a system.



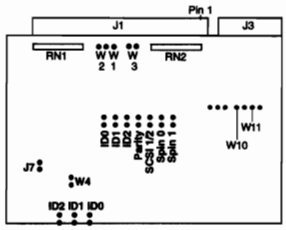
DRIVE CONFIGURATION		
W1	W2	Description
In	In	Drive emulates both Master and Slave*
In	Out	Drive is Master, Slave is present
Out	In	Drive is Slave
Out	Out	Drive is Master

*The factory default configuration

MICROPOLIS 2217

Drive Addressing and Interface Termination
ID0, ID1, ID2 - SCSI Address Jumpers
The SCSI ID (drive address) jumpers are identified as ID0, ID1, and ID2.
ID selection is binary as shown in the table below.
For multiple drive installations, on one Host Adapter, each drive must have a unique address. Drives are configured as SCSI ID 7 at the factory.
RN1, RN2, (RN3) Interface Terminator
The Interface Terminator factory installed at RN1, RN2, and RN3 provides proper termination for the interface lines. When daisy-chaining multiple drives, leave the terminators installed only in the last physical drive on the daisy chain cable; remove all three terminators from each of the other drives (or host computer). Note that there is no RN3 on the revision 2 board.
Bus Termination Power Option
A jumper is installed at W1, at W2, or at W2 and W3 to select the source of terminator power (+5V) for the SCSI Bus terminator packs on the device electronics board.
When a jumper is installed at W1 (the factory default configuration), the drive provides terminator power to it's on-board terminators.
When a jumper is installed at W2, terminator power is provided by the host system via the interface cable J1, pin 26 (TERMPWR).
When a jumper is installed at both W2 and W3, the drive provides terminator power to its on-board terminators and also to the SCSI bus via interface cable J1, pin 26 (TERMPWR).

SCSI ID	PRIORITY	JUMPERS		
		ID2	ID1	ID0
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



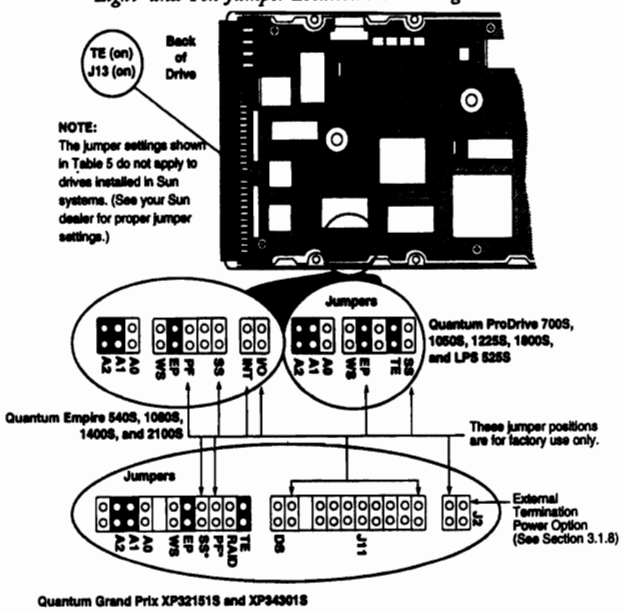
Connectors
J1 = 50 Pin Ribbon Cable
J3 = 4 Pin Power Cable
J7 = External LED Light

Resistors
RN (1-2) = Terminators (x2)

Jumpers
ID (0-2) = SCSI ID
Parity = Parity enable/disable
SCSI 1/2 = Write Protect
Spin 0 = Spindle Control
Spin 1 = Spindle Delay
W1/W2 = Termination Power
W3 = +5V to Bus
W4 = Bezel LED Option
W10 = Slave Sync Term
W11 = Master Sync Term

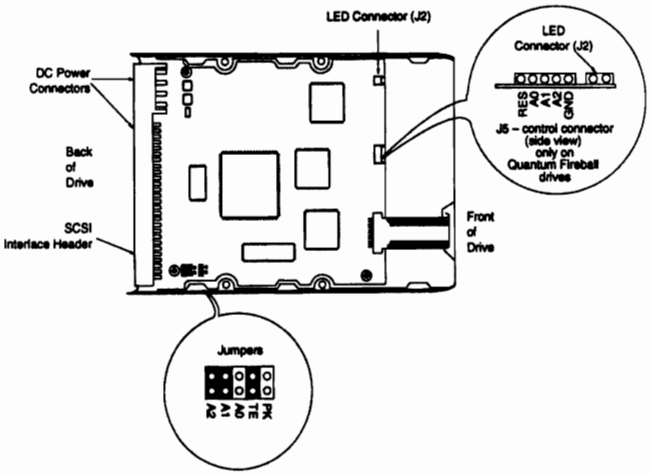
QUANTUM 8 and 10 JUMPER LOCATIONS

Eight- and Ten-Jumper Location and Settings



Quantum Grand Prix XP32151S and XP34301S

QUANTUM 3.5" 5-JUMPER



3.5-Inch Five-Jumper Locations and Settings

CAUTION: Verify that no two drives on the SCSI bus have the same address (see Table 4 for drive address information).

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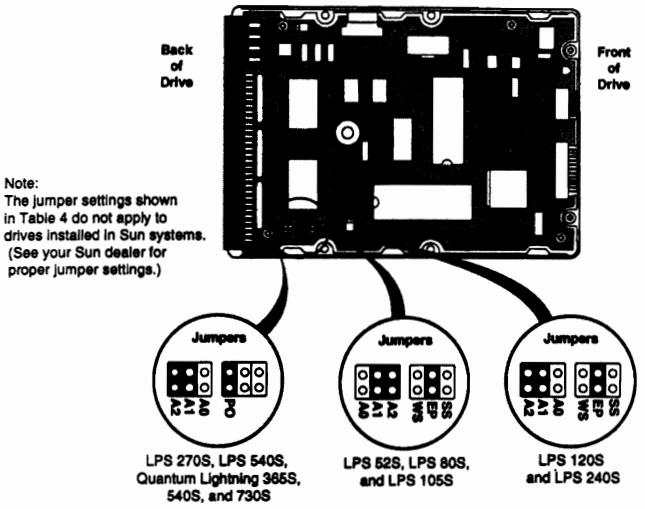
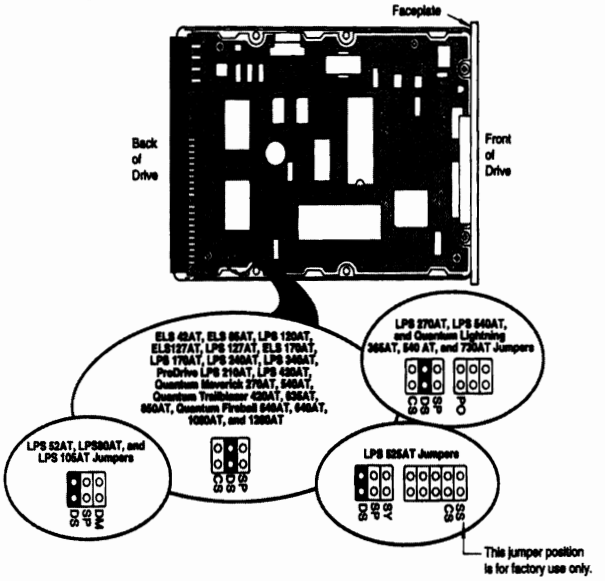
QUANTUM 3.5″ 6-JUMPER



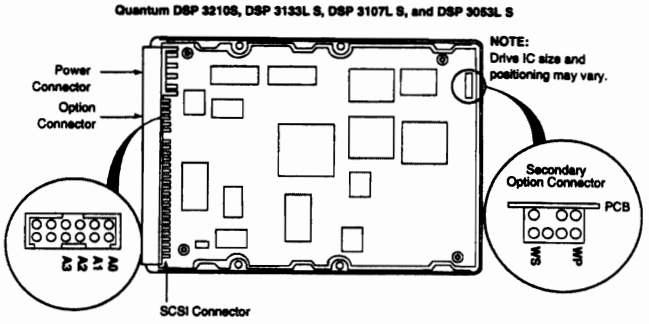
3.5-Inch Six-Jumper Locations and Settings

QUANTUM 3.5″ PC-AT



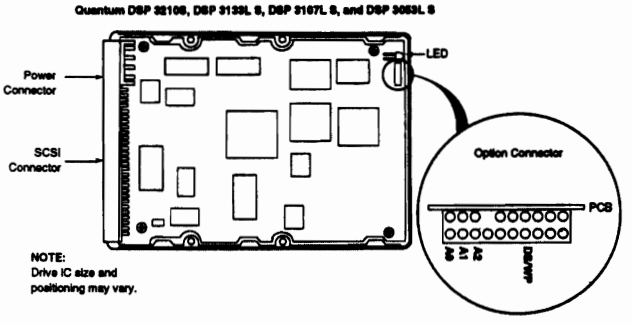
3.5-Inch PC-AT Drive Jumper Block Locations

QUANTUM DSP SERIES 16-BIT



Quantum DSP Series (16-bit) Jumper Locations and Settings

QUANTUM DSP SERIES 8-BIT



DSP Series (8-bit) Jumper Location and Settings

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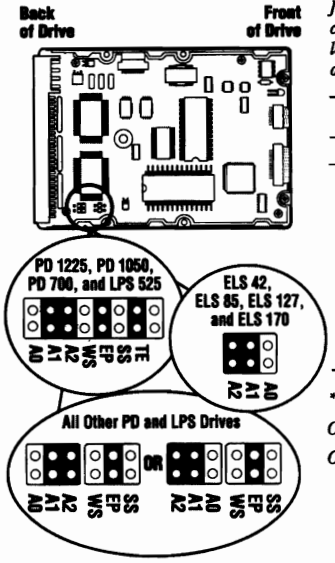
QUANTUM ELS 127



Jumper and Terminator location is constant on all SCSI drives. Chip location and size may vary depending on drive.

ProDrive Address Jumpers			SCSI ID
A2	A1	A0	
OFF	OFF	OFF	0
OFF	OFF	ON	1
OFF	ON	OFF	2
OFF	ON	ON	3
ON	OFF	OFF	4
ON	OFF	ON	5
ON*	ON*	OFF*	6*
ON	ON	ON	7

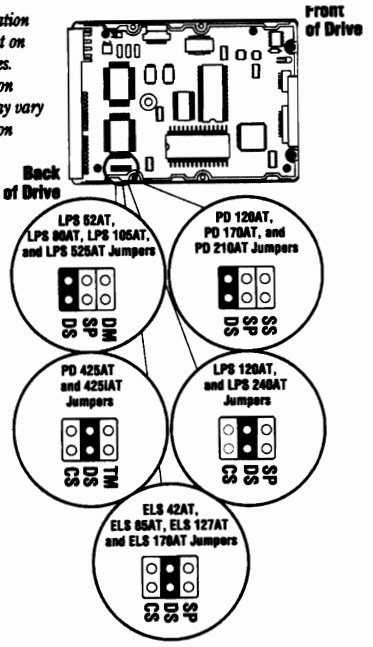
** Indicates the factory default jumper setting.*

ON indicates that the jumper is connected.

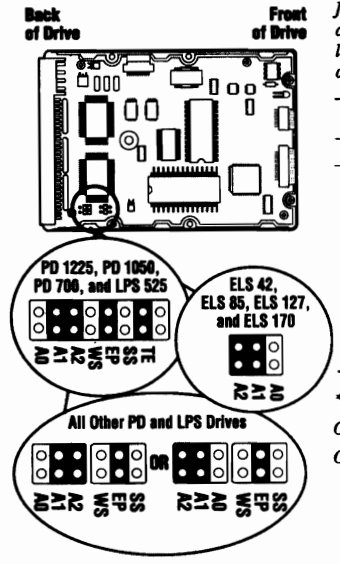
OFF indicates that the jumper is not installed.

QUANTUM ELS 127AT

Jumper location is consistant on all AT drives. Chip location and size may vary depending on drive.



QUANTUM ELS 170



Jumper and Terminator location is constant on all SCSI drives. Chip location and size may vary depending on drive.

ProDrive Address Jumpers			SCSI ID
A2	A1	A0	
OFF	OFF	OFF	0
OFF	OFF	ON	1
OFF	ON	OFF	2
OFF	ON	ON	3
ON	OFF	OFF	4
ON	OFF	ON	5
ON*	ON*	OFF*	6*
ON	ON	ON	7

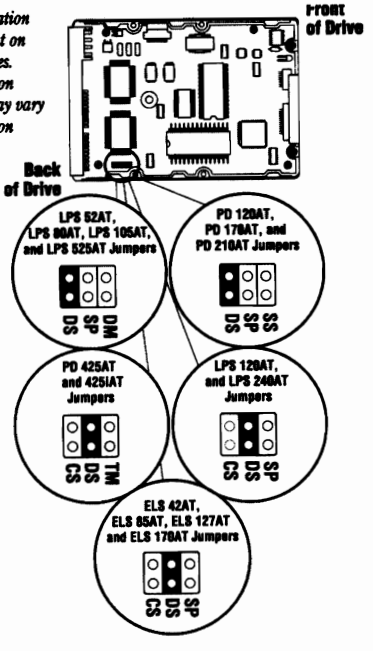
** Indicates the factory default jumper setting.*

ON indicates that the jumper is connected.

OFF indicates that the jumper is not installed.

QUANTUM ELS 170AT

Jumper location is consistant on all AT drives. Chip location and size may vary depending on drive.



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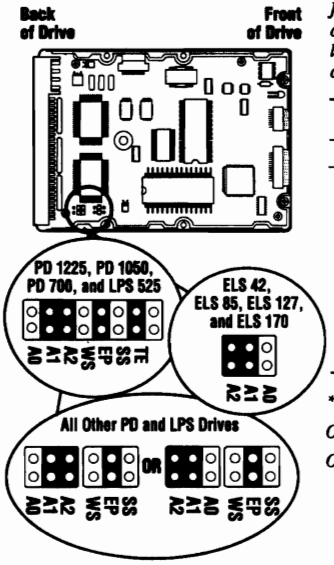
QUANTUM ELS 42



Jumper and Terminator location is constant on all SCSI drives. Chip location and size may vary depending on drive.

ProDrive Address Jumpers			SCSI ID
A2	A1	A0	
OFF	OFF	OFF	0
OFF	OFF	ON	1
OFF	ON	OFF	2
OFF	ON	ON	3
ON	OFF	OFF	4
ON	OFF	ON	5
ON*	ON*	OFF*	6*
ON	ON	ON	7

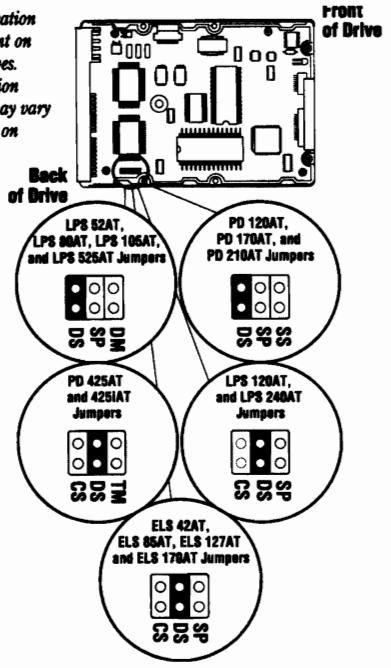
** Indicates the factory default jumper setting.*

ON indicates that the jumper is connected.

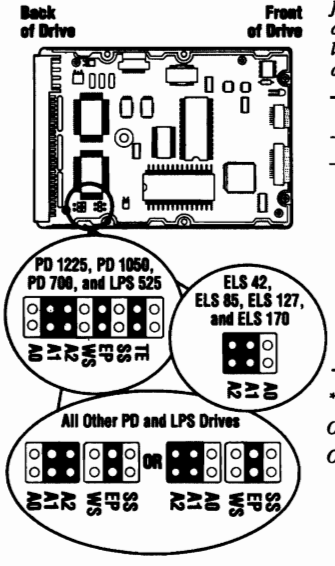
OFF indicates that the jumper is not installed.

QUANTUM ELS 42AT

Jumper location is consistant on all AT drives. Chip location and size may vary depending on drive.



QUANTUM ELS 85



Jumper and Terminator location is constant on all SCSI drives. Chip location and size may vary depending on drive.

ProDrive Address Jumpers			SCSI ID
A2	A1	A0	
OFF	OFF	OFF	0
OFF	OFF	ON	1
OFF	ON	OFF	2
OFF	ON	ON	3
ON	OFF	OFF	4
ON	OFF	ON	5
ON*	ON*	OFF*	6*
ON	ON	ON	7

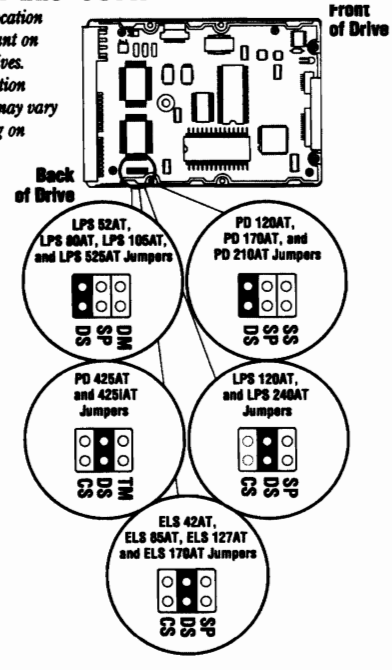
** Indicates the factory default jumper setting.*

ON indicates that the jumper is connected.

OFF indicates that the jumper is not installed.

QUANTUM ELS 85AT

Jumper location is consistant on all AT drives. Chip location and size may vary depending on drive.



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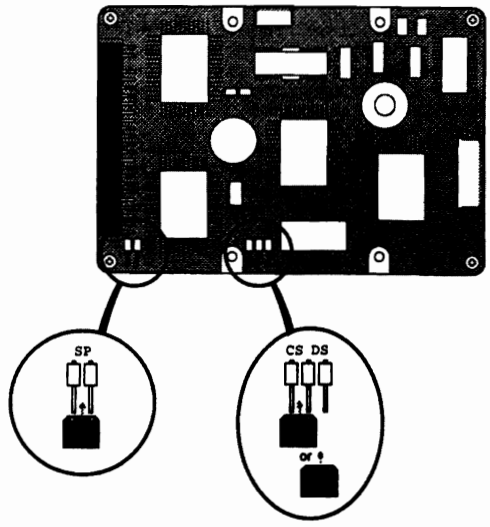
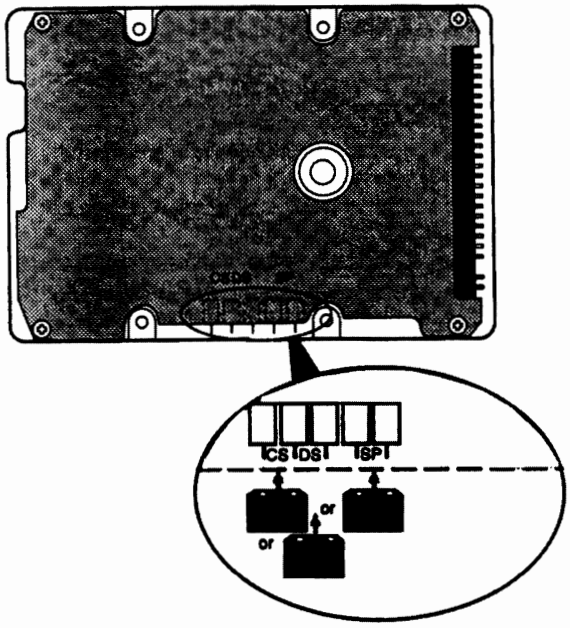
QUANTUM GO DRIVE AT



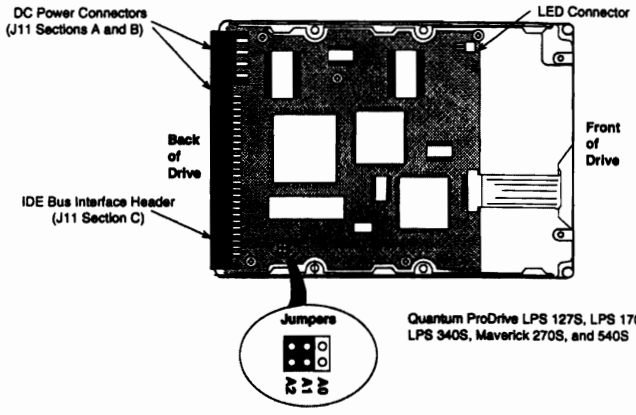
Quantum Go•Drive AT Jumper Block Locations

QUANTUM EUROPA SERIES



Jumper Locations for the Quantum Europa Series

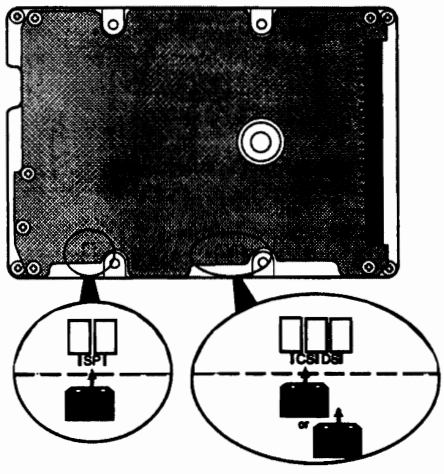
QUANTUM LPS/MAVERICK



Quantum ProDrive LPS 127S, LPS 170S, LPS 340S, Quantum Maverick 270S, and 540S Jumper Location and Settings

The black jumper body indicates that a jumper is installed (the setting is ON).

QUANTUM GO DRIVE GLS/DAYTONA

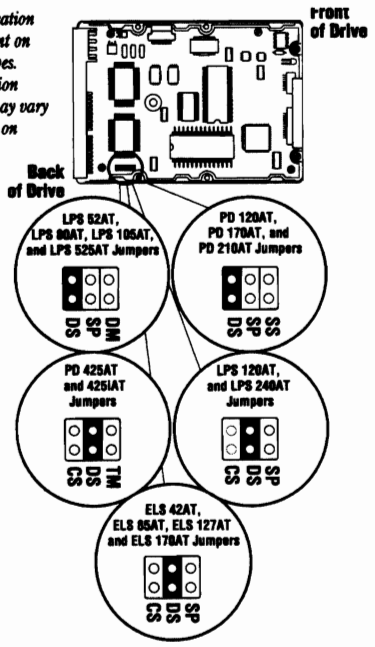


Quantum Go•Drive GLS and Quantum Daytona AT Jumper Locations

© CSC 1996

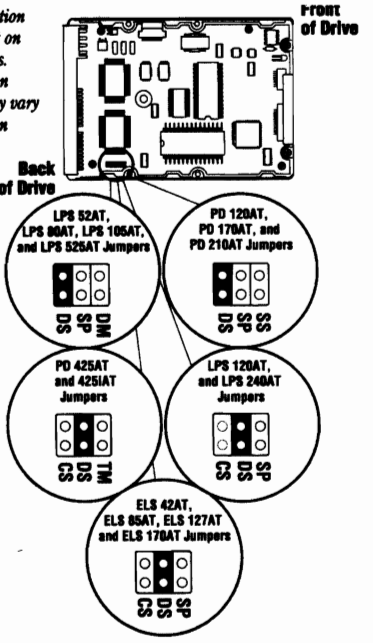
QUANTUM LPS 105AT

Jumper location is consistant on all AT drives. Chip location and size may vary depending on drive.



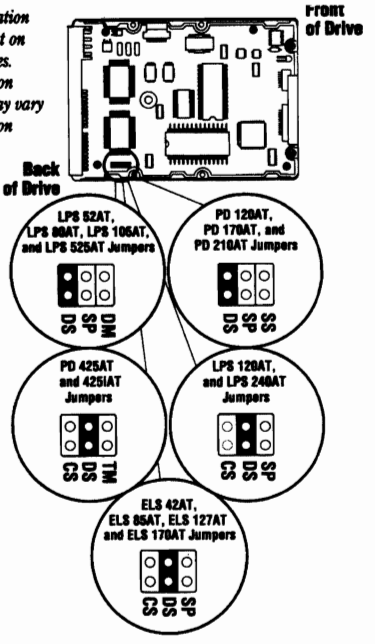
QUANTUM LPS 120AT

Jumper location is consistant on all AT drives. Chip location and size may vary depending on drive.

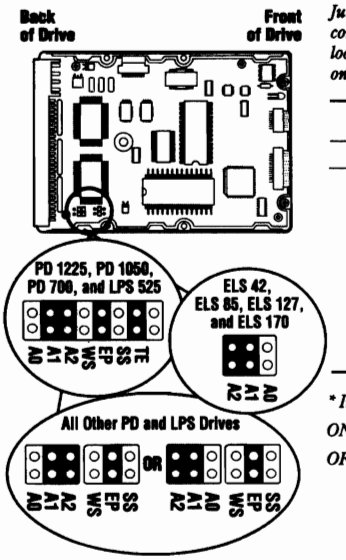


QUANTUM LPS 240AT

Jumper location is consistant on all AT drives. Chip location and size may vary depending on drive.



QUANTUM LPS 525



Jumper and Terminator location is constant on all SCSI drives. Chip location and size may vary depending on drive.

ProDrive Address Jumpers			SCSI ID
A2	A1	A0	
OFF	OFF	OFF	0
OFF	OFF	ON	1
OFF	ON	OFF	2
OFF	ON	ON	3
ON	OFF	OFF	4
ON	OFF	ON	5
ON*	ON*	OFF*	6*
ON	ON	ON	7

** Indicates the factory default jumper setting.*

ON indicates that the jumper is connected.

OFF indicates that the jumper is not installed.

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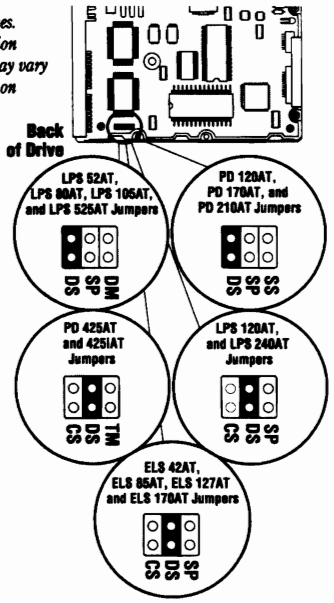
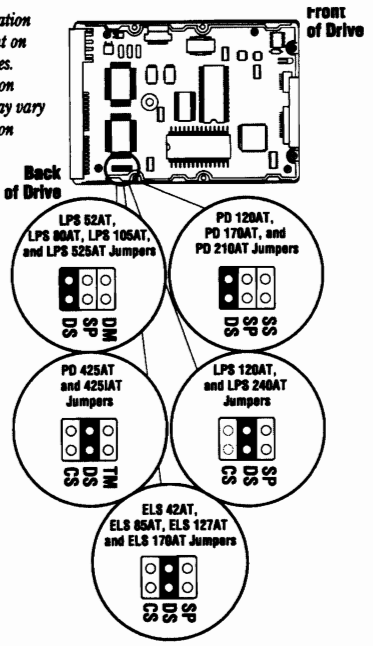
QUANTUM LPS 525AT

all AT drives. Chip location and size may vary depending on drive.



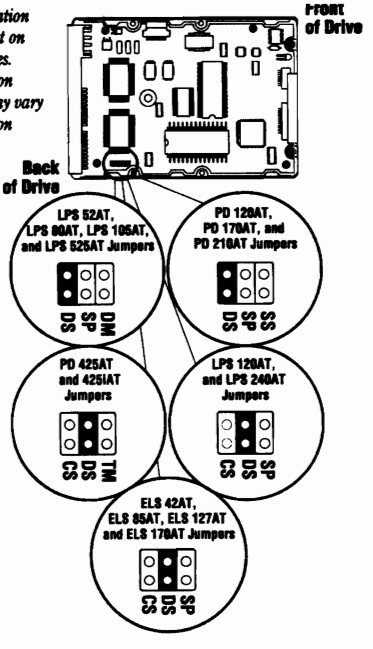
QUANTUM LPS 52AT

Jumper location is consistant on all AT drives. Chip location and size may vary depending on drive.

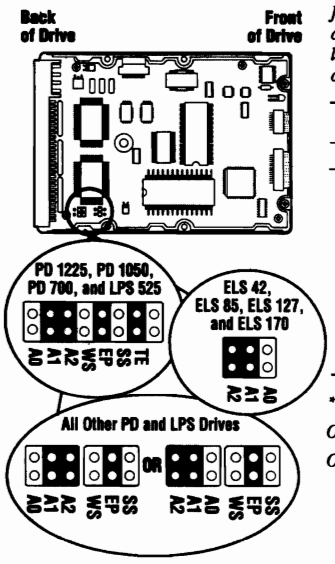


QUANTUM LPS 80AT

Jumper location is consistant on all AT drives. Chip location and size may vary depending on drive.



QUANTUM PD 1050



Jumper and Terminator location is constant on all SCSI drives. Chip location and size may vary depending on drive.

ProDrive Address Jumpers			SCSI ID
A2	A1	A0	
OFF	OFF	OFF	0
OFF	OFF	ON	1
OFF	ON	OFF	2
OFF	ON	ON	3
ON	OFF	OFF	4
ON	OFF	ON	5
ON*	ON*	OFF*	6*
ON	ON	ON	7

** Indicates the factory default jumper setting.*

ON indicates that the jumper is connected.

OFF indicates that the jumper is not installed.

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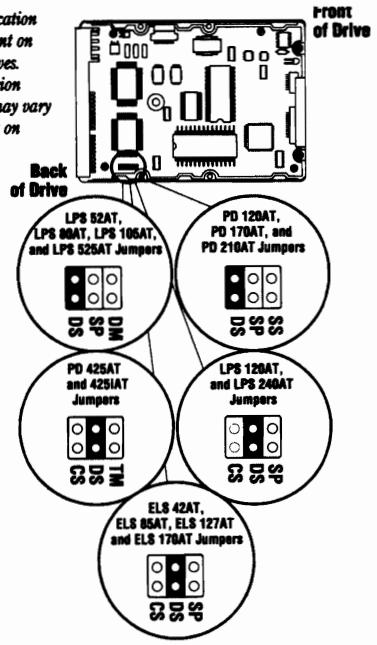
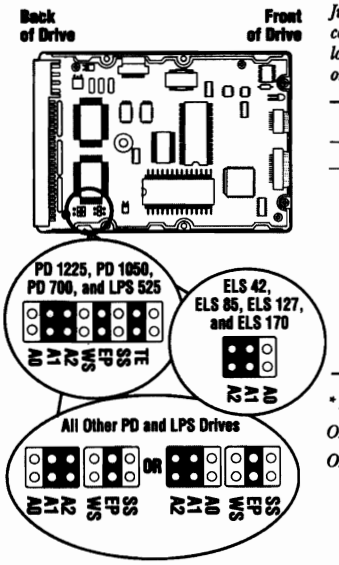
QUANTUM PD 120AT

Jumper location is consistant on all AT drives. Chip location and size may vary depending on drive.



QUANTUM PD 1225



Jumper and Terminator location is constant on all SCSI drives. Chip location and size may vary depending on drive.

ProDrive Address Jumpers			SCSI ID
A2	A1	A0	
OFF	OFF	OFF	0
OFF	OFF	ON	1
OFF	ON	OFF	2
OFF	ON	ON	3
ON	OFF	OFF	4
ON	OFF	ON	5
ON*	ON*	OFF*	6*
ON	ON	ON	7

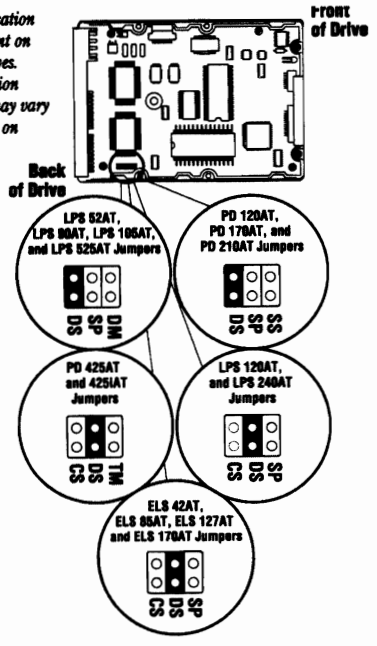
** Indicates the factory default jumper setting.*

ON indicates that the jumper is connected.

OFF indicates that the jumper is not installed.

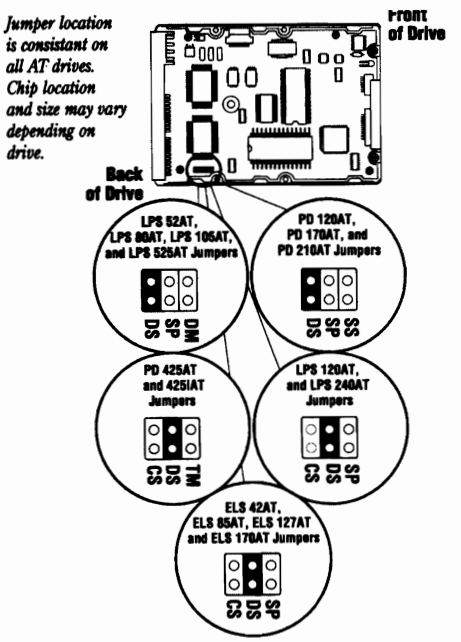
QUANTUM PD 170AT

Jumper location is consistant on all AT drives. Chip location and size may vary depending on drive.



QUANTUM PD 210AT

Jumper location is consistant on all AT drives. Chip location and size may vary depending on drive.



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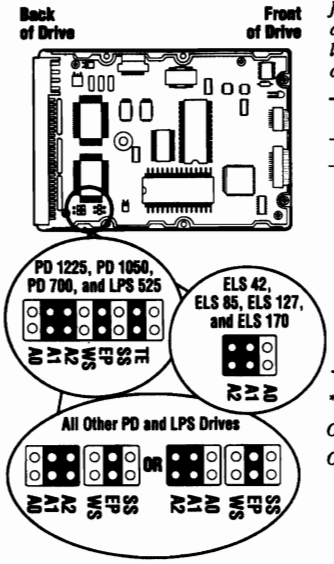
QUANTUM PD 700



Jumper and Terminator location is constant on all SCSI drives. Chip location and size may vary depending on drive.

ProDrive Address Jumpers			SCSI ID
A2	A1	A0	
OFF	OFF	OFF	0
OFF	OFF	ON	1
OFF	ON	OFF	2
OFF	ON	ON	3
ON	OFF	OFF	4
ON	OFF	ON	5
ON*	ON*	OFF*	6*
ON	ON	ON	7

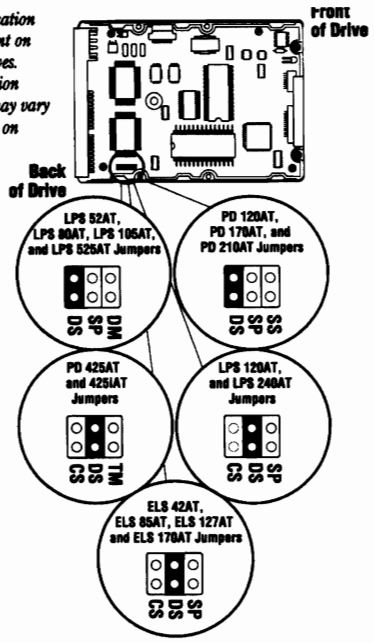
** Indicates the factory default jumper setting.*

ON indicates that the jumper is connected.

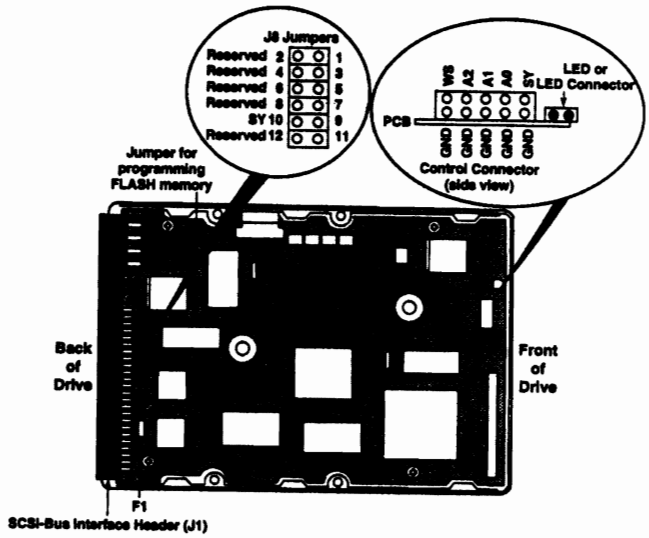
OFF indicates that the jumper is not installed.

QUANTUM PD 425AT/425iAT

Jumper location is consistant on all AT drives. Chip location and size may vary depending on drive.

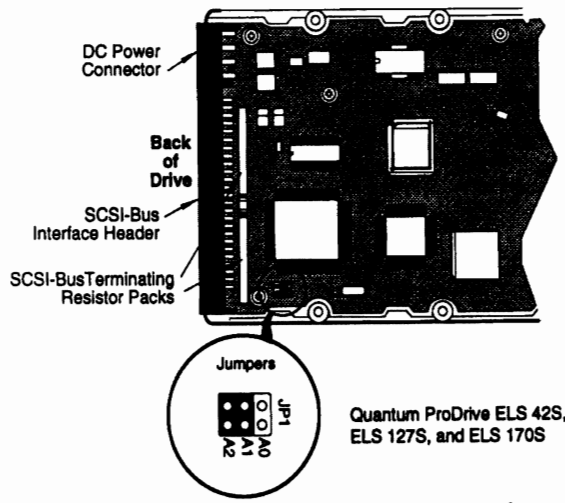


QUANTUM PRODRIVE



Quantum ProDrive LPS 525S, 700S, 1050S, 1225S, and 1800S Options

QUANTUM PRODRIVE ELS



Quantum ProDrive ELS 42S, ELS 85S, ELS 127S, and ELS 170S

Quantum ProDrive ELS Jumper Location and Settings

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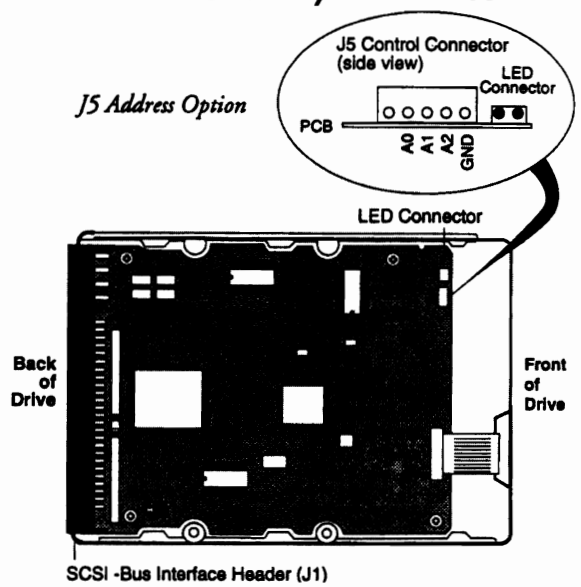
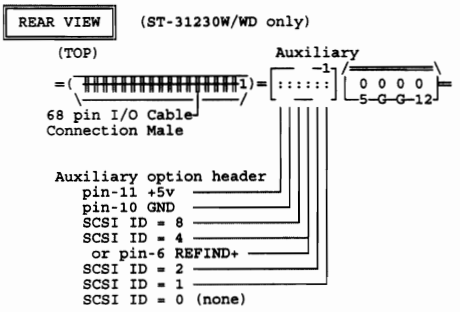
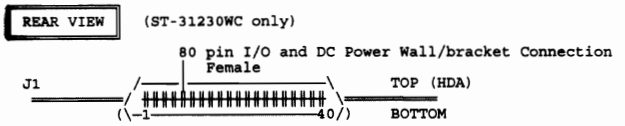
QUANTUM PRODRIVE/LIGHTNING



The PCB address jumpers (A0, A1, and A2) must be removed if the J5 remote address connector is used.

SEAGATE 31230W/WC/WD



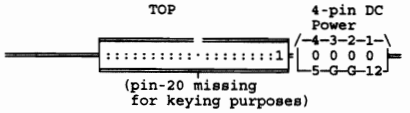


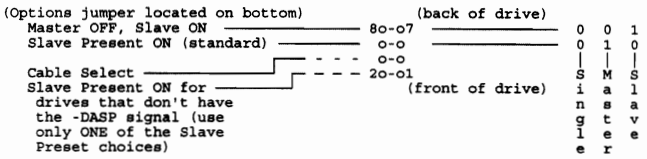
Notes on 80 pin I/O connector:

pins 1 - 4	= +12v	41 - 44	= 12v GND
34 - 36	= +5v	74 - 76	= 5v GND
37	= SYNC	77	= LEDC
38	= MTRON	78	= DLYDST
39	= SCSIA0	79	= SCSIA1
40	= SCSIA2	80	= SCSIA3

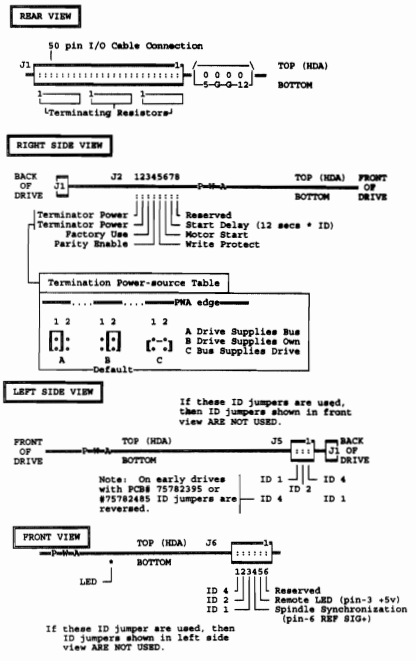
Mating NC connector: AMP US p/n: 2-557103-1 straight-in, Male 80-pin
2-557101-1 right angle to PCB

SEAGATE 3491A





SEAGATE ST11200N



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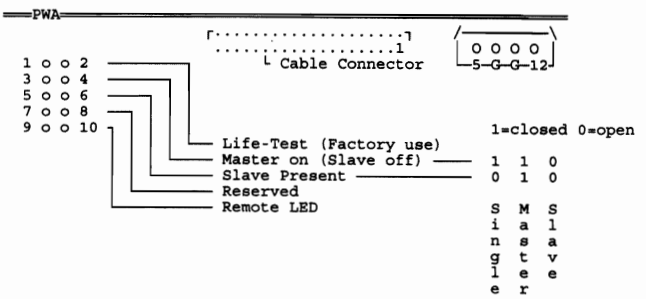
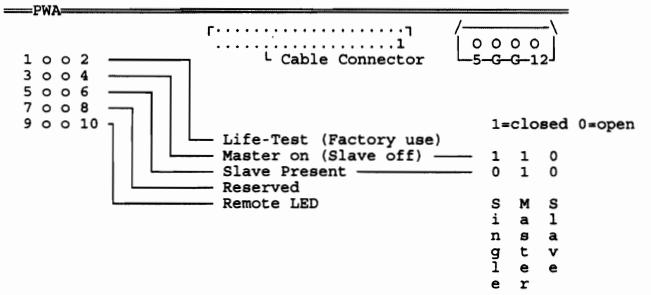
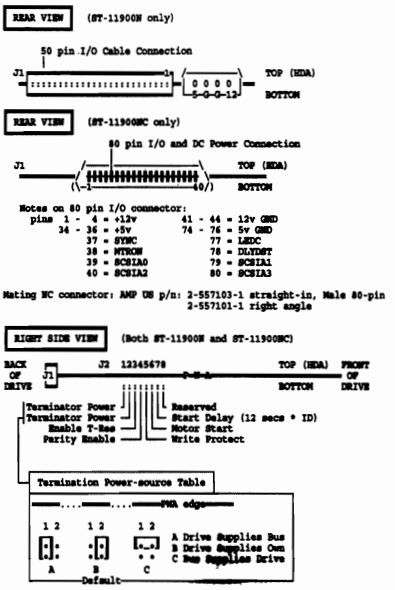
SEAGATE ST1144A-32



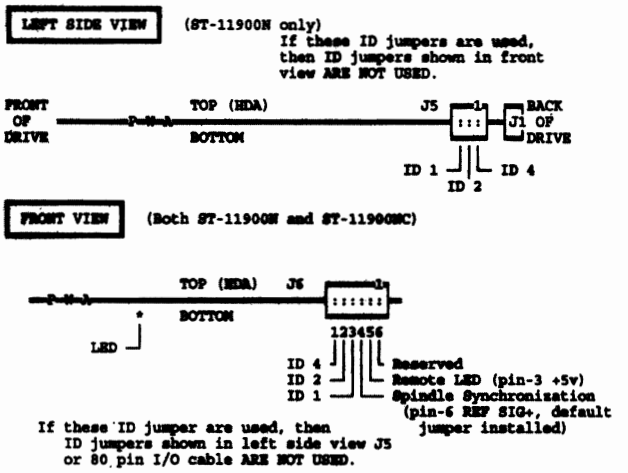
SEAGATE ST1144A



SEAGATE ST11910ND



SEAGATE ST11910ND (Continued)



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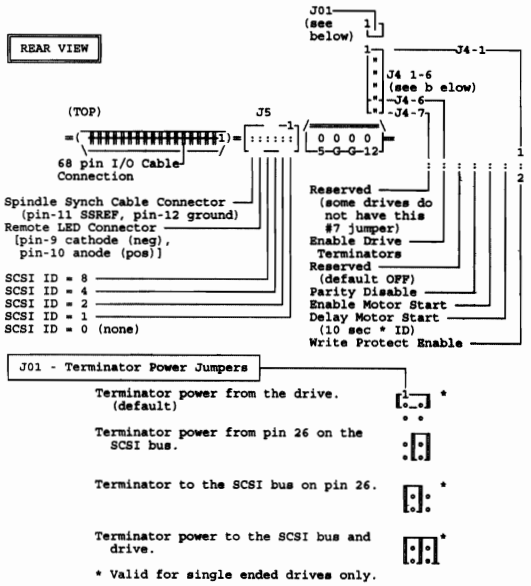
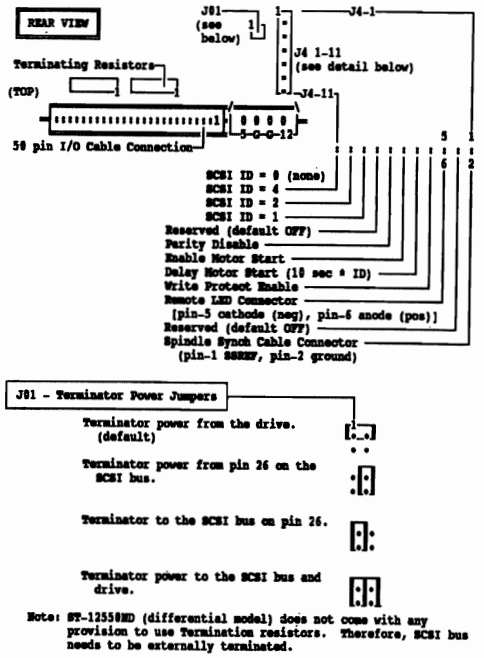
SEAGATE ST1245OW

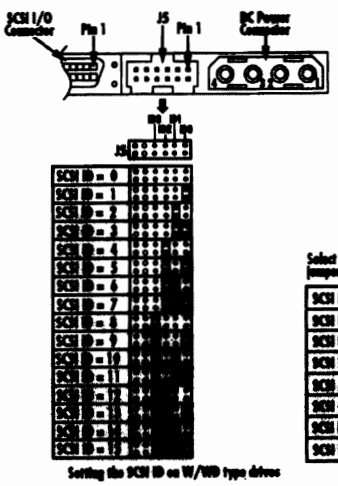


SEAGATE ST1255ON

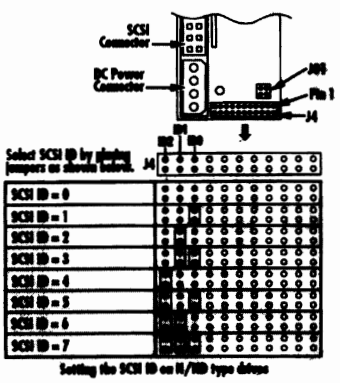


Note: ST-12550ND (differential model) does not come with any provision to use Termination resistors. Therefore, SCSI bus needs to be externally terminated.

SEAGATE ST1255ON/ND/W/WD



Setting the SCSI ID on W/WD type drives



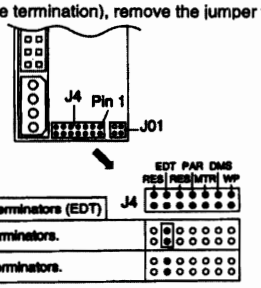
Setting the SCSI ID on N/WD type drives

SEAGATE ST1255ON/ND/W/WD (Continued)

The ST12550W drives are equipped with permanently mounted IC terminators. This means you can either enable or disable termination using jumpers as described below.

To terminate ST12550W drives (enable termination), install a jumper on J4 pins 11 and 12

To remove termination (disable termination), remove the jumper from J4 pins 11 and 12.



ST12550ND/WD drives have no provisions for internal termination. To terminate these drives, you must provide external termination.

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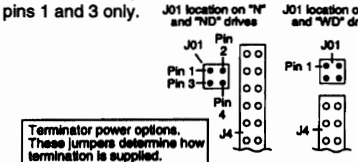
SEAGATE ST1255ON/ND/W/WD (Continued)

Termination power

Single-ended (N and W) drives have four valid configurations for terminator power (see below). Differential (ND and WD drives) must be configured with a jumper on J01 pins 1 and 3 only.



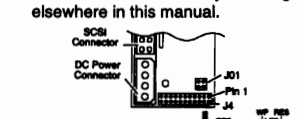
Terminator power options. These jumpers determine how termination is supplied.	
* Terminator power from the drive. The drive provides its own terminator power.	
* Terminator power from TERMPWR on the SCSI bus.	
Terminator power to the SCSI bus. The drive supplies power to TERMPWR on the SCSI bus.	
* Terminator power to the SCSI bus and drive.	

* Valid for single-ended ("N" and "W") drives only.

SEAGATE ST1255ON/ND/W/WD (Continued)

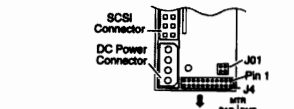
Changing other applicable jumper options for ST12550N/ND

Barracuda 1 and 2 drives are designed to be used in a variety of systems. Unique instlations may require you to change one or more of the other jumpers to meet specific system requirements; however, in most cases, you will not need to change any of these jumpers for normal drive operation. These figures provide the information necessary to configure all N and ND drive jumpers not discussed elsewhere in this manual.



Write Protect option (WP)	J4
Write Protect = On (disables writing).	
Write Protect = Off (enables writing – default).	
Remote LED Connector*	
Pin 5 (top pin in this illustration) is negative, Pin 6 (bottom pin) is positive.	
Reserved (RES)	
Reserved for factory use.	

*Note to subsystem designers: In Europe, a red LED indicates an error or warning condition. For this reason, you may want to use a color other than red with this connection.

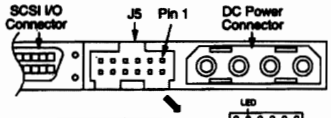


Parity Check option (PAR)	J4
Enable parity check of SCSI bus data (default).	
Disable parity check.	
Motor Start option (MTR)	
Enable motor start. This makes the drive wait for the Start Unit command from the host before starting the spindle motor.	
Disable motor start (default). This causes the drive to start according to the Delay Motor Start option setting as described below.	
Delay Motor Start option (DMS) (valid only if the Motor Start jumper is not connected)	
Motor start delay equal to the SCSI ID multiplied by 10 seconds. For example, if the SCSI ID = 2, the drive will delay for 20 seconds before starting.	
Disable the Delay Motor Start option (default).	

SEAGATE ST1255ON/ND/W/WD (Continued)

Additional jumper options for 12550W/WD

These figures provide the information necessary to configure all W and WD drive jumpers not discussed elsewhere in this manual.



Remote LED Connector*	J5
Pin 9 (top pin in this illustration) is negative (cathode), Pin 10 (bottom pin) is positive (anode).	

*Note to subsystem designers: In Europe, a red LED indicates an error or warning condition. For this reason, you may want to use a color other than red with this connection.

Reserved (RES)	
Reserved for factory use.	
Parity Check option (PAR)	
Enable parity check of SCSI bus data (default).	
Disable parity check of SCSI bus data.	
Motor Start option (MTR)	
Enable motor start. This makes the drive wait for the Start Unit command from the host before starting the spindle motor.	
Disable motor start (default). This causes the drive to start according to the Delay Motor Start option setting as described below.	
Delay Motor Start option (DMS) (valid only if the Motor Start option jumper is not connected)	
Motor start delay equal to the SCSI ID multiplied by 10 seconds. For example, if the SCSI ID = 2, the drive will delay for 20 seconds before starting.	
Disable the Delay Motor Start option (default).	
Write Protect option (WP)	
Write Protect = On (disables writing).	
Write Protect = Off (enables writing – default).	

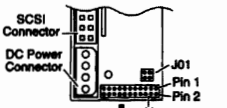
SEAGATE ST1255ON/ND/W/WD (Continued)

Synchronizing spindles

If you are installing two or more Barracuda drives, you may (optionally) want to synchronize their spindles to reduce the latency associated with switching from one drive to another. Spindle sync cables are used to connect the drives.

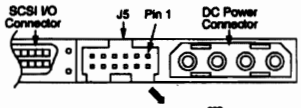
For N- and ND-type drives, use pins 1 and 2 on the J4 connector to attach the spindle sync cable. Pin 1 provides the reference index signal (REFSIG+) and pin 2 provides ground (GND). *see below*

For W- and WD-type drives, use pins 11 and 12 on the J5 connector to attach the spindle sync cable. Pin 11 provides the reference index signal (REFSIG+) and pin 12 provides ground (GND). *see below*



Spindle Sync Cable Connector (SSC). These pins are used to connect a spindle sync cable.	J4
Spindle sync reference index signal (REFSIG+).	
Ground (GND).	

For N- and ND-type drives



Spindle Sync Cable Connector (SSC) These pins are used to connect a spindle sync cable.	J5
Spindle sync reference index signal (REFSIG+).	
Ground (GND).	

For W- and WD-type drives

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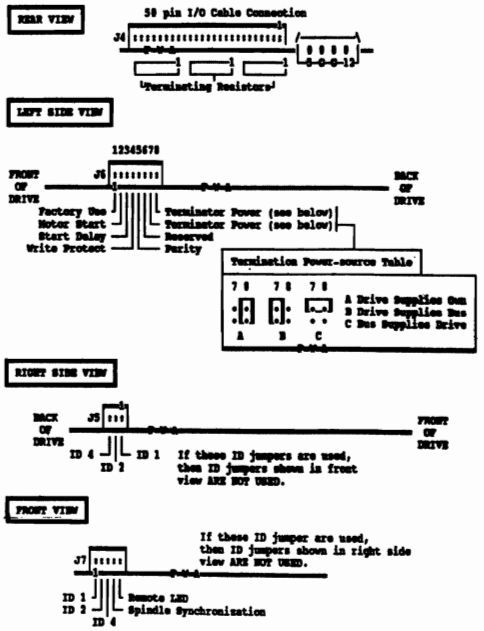
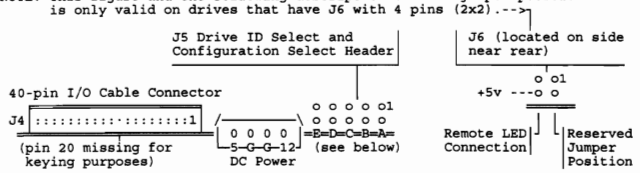
SEAGATE ST1401N



SEAGATE ST1480A

NOTE: This figure and the following description of each jumper position is only valid on drives that have J6 with 4 pins (2x2).-->



J5
JUMPER | FUNCTION:

A REFSIG: This location provides a port for external connection of the synchronized spindle reference signal (pin-1) and ground (pin-2). The reference signal is bi-directional, single-ended, and terminated without an external resistor. It is also available on J4 pin-28 if the factory jumper is installed. The drive will self-determine if it is a master of slave for spindle synchronization.

B HOST SLV/ACT: When this shunt is installed, -SLAVE PRESENT (provided by the output of a 74HCT14) is applied to J4 pin-39 for systems that require this signal from the Master drive. If jumper "B" is installed, then jumper "E" must not be installed.

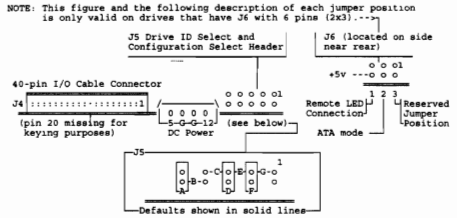
C MASTER: When this shunt is installed, the drive is configured as the Master. When not installed, the drive is a Slave.

D SLAVE PRESENT: When installed, this shunt indicates to the Master drive that a Slave is present. This shunt must be installed on the Master drive in a two-drive system.

E ACTIVE: When this shunt is installed, DASP- is made present on J4 pin-39. If "E" is installed, then "B" must not be installed.

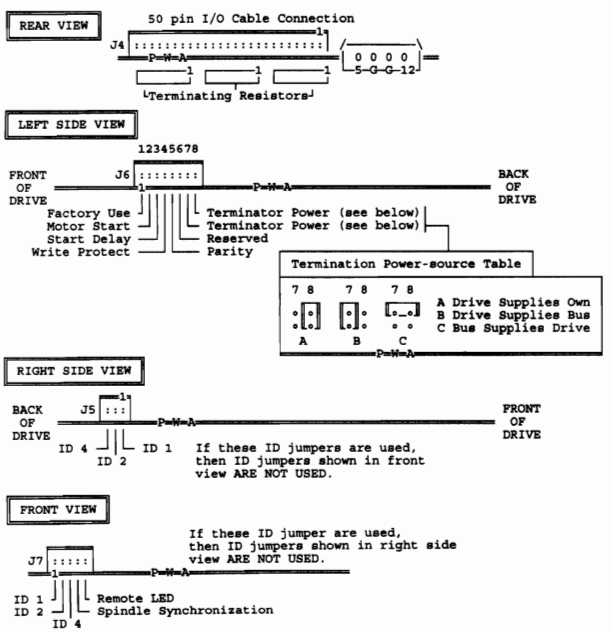
SEAGATE ST1480A (Continued)

NOTE: This figure and the following description of each jumper position is only valid on drives that have J6 with 6 pins (2x3).-->



J5 Jumper A	B	Function Description
OFF*	OFF	(A=vertical, pins 9 & 10; B=horizontal, pins 8 & 10) Drive is the slave (Drive 1).
OFF	ON	Drive is the master (Drive 0) with slave (Drive 1) present.
ON*	OFF	Drive s the master (Drive 0)
C		(C=horizontal, pins 5 & 7)
ON		Slave (Drive 1) Present is connected to J4 pin 39. Jumpers "D" or "E" cannot be installed if jumper "C" is installed.
D		(D=vertical, pins 5 & 6)
ON*		DASP- is connected to J4 pin 39. Jumpers "C", "D", "F", or "G" cannot be installed if jumper "E" is installed.
OFF		REFSIG is not connected to J4 pin 39.
E		(E=horizontal, pins 3 & 5)
ON		REFSIG is connected to J4 pin 39. Jumpers "C", "D", "F", or "G" cannot be installed if jumper "E" is installed.
OFF		REFSIG is not connected to J4 pin 39.
F		(F=vertical, pins 3 & 4)
ON*		No external reference for REFSIG. Jumpers "E", "G", or "H" cannot be installed if jumper "F" is installed.
OFF		This location provides a port for external connection of the synchronized spindle reference signal (pin 3) and ground (pin 4)
G		(G=horizontal, pins 1 & 3)
ON		REFSIG is connected to J4 pin 28. Jumpers "E" or "F" cannot be installed if jumper "G" is installed.
OFF		REFSIG is not connected to J4 pin 28.

SEAGATE ST1480N



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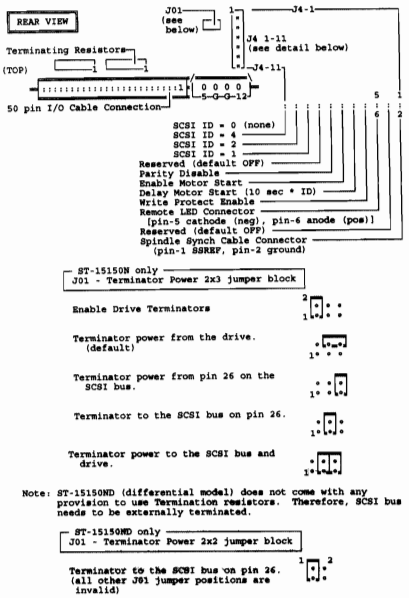
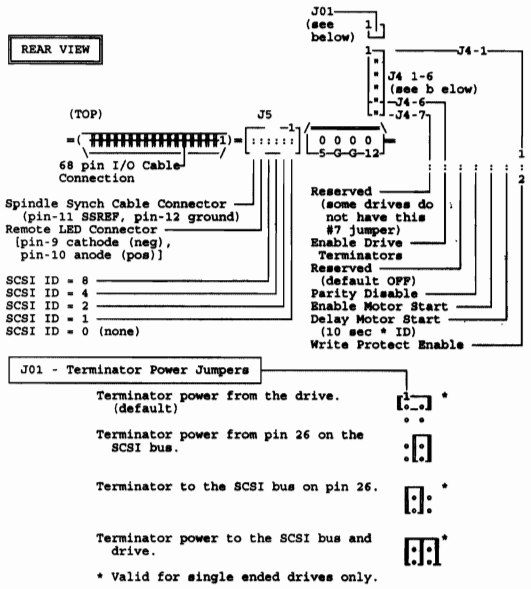
SEAGATE ST1150N



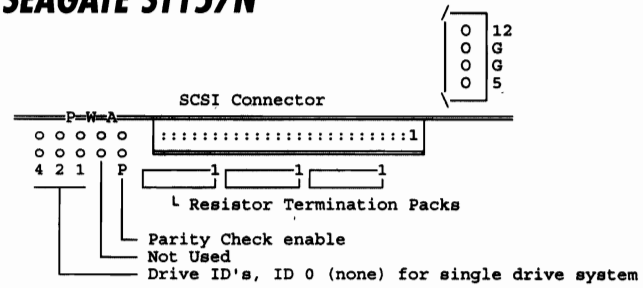
Note: ST-15150ND (differential model) does not come with any provision to use Termination resistors. Therefore, SCSI bus needs to be externally terminated.

SEAGATE ST15150W

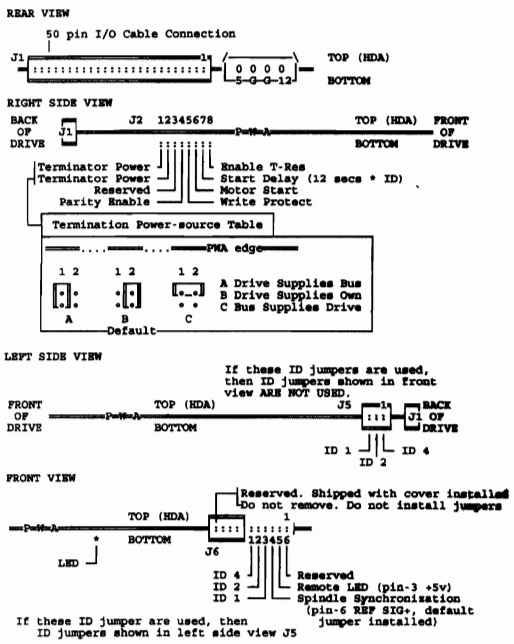


* Valid for single ended drives only.

SEAGATE ST157N



SEAGATE ST1230N



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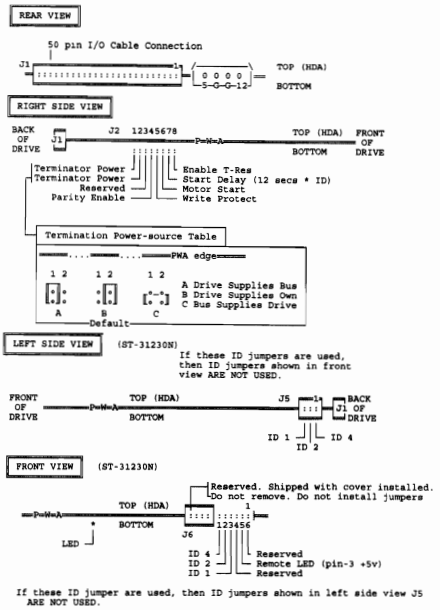
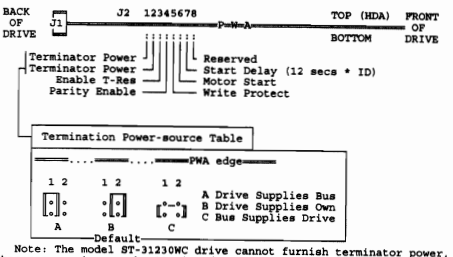
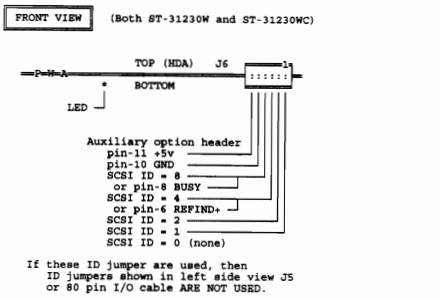
SEAGATE ST3123ON



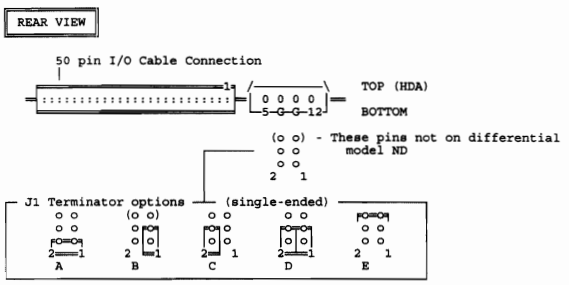
SEAGATE ST3123OW/WD/WC



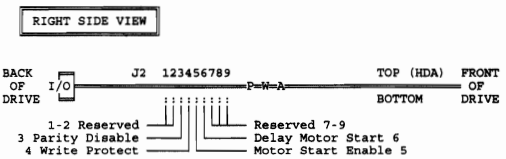
Note: The model ST-31230WC drive cannot furnish terminator power, because no pins on the 80 pin I/O connector are devoted to terminator power.



SEAGATE ST3255ON



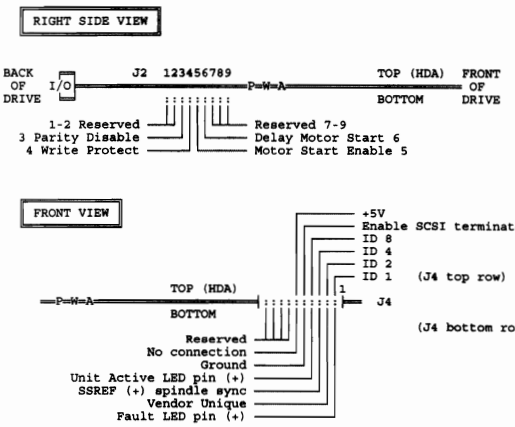
A - Term. power from drive (default)
B - Term. power to SCSI bus (only option available for differential ND)
C - Term. power from SCSI bus
D - Term. power to SCSI bus and drive
E - Enable SCSI terminator (jumper on pins 5-6)



SEAGATE ST3255ON (Continued)

pins	1 - 4 = +12v	41 - 44 = 12v GND	
	34 - 36 = +5v	74 - 76 = 5v GND	
	37 = SYNC	77 = LEDC	
	38 = MTRON	78 = DLYDST	
	39 = SCSIA0	79 = SCSIA1	
	40 = SCSIA2	80 = SCSIA3	

Mating WC connector: AMP US p/n: 2-557103-1 straight-in, Male 80-pin
2-557101-1 right angle to PCB



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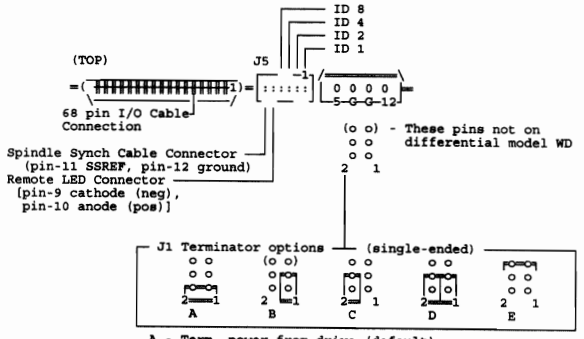
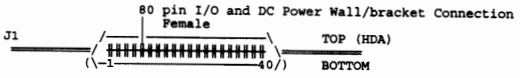
SEAGATE ST32550W/WD

REAR VIEW (ST-32550W only)



A - Term. power from drive (default)
B - Term. power to SCSI bus (only option available for differential WD)
C - Term. power from SCSI bus
D - Term. power to SCSI bus and drive
E - Enable SCSI terminator (jumper on pins 5-6)

REAR VIEW (ST-32550WC only)



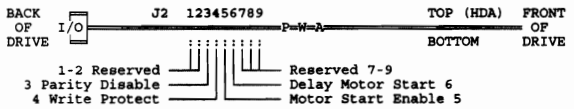
Notes on 80 pin I/O connector:

SEAGATE ST32550W/WD (Continued)

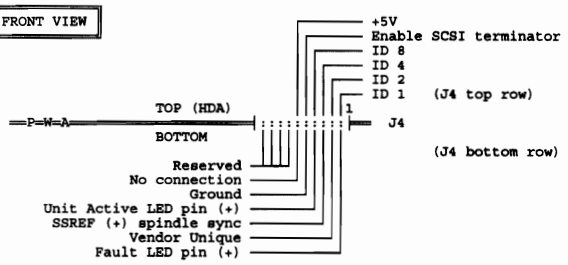
pins 1 - 4	= +12v	41 - 44	= 12v GND
34 - 36	= +5v	74 - 76	= 5v GND
37	= SYNC	77	= LEDC
38	= MTRON	78	= DLYDST
39	= SCSIA0	79	= SCSIA1
40	= SCSIA2	80	= SCSIA3

Mating WC connector: AMP US p/n: 2-557103-1 straight-in, Male 80-pin
2-557101-1 right angle to PCB

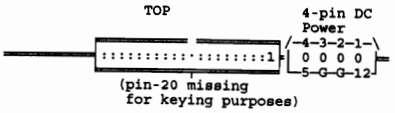
RIGHT SIDE VIEW



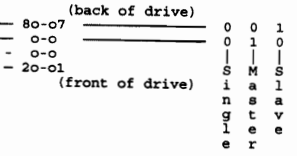
FRONT VIEW



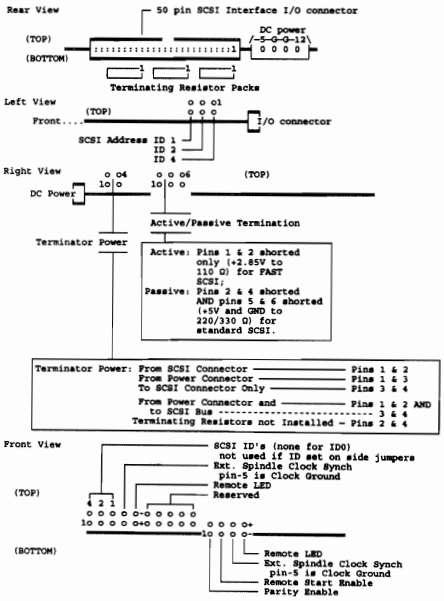
SEAGATE ST3295A



(Options jumper located on bottom)
Master OFF, Slave ON
Slave Present ON (standard)
Cable Select
Slave Present ON for drives that don't have the -DASP signal (use only ONE of the Slave Preset choices)
Spare jumper stored on pins 1-3



SEAGATYE ST3390N



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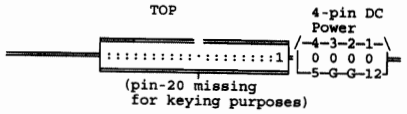
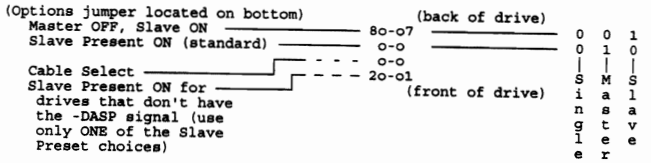
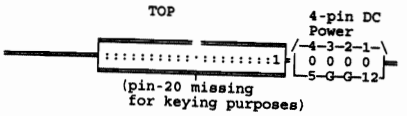
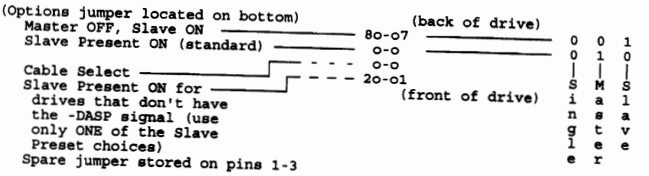
SEAGATE ST3391A



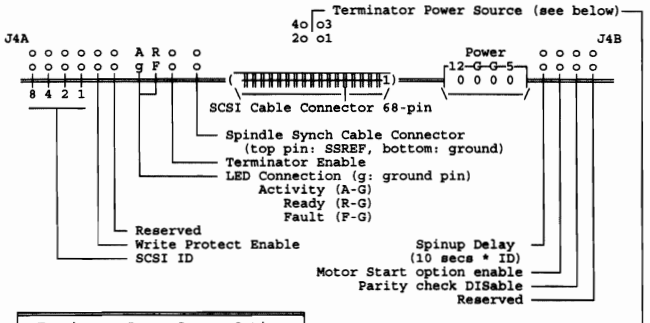


SEAGATE ST3660A





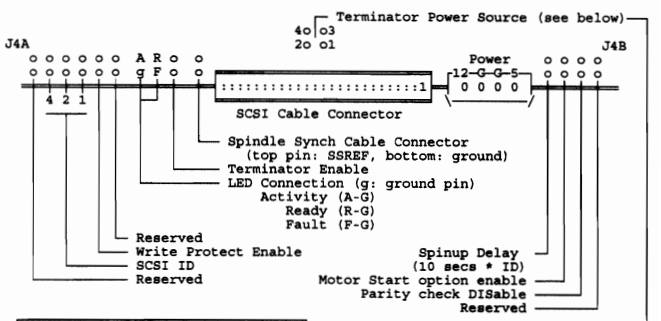
SEAGATE ST41800W



Terminator Power Source Options
2 & 4 – Initiator supplies power over the SCSI Bus for terminators. Drive supplies no terminator power. 1 & 2 – Drive supplies power for its own terminator resistor-paks but not to SCSI Bus. This is the factory setting. 1 & 3 AND 2 & 4 – Drive supplies power for external terminator at end of the daisy chain. Terminator resistor-paks must be removed. This option is recommended only for last drive on daisy chain.

ST410800WD drives are shipped without terminators and have empty terminator sockets on the PCB. You must provide termination resistors for these drives.

SEAGATE ST41080N



Terminator Power Source Options
2 & 4 – Initiator supplies power over the SCSI Bus for terminators. Drive supplies no terminator power. 1 & 2 – Drive supplies power for its own terminator resistor-paks but not to SCSI Bus. This is the factory setting. 1 & 3 AND 2 & 4 – Drive supplies power for external terminator at end of the daisy chain. Terminator resistor-paks must be removed. This option is recommended only for last drive on daisy chain.

ST410800ND drives are shipped without terminators and have empty terminator sockets on the PCB. You must provide termination resistors for these drives.

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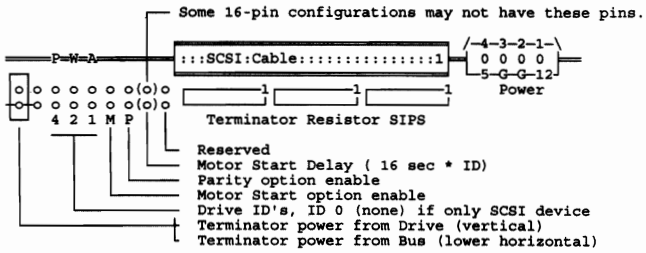
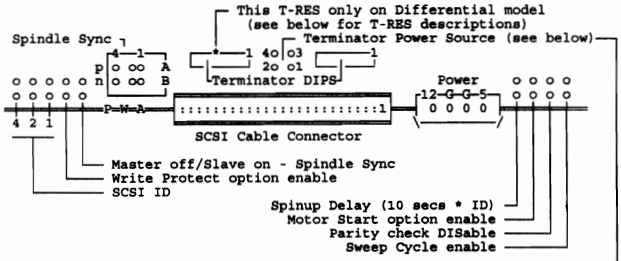
SEAGATE ST41200N



SEAGATE ST41600N



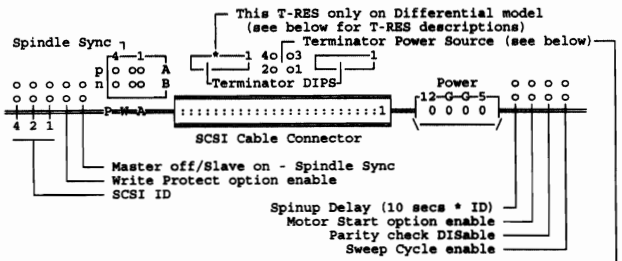
Terminator Power Source Options

2 & 4 – Initiator supplies power over the SCSI Bus for terminators. Drive supplies no terminator power.
1 & 2 – Drive supplies power for its own terminator resistor-paks but not to SCSI Bus. This is the factory setting.
1 & 3 AND 2 & 4 – Drive supplies power for external terminator at end of the daisy chain. Terminator resistor-paks must be removed. This option is recommended only for last drive on daisy chain.

T-RES descriptions:

ST41600N	1 DIP
ST41601N	2 SIPs
ST41600ND	2 DIPs
ST41601ND	2 DIPs

SEAGATE ST42000N



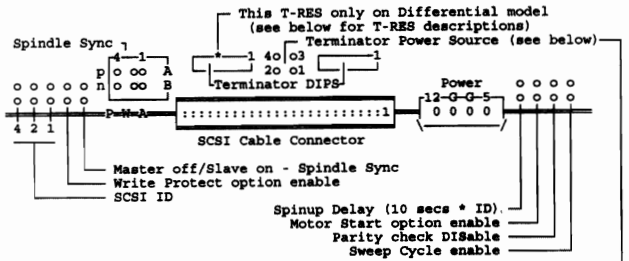
Terminator Power Source Options

2 & 4 – Initiator supplies power over the SCSI Bus for terminators. Drive supplies no terminator power.
1 & 2 – Drive supplies power for its own terminator resistor-paks but not to SCSI Bus. This is the factory setting.
1 & 3 AND 2 & 4 – Drive supplies power fpr external terminator at end of the daisy chain. Terminator resistor-paks must be removed. This option is recommended only for last drive on daisy chain.

T-RES descriptions:

ST42000N	2 SIPs
ST42000ND	2 DIPs

SEAGATE ST43400N



Terminator Power Source Options

2 & 4 – Initiator supplies power over the SCSI Bus for terminators. Drive supplies no terminator power.
1 & 2 – Drive supplies power for its own terminator resistor-paks but not to SCSI Bus. This is the factory setting.
1 & 3 AND 2 & 4 – Drive supplies power for external terminator at end of the daisy chain. Terminator resistor-paks must be removed. This option is recommended only for last drive on daisy chain.

T-RES descriptions:

ST43400N	2 SIPs
ST43400ND	2 DIPs

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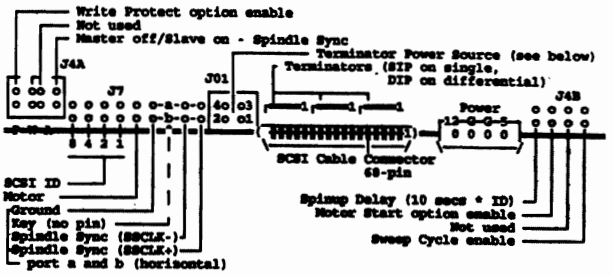
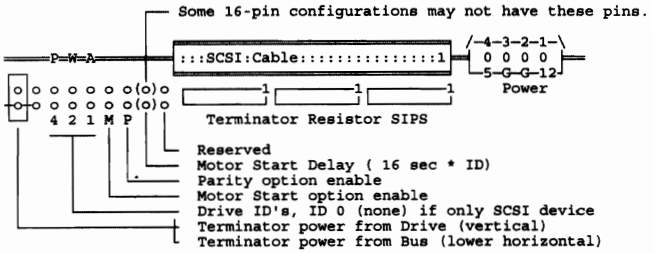
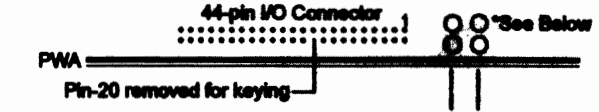
SEAGATE ST43401N/ND



SEAGATE ST4766N



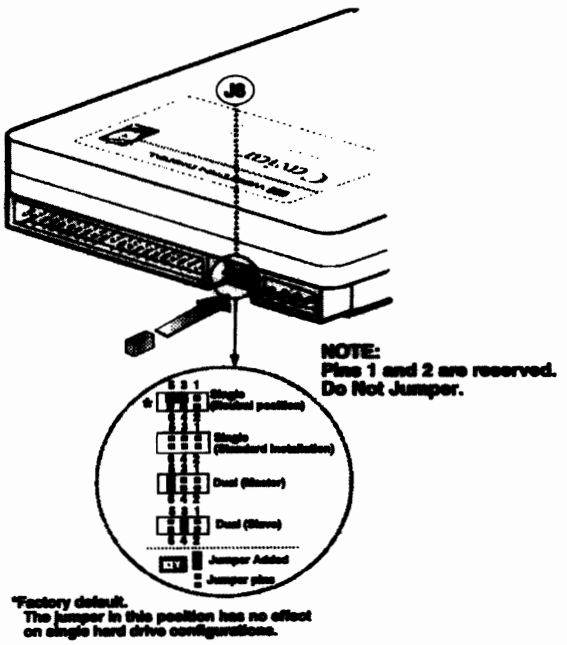
SEAGATE ST9145AG



Drive is Master, no Slave drive present	0	0
Drive is Master, Seagate Slave drive present	1	0
Drive is Slave to another Seagate 2.5" Master	0	1
Reserved Position (Do Not Use)	1	1

*Drive uses +5VDC power supplied to the drive via the interface connector. The drive does NOT make use of a +12VDC power line.
Pin-41 +5VDC - Logic
Pin-42 +5VDC - Motor
Pin-43 - Ground
Pin-44 - Reserved

WESTERN DIGITAL WDAC 1210



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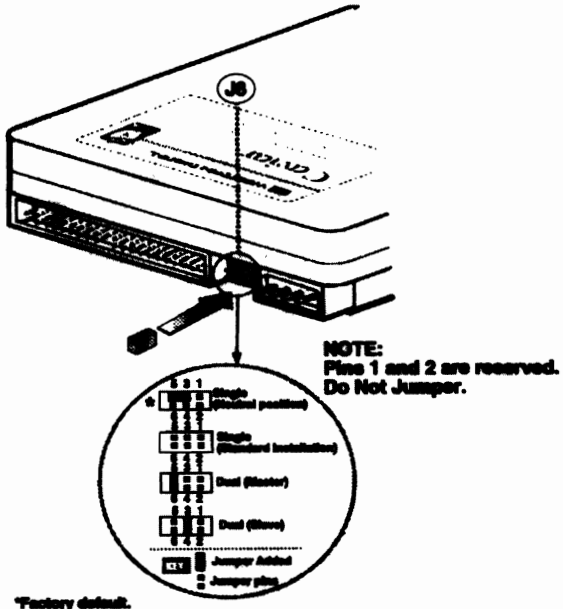
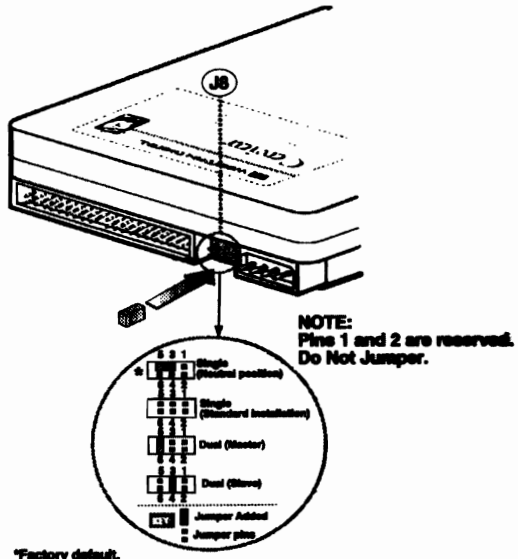
WESTERN DIGITAL WDAC 1270



NOTE:
Pins 1 and 2 are reserved.
Do Not Jumper.

*Factory default.
The jumper in this position has no effect on single hard drive configurations.

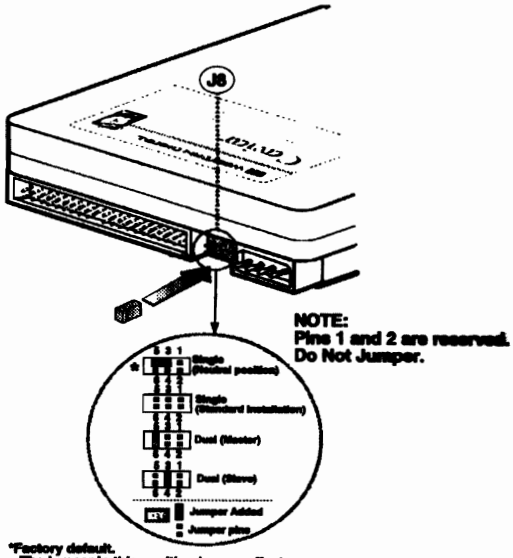
WESTERN DIGITAL WDAC 1365



NOTE:
Pins 1 and 2 are reserved.
Do Not Jumper.

*Factory default.
The jumper in this position has no effect on single hard drive configurations.

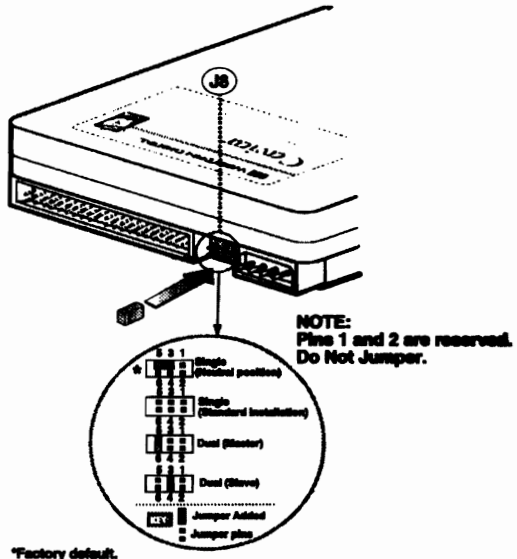
WESTERN DIGITAL WDAC 2200



NOTE:
Pins 1 and 2 are reserved.
Do Not Jumper.

*Factory default.
The jumper in this position has no effect on single hard drive configurations.

WESTERN DIGITAL WDAC 2420



NOTE:
Pins 1 and 2 are reserved.
Do Not Jumper.

*Factory default.
The jumper in this position has no effect on single hard drive configurations.

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CD-ROM

CD-ROM

Compact Disk Read Only Memory 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 a thinner gold metallic layer. CD's store information using microscopic pits in the metal layer that 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 immu-

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nity 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, etched glass CD masters are first made using a photo lithography process. These glass 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 that 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 that isn't the ideal way to pack data on an optical disk, but it was chosen to keep the complexity and cost of the CD-ROM and audio player 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

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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

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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.

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CHOOSING A CD-ROM DRIVE

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

- You must have full MPC level-II 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 4X, 6X or faster spin speeds.
- You will 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 quad speed 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 STANDARDS

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.

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BUILDING A REAL MULTIMEDIA PC

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

- A fast Pentium processor.
- A PCI video card.
- A Sound Blaster 2.0 compatible sound board.
- A quad speed or faster CD drive (SCSI is preferred)
- 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 32MB or more memory. Full resolution Kodak Photo CD images are 4.5MB each! A PCI 32 bit video board with a Windows accelerator is recommended. A quad speed 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 that 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 com-

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patible 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)462-8260

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

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.

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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.

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FLOPPY DRIVES

FLOPPY DRIVES

At present, the computer industry has standardized the five floppy drive types listed below. 1.44MB drives are the most popular, although a large number of 5.25 and low density 3.5 diskettes still exist in field installations.

INDUSTRY STANDARD FLOPPY DRIVES

Capacity	Tracks	Transfer Rate	Form Factor
360K	40	250KHz	5.25"
1.2MB*	40/80	250/500KHz	5.25"
720K	40	250KHz	3.50"
1.44MB	40/80	250/500KHz	3.50"
2.88MB	80	1000KHz	3.50"
100MB	~700	1000khz+	External Zip Drive

Note:
Some early 1.2MB drives used a data transfer rate of 300KHz when reading 360K disks.

FLOPTICAL DRIVES

The original floptical drive standard stored 20MB on a disk. This disk used optical tracking to ìclose the loopî and increase track density. This standard is now obsolete.

ZIP DRIVES

The Bornoullei Zip drive uses high coercivity flexible disk media coupled with imbedded servo to achieve higher densities than stan-

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dard diskettes. Zip drives store 100MB per cartridge. Zip cartridges donít interchange with standard floppy diskettes. Data transfer rates are slightly faster than 2.88MB drives.

ACCELERATED FLOPPY DRIVES

CSC manufactures accelerated floppy drive/controller kits for workstations and diskette duplication. These drives combine an intelligent controller with 1.5MB cache memory and a special drive mechanism.The drive mechanism uses faster spindle speeds and simultaneous double sided (SDS) data transfer to achieve performance which is typically 10 times that of standard, uncached drives. Call (408) 734-DISK for more information on X10 floppy drives.

FLOPPY DRIVE LIST

The floppy drive list below is designed to aid in identifying some of the more common floppy drives.

Manufacturer	Model No.	Drive Type
CannonMD	5501	1.2MB
Chinnon	F2506	1.2MB
Fujitsu	2532	720K
Fujitsu	2537	1.44MB
Fujitsu	2551	360K
Fujitsu	2553	1.2MB
Mitsubishi	MB4853	360K
Tandon	75-8	1.2MB
Toshiba	FDD4603	720K
Toshiba	FDD6471	360K
Toshiba	FDD6784	1.2MB
Toshiba	FDD6882	1.2MB
Teac	55BV	360K
Teac	55GFV	1.2MB
Teac	FD-235A	1.44MB
Teac	FD-235HG	1.44MB
YE-Data	646	720K

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OPTICAL DISK DRIVE TECHNOLOGY

OPTICAL DISK DRIVE TECHNOLOGY

There is a constant struggle between optical and magnetic disk drive manufacturers. Respected industry analysts have predicted that optical drives may 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. Most hard drives employ only one closed loop servo system. Most optical drive employ two or three servo systems. These servo systems interact, making it more difficult to design optical drives for high performance.

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 $200. The equivalent optical drive costs about $1000. 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 $60. The total cost of 20GB of storage with the optical drive is $2200, but the total cost of a magnetic system is $4000!

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Optical removability only makes sense in applications where large amounts of data can be stored without 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-ROMs produced one at a time are called one-off disks. One-offs are produced using a CD compatible WORM disk, called a CD-R drive. See the CD-R chapter for more information on how this is done.

CD-ROM Drives

CD-ROM disks are the future of software distribution. Instead of distributing programs on floppy diskettes, software manufacturers have switched to CD-Rom. In quantity, a 650MB CD-ROM costs around 50 cents to produce. This compares with a cost of 25 cents 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 $30.

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 drives are available with capacities of up to 15GB per disk. WORM media is also usually much cheaper than erasable optical media.

Driver software is often used with WORM drives so that the inability to erase becomes invisible to the operating system. When previously recorded 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

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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. Drive software is needed only for hot cartridge changing of the media while the operating system is running.

Newer erasable opticals record on both sides of the media and store 2600MB 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 Hewlett Packard erasable drives offer access times approaching hard disks. These drives are among the highest performance optical drives available.

DVD AND HDCD

The future of WORM disks will lie in one of two competing technologies. The Digital Video Disk (DVD) standard is currently being developed by a consortium of 10 consumer electronics companies, and will likely become an industry standard. DVD disks are double sided and hold 5GB of data per side. This is enough for both computer applications and home video.

DVD's competitor is High Density Compact Disk (HDCD)

HDCDisks hold 3.7GB per layer. Current standards proposed by Phillips (the original creator of CD-ROM), support 2 layers for a total capacity of 7.4GB per single sided disk. HDCD drives will also be able to read exsisting CD-ROM and CD-audio disks. Although the HDCD standard appears technically more robust than DVD, it won't necessarily become the industry standard. The first manufacturer with volume availability of products will likely determine the market.

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OPTICAL DISK CAPACITY

Erasable Drive Capacities

Form Factor	Generation	Capacity	Typical Access
3.5"	1	128MB	65ms
3.5"	2	230MB	35ms
3.5"	3	650MB	30ms
5.25"	1	650MB	65ms
5.25"	2	1.3GB	30ms
5.25"	3	2.6GB	25ms
12"Nikon	1	8GB	40ms

WORM Drive Capacities

Form Factor	Generation	Capacity	Typical Access
CD-R	1	650MB	100ms
DVD	1	5GB	60ms
HDCD	1	3.7GB	60ms
HDCD (2 layer)	2	7.4GB	60ms
12" Sony	1	15GB	40ms

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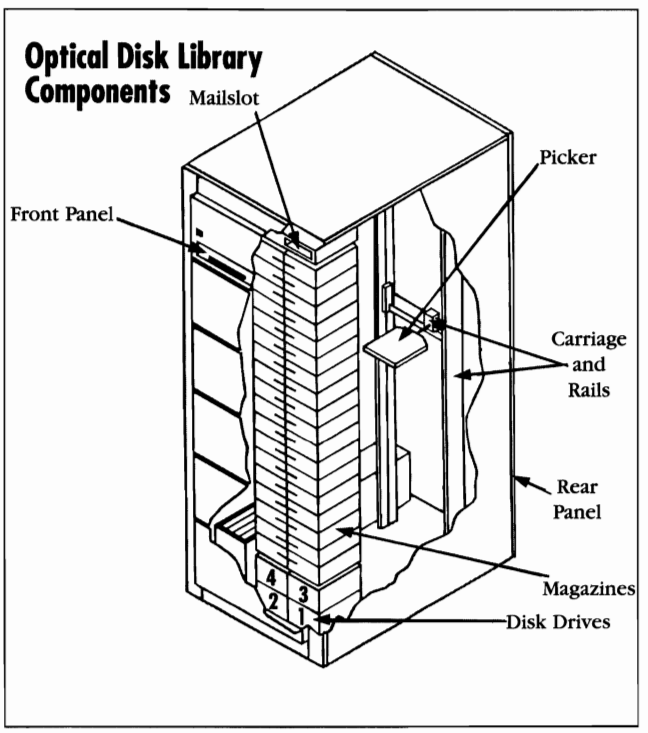
OPTICAL JUKEBOXES

New erasable optical drives offer removability, reliability, and performance approaching hard drive speeds. The catch is that it's tough to find a reliable optical drive that stores more than 2.6GB per cartridge. The simple solution is to add more cartridges. Optical cartridges are cheap, removable, easy to ship, and reliable. Here's where optical jukeboxes fit in. They work just like the old Wurlitzer jukebox at the pool hall.

An optical jukebox is a computer controlled robotics mechanism designed to insert and remove cartridges quickly. Larger jukeboxes (like the HP unit pictured below) may have several drives fed from a library of cartridges. These drives are connected to an array controller that can "stripe" data between cartridges to increase performance. Additional drives can be added to form a RAID style array which can be configured to offer redundancy.

This HP jukebox uses a feed tray to insert cartridges, storing them in the magazine located in the center of the drive. A system of DC servo motors move a "pick arm" which shuttles up and down the stack of cartridges. The pick are also moves horizontally



HP Jukebox

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to select different stacks and drives. This particular jukebox can "feel" the cartridges by sensing differences in the pressure required to move the pick arm.

The performance of a jukebox is rated in changing time and reliability. Typical changing times range from 5 to 60 seconds per cartridge switch. This makes jukeboxes useful primarily for "near on line" storage applications.

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OPTICAL DRIVE SPECIFICATIONS

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	594MB	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	-	-
ISS10-M	5.25"	WMRM	592MB	83ms	SCSI(S)	-	-
ISS20-D,T,S,R	5.25"	WMRM	1184MB	83ms	SCSI(S)	-	-
APT Odessa							
ROS-3250EIS	5.25"	WMRM	560MB	107ms	SCSI	-	-

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MODEL NUMBER	FORM FACTOR	TYPE	CAPACITY	ACCESS TIME	INTERFACE	MEDIA	AUDIO
Apple Computer							
CD SC	5.25" FH	-	550MB	600ms	SCSI-M	Disk	Yes
Axis Computer							
RO-5030E	5.25"	WMRM	652MB	67ms	SCSI	-	-
ASC							
MO-55	5.25"	WMRM	596MB	49ms	SCSI	-	-
CD Technology							
T3201Portadrive	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 System							
OptiServer 600	5.25"	WMRM	595MB	67ms	SCSI	-	-
OptiServer 650	5.25"	WMRM	595MB	67ms	SCSI	-	-
Denon							
DRD-253	5.25" HH	RO	-	400ms	SCSI	-	Yes
Dophin Systems							
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	-	-
ROS600	5.25"	WMRM	600MB	50ms	SCSI	-	-
Exsys Storage							
Laser RA-2M	5.25"	WMRM	934MB	35ms	SDI	-	-

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MODEL NUMBER	FORM FACTOR	TYPE	CAPACITY	ACCESS TIME	INTERFACE	MEDIA	AUDIO
Exsys Storage (continued...)							
Laser RA-2S	5.25"	WMRM	674MB	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	3.5"	WMRM	-	-	SCSI	-	-
Laser Magnetics							
CM-201	5.25" HH	RO	600MB	400ms	IDE	Cart	Digital
CM-212	5.25" HH	RO	600MB	400ms	SCSI	Cart	Digital
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	-
D-4100	Rack	WMRM	5.6GB	80ms	SCSI	Cart	-
LF-4500	Rack	WMRM	28.0GB	80ms	SCSI	Cart	-

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MODEL NUMBER	FORM FACTOR	TYPE	CAPACITY	ACCESS TIME	INTERFACE	MEDIA	AUDIO
M.O.S.T.							
RMD-5100-S	3.5" HH	WMRM	128MB	35ms	SCSI	-	-
Macsetra							
Genesis 6000	5.25"	WMRM	600MB	95ms	SCSI	-	-
Maxcess							
M-600L	5.25"	WMRM	600MB	95ms	SCSI	-	-
Maxoptix							
RXT-800HS	5.25" HH	WORM	786MB	35ms	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" HH	RO	600MB	350ms	SCSI	Disk	-
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	-	-
NEC							
CDR-73	5.25" HH	RO	600MB	300ms	SCSI	-	Yes
N/Hance							
R6501mce-DOS,LAN,OS/2	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	-	-

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MODEL NUMBER	FORM FACTOR	TYPE	CAPACITY	ACCESS TIME	INTERFACE	MEDIA	AUDIO
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" HH	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	53m	SCSI	Cart	-
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	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

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MODEL NUMBER	FORM FACTOR	TYPE	CAPACITY	ACCESS TIME	INTERFACE	MEDIA	AUDIO
Reference Technology *(continued...)*							
500AT Int. SCSI	5.25" HH	RO	-	500ms	SCSI	Disk	Optical
500PS2 External	5.25" HH	RO	-	500ms	PRO	Disk	Optical
500PS2 Ext SCSI	5.25" HH	RO	-	500ms	SCSI	Disk	Optical
Relax Technology							
500AT Dual SCSI	5.25" HH	RO	-	500ms	SCSI	Disk	Optical
Ricoh							
RO-5030E II	5.25" HH	WMRM	652MB	67ms	SCSI	Cart	-
RA-9100H	5.25" HH	WORM	800MB	168ms	SCSI	Cart	-
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 Company							
SO-600	5.25"	WMRM	594MB	900ms	SCSI	-	-
Sumo System							
RSSM600-C	5.25"	WMRM	594MB	50ms	SCSI	Cart	-
RSSM600 DEC	5.25"	WMRM	594MB	50ms	SCSI	Cart	-
RSSM600S(Sun)	5.25"	WMRM	594MB	50ms	SCSI(S)	Cart	-
Tandy							
CDR-1000	5.25"	RO	600MB	1000ms	Prop	-	-
Techmar							
Laservault	5.25"	WMRM	1000MB	107ms	SCSI	-	-

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MODEL NUMBER	FORM FACTOR	TYPE	CAPACITY	ACCESS TIME	INTERFACE	MEDIA	AUDIO
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	-	-
WM-070	5.25"	WORM	900MB	90ms	SCSI	-	-
XM-3301-A1 MAC	5.25" HH	RO	600MB	350ms	SCSI(M)	-	Yes
XM-3201-A1 PC	5.25" HH	RO	600MB	350ms	SCSI	-	Yes
XM-3201-PS/2	5.25" HH	RO	600MB	350ms	SCSI	-	Yes
XM-3201B	5.25" HH	RO	683MB	350ms	SCSI	Cart	Yes
XM-5100A	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	-	-
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)	-	-
QT-1000-U	5.25"	WMRM	1000MB	35ms	Unibus	-	-
Xyxis							
XY600RW	5.25"	WMRM	574MB	61ms	SCSI	-	-
Zetaco							
SKR-600	5.25"	WMRM	650MB	95ms	SCSI	-	-

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TAPE DRIVES

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. Some newer floppy controller chips, like the Intel 82078SL and National Semiconductor 8477 can support 1Mbit/sec transfer rates with newer drives. National Semiconductor integrated motherboard floppy and PCI I/O controllers also support 1Mbit/sec transfer rates. Some new chips will support 2Mbit/sec transfer rates, although we aren't aware of any tape drives that can run that fast.

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. Pertec and Fujitsu 9 track drives are still commonly used for information interchange between minicomputers, mainframes, and PC's.

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QIC02

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 to 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 1/4 tape drives. Many companies offer "bridge controllers" that connect QIC-02 and QIC-36 drives to the SCSI bus. Faster high end tape drives are also available with Fast & Wide SCSI-II interfaces.

ESCON

Escon is IBM's standardized high performance mainframe optical fiber interface. Escon is used only on high end tape and disk storage arrays.

FIRE WIRE

The Fire Wire interface has recently been standardized by the IEEE. Fire Wire interfaces are now available on high end tape drives.

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 advertis-

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ing 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. Some tape drives include data compression algorithms on the drive. Examples of these are the Exabyte 8505CS and Archive DDS-2 autoloaders.

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. While certain manufacturers may advertise floppy tape drives with capacities of 800MB or more, many of these drives store less than 300MB of data (not including compression). As we mentioned earlier, many types of data will not compress at all!

Another main consideration in selecting a tape drive is data transfer rate. In PC applications, floppy tape drives are generally the slowest and SCSI drives are generally the fastest available. Using data compression can slow data transfer significantly. The table below lists the backup times and transfer rates of some typical drives tested at CSC. These real world tests were made with a CSC Wide/Narrow SCSI card connected to an Intel 120mhz Pentium motherboard. The actual transfer rate and backup time you achieve will depend on several factors including: processor speed, bus speed, hard drive speed, and controller setup. So the performance you get may differ, but this chart does provide a relative reference.

TAPE DRIVE RELATIVE PERFORMANCE TESTS

Tape Drive:	Archive/Conner 2750 1/4î"
Interface :	Fast SCSI-II
Controller:	CSC PCI Wide/Narrow
Rated Capacity:	1350MB
Honest Capacity:	1388MB to end of Tape
Entire tape transfer Rate:	17.5MB/minute
Time to write 100MB:	6 minutes
Average Price (May, 1996):	$195

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Tape Drive:	Exabyte 8500CS 8mm
Interface :	Fast SCSI-II
Controller:	CSC PCI Wide/Narrow
Rated Capacity:	5000MB
Honest Capacity:	4870MB to end of Tape
Entire tape transfer Rate:	9.1MB/minute
Time to write 100MB:	10 minutes
Average Price (May, 1996)	$1595

Tape Drive:	Archive/ConnerDDS-2 Autloader P/N 4586NP
Interface :	Fast SCSI-II
Controller:	CSC PCI Wide/Narrow
Rated Capacity:	4000MB per tape, 48GB per 12 tape cartridge
Honest Capacity:	4000MB to end of Tape
Entire tape transfer Rate:	14.6MB/minute
Time to write 100MB:	6 minutes
Average Price (May, 1996)	$895

Tape Drive:	DEC/Quantum DLT 10
Interface :	Fast SCSI-II
Controller:	CSC PCI Wide/Narrow
Rated Capacity:	10GB per tape
Honest Capacity:	10540MB to end of Tape
Entire tape transfer Rate:	14.6MB/minute
Time to write 100MB:	6 minutes
Average Price (May, 1996):	$1795

Tape Drive:	Archive/Conner Travan
Interface :	Floppy Controller
Rated Capacity:	800MB per tape
Honest Capacity:	425MB to end of Tape
Entire tape transfer Rate:	4.5MB/minute
Time to write 100MB:	20 minutes
Average Price (May, 1996):	$149

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Tape Drive:	PerSci 9 Track 6250BPI reel-reel
Interface:	Pertec
Controller:	MicroTech
Capacity with 9" tape:	165MB
Transfer Rate:	5MB/minute
Time to write 40MB:	8 minutes
Average Price (May, 1996):	$2195

It's interesting to note that the 8mm drives offer a transfer rate similar to the DAT drives, although advertising purports that 8mm is much faster. The speed of the floppy tape drive was slower than most CD-Writers.

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. Some thin tapes tend to tear under heavy use. If you don't need the extra capacity that extended length tapes provide, or if you use your tapes frequently, a standard length tape will prove more reliable. Thinner tapes often have an XL added to the tape part number. The chart below lists the standard capacities of most common standard and extra length tape cartridges.

STANDARD TAPE CAPACITY

Cartridge Type	*Length (feet)*	*Tracks*	*Capacity (no compression)*
DC 100	10MB	16	10MB
DC 1000	100	16	10MB
DC 1000 Alphamat	100	24	20MB
DC 2000	200	24	40MB
DC 2000XL	200	24	60MB
DC 2120	220	30	120MB
DC 2120XL	220	30	170MB
QW5122F	222	30	208MB
.315"Travan TR1	350	30	400MB
DC 615	150	9	15MB
DC 600	600	9	60MB
DC 600A	600	9	60MB

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STANDARD TAPE CAPACITY
(continued....)

Cartridge Type	Length (feet)	Tracks	Capacity (no compression)
DC 600A	600	9	60MB
DC 600XTD	600	15	125MB
DC 600XL	960	15	200MB
DC 6135	1000	41	1350MB
.315" 3M Travan TR2	800	24	600MB
.315" 3M Travan TR3	1200	24	1600MB
1/2" IBM 3480 Cart	200	18	200MB
1/2" IBM 3490 Cart	400	36	800MB
1/2" IBM 3490E Cart	400	36	800MB
4MM DAT (DDS-1)	275	Helical Scan	1300MB
4MM DAT (DDS-1)	275	Helical Scan	2000MB
4MM DAT (DDS-2)	275	Helical Scan	4000MB
4MM DAT (DDS-2)	360	Helical Scan	6000MB
8MM Exabyte 8200	175	Helical Scan	2200MB
8MM Exabyte 8500	175	Helical Scan	5000MB
DLT 2.6	200	Serpentine	2600MB
DLT 6.0	200	Serpentine	6000MB
DLT 10.0	200	Serpentine	10GB
Sony ID2	1500	Helical Scan	175GB
Ampex DST	2000	Helical Scan	165GB

Reel to Reel Tapes

9 TRACK 800BPI	2400'	9	20.7MB
9 TRACK 1600BPI	2400'	9	41.5MB
9 TRACK 6250BPI	2400'	9	162MB

Tape Technology Improvements

1/4 Improvements

Minnesota Mining and Manufacturing (The 3M Company) continues to push the capacities of its 1/4 and Travan tapes. In an attempt to enter the midrange market, capacities of 100GB per 1/4 cartridge are planned for late 1998. Tape widths have been increased to .315"

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per cartridge, and an attempt is being made to make the newer drives downward compatible with older 1/4 cartridges.

Travan

Travan is a 3M trademark for data minicartridges used mainly in PC applications. Travan tapes are up to 750 feet long and are slightly wider (.065") than previous generations of floppy tape minicartridges.

Most manufacturers (including Colorado, Mountain and Conner/Archive) have modified their drives to handle the slightly larger Travan cartridge. Most of these drives can read and write smaller capacity cartridges from the same QIC family. This makes the following tapes generally compatible in newer QIC-80 drives:

DC2120	120MB
DC2120XL	170MB
QW5122F	208MB
TR1(Travan)	400MB

The newer TR3 series of cartridges are available in the following capacities:

DC3010XL	346MB
QW3010XLF	425MB
DC3020XL	692MB
QW3020XLF	850MB
TR3	1600MB

4mm Improvements

Current 4mm DAT drives store between 1.3GB per 90M tape in DDS-1format to 6GB per 120 meter tape in DDS-2 format. Attempts are being made to increase tape lengths to 200 meters while maintaining acceptable reliability. DAT drives already use sophisticated tape tensioning controls to avoid stretching and damaging tapes. New standards should increase DAT capacity to 10GB per cartridge in the near future.

8mm Future Improvements

One manufacturer, Exabyte Corporation, appears to hold a lock on

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8mm tape drive production. All their products use the SCSI interface, and have evolved from the original 220KB/sec EXB 8200 2.2GB model that offered good reliability but slow seek times, to the current EXB 8500 series which holds 5GB per tape and transfers at 500 KB/sec. Their new product is called Mammoth and holds 20GB uncompressed per cartridge, at sustained transfer rates of 1.1MB/s. As of May, 1996, the Mammoth had not reached the market in volume. DLT drives are significant competitors to 8mm products, and may overtake Exabyte drives in the future.

DLT Future Improvements

DLT was originally developed by DEC in the late 1980's, and stands for Digital Linear tape. DEC grew the technology to hold over 10GB per tape. Quantum purchased this production line from DEC in 1995. Development continues on tapes that will hold over 50GB in the near future. DLT drives hold the best reputation for reliability and have fast transfer rates (1.265MB/sec sustained for DLT20 drives). Prices on DLT drives are significantly higher than 8mm drives, but in mission critical applications, the extra reliability may be worth it. DLT drives have a good reputation for downward compatibility, so you can expect the newer drives to read DLT tapes you may already have. DEC also builds autoloaders for these drives.

ID1 and ID2 Tape drives

4mm and 8mm tape drives were originally intended for consumer applications like Digital Audio Tape and video camcorders. Two types of video tape (D1 and D2) have now been adapted for computer data storage. These 3/4 helical scan drives are produced by Sony Corporation, and are highly modified versions of professional video recorders. These drives pump data at up to 40MB/sec an store up to 175GB per tape. These high end drives are extremely expensive (around $125K), but transfer rates are impressive, and they provide good competition for tape drive arrays in fast applications. Sony continues to improve the reliability and tape wear characteristics of these drives. Capacities over 250GB per tape are expected soon.

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CSC BENCHMARK TESTS

CSC Benchmark Tests

CSC has selected several high performance drives for review. The average seek times are those advertised by the manufacturer, along with actual test results. Seek times were tested on Flexstar factory testers of the type used for factory final test.

Our PCI test computer was an Intel PCI motherboard with a 120MHz Pentium Processor. We used the CSC PCI wide/narrow controller to connect SCSI drives, and the on-board IDE connector for testing IDE drives.

Model:	Maxtor 71626AP E-IDE
Formatted Capacity:	1620MB
Rated Average Seek:	14
Tested Average Seek:	13.7
Rated MTBF:	300,000 hours
Average Data Transfer Rate:	3,105KB/sec

Model:	Conner CFP31200A E-IDE
Formatted Capacity:	1200MB
Rated Average Seek:	15ms
Tested Average Seek:	15.3ms
Rated MTBF:	350,000 hours
Average Data Transfer Rate:	2,630KB/sec

Model:	Western Digital WDAP200 IDE
Formatted Capacity:	212MB
Rated Average Seek:	12ms
Tested Average Seek:	14.7ms

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Rated MTBF:	150,000 hours
Average Data Transfer Rate:	1,420KB/sec

Model:	Seagate ST15150WC SCA
Formatted Capacity:	4200MB
Rated Average Seek:	8ms
Tested Average Seek:	8.2ms
Rated MTBF:	300,000 hours
Average Data Transfer Rate:	5,240KB/sec

Model:	Seagate ST32550W WIDE
Formatted Capacity:	2100MB
Rated Average Seek:	8ms
Tested Average Seek:	8.6ms
Rated MTBF:	300,000 hours
Average Data Transfer Rate:	4,130KB/sec

Model:	Micropolis 2217AV
Formatted Capacity:	2044MB
Rated Average Seek:	10ms
Tested Average Seek:	9.2ms
Rated MTBF:	300,000 hours
Average Data Transfer Rate:	3,110KB/sec

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SOFTWARE

SOFTWARE

The software included with the Hard Drive Bible is a collection of disk utilities that you will find useful. This software is copyrighted by the various authors of the programs and provided through the courtesy and with the written permission from manufacturers including Maxtor Corporation and Seagate Technologies. Some of the programs are referred to as "shareware", which is a means of distributing software for evaluation before paying for it.

All of the programs have their own documentation and indicate whether a fee is required after an evaluation period. A software utility called PKUNZIP is provided by PKWare, Inc., and is used by typing:

PKUNZIP<filename>

If you need a manual for a difficult to find drive (including those not listed in the jumpers section), try our automatic document printer. To install the document printer, type:

HDBDOC<return>

or select it from the Windows file manager. The document printer includes manuals for CSC products, including the disk drives sold by CSC.

DISCLAIMER

CSC, DTC, Maxtor Corporation, and Seagate Technology expressly disclaim any liability which may arise from the use of the software

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included with the Hard Drive Bible. To the best of our knowledge, this software is workable and free of any major bugs, but no guarantee of performance of 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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This list of the most commonly used CD-ROM files is provided by Maxtor Corporation:

1ADAY10.ZIP MAIN
116K 09/92 Run files daily, weekly, monthly
Runs files once a day, weekly, or on a certain day of the month.

2SOCKET.DOC PCMCIA
2.7K 11/94 Socket App for >=10MB flashcards
2-Socket application for 10MB or greater Flashcards. This docu ment is in WS for Windows 2.0 Format.

3DRVS260.ZIP MAIN
73K 11/93 Driver for 3 drives in one system
Device driver to add a 2nd 16bit HDD interface to your DOS AT (286+) system. Windows compatible.
Shareware, version 2.60 by Dustbowl Designs

4DRVU100.ZIP MAIN
32K 11/93 Inquiry utility for up to 4 drives
Inquiry for drives on both primary and secondary drive ports.
Shareware, V1.0 by Dustbowl Designs.

4SPD100.ZIP MAIN
64K 11/93 Graphical HDD data transfer rate test utility
Graphical Hard Drive Test utility.
Shareware, V1.0 by Dustbowl Designs

7000LLF.EXE MAIN
47K 03/96 7000 A series Low Level Format program
Self-extracting zip file.

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7000LLF.EXE MAIN

47K 03/96 7000A series Low Level format program.
Self-extracting zip file.

ACCULOG.TXT 3RDPARTY

5.9 10/93 Acculogic IDE controller card documentation.

AMIGA.ZIP MAIN

3.5K 12/93 Notes on installing IDE & SCSI's on Amiga
Amiga computer installation notes and tips.

AN001HP.DOC PCMCIA

15K 1MB Flashcard install into HP 95LX PC
1MB Flashcard installation procedure for HP 95LX Palmtop PC.
This document is in MS Word for Windows 2.0 format.

AN002HP.DOC PCMCIA

12K 11/94 2MB+ Flashcard install into PP 95LS PC
2MB thru 20MB Flashcard installation procedure for HP 95LX
Palmtop PC. This document is in MS Word for Windows 2.0 format.

AN003HP.DOC PCMCIA

12K 11/94 1MB Flashcard install into HP x00LX PC
1MB Flashcard installation procedure for HP 100LX/200LX
Palmtop. This document is in MS Word for Windows 2.0 format

AN004HP.DOC PCMCIA

10K 11/94 2MB+ Flashcard install into HP x00LX PC
2MB thru 20MB Flashcard installation procedure for HP 100
LX/200LX Palmtop PC. This document is in MS Word for Windows
2.0 format.

ASPITOOL.ZIP MAIN

2.4K 06/92 Tahiti Temp (TX-TEMP) /Scan
(SCANS The To Files (TX-TEMP/SCANSCSI) are to little tools to
check the temperature of a MaxOptix Tahiti Sub-System
(TX-TEMP) and Scanning all Host Adapters for SCSI-Devices
(SCANSCSI). All you need is an ASPI-DOS Driver installed for
each Host Adapter.
Christoph Kummer/datacomp ag/Switzerland

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AT_V1.ZIP MAIN

11K 09/92 ASPI-TOOLS

ASPI-Tool contains some programs such as SCSISCAN, UNITATTN.EXE, TX-TEMP.EX, FMT-512, FMT-1024. Please put this file on the Banyon for Michael Davis, Maxtor UK.

AUTOCORE.EXE MAIN

101K 02/95 Runs CORETEST in "automatic" mode. That is, it executes Coretest several times changing bl size each time. CORETEST TEST UTILITY

BEEPCODE.DOC MAIN

652 11/93 Beep error codes for AMI BIOS's

List of what errors the Beep codes stand for in the American Megatrends International BIOS.

BIOSBNC.ZIP MAIN

159K 08/93 BIOS Bench Mark

Maxtor's BIOS Benchmark Program. Sorry, no documents, how to use it and interpretation of results is up to you.

OTT140.ZIP MAIN

81K 10/93 Boot Mgt Pgm

Manages boot up environments, ie: different CONFIG.SYS and AUTOEXEC.BAT

CACHE.EXE MAIN

3.6K 08/93 Turn 7000A CACHE on or off.

CARD112.EXE PCMCIA

49K 06/94 Cardlock - Lock access to MobileMax Drvs

Cardlock V1.12 Limits access to your MobileMax card with single or multiple passwords.

CARDTALK.EXE PCMCIA

618K 11/94 Cardtalk V2.20.15 drivers for deskrunner

Cardtalk V2.20.15 drivers for Maxtor's Deskrunner PC/AT PCMCIA adapter.

Self-extracting ZIP file.

CLEAN112.ZIP MAIN

271K 03/94 McAffee Virus Clean V112.

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COMPORT.DOC PCMCIA

4.2K 11/94 Deskrunner COM Port problem tips
Some solutions for COM port problems encountered while installing Deskrunner. This document is in MS Word for Windows 2.0 format.

CORETEST.EXE MAIN

64K 05/88 CORETEST - Hard disk benchmark utility.

CT-303.EXE PCMCIA

944K 07/94 Cardtalk V3.03 for Maxtor Deskrunner
Self-extracting ZIP file.

DBK310.ZIP PCMCIA

1.1 05/95 Latest release of Desk Runner Drivers.
5/11/95

DESKRUNR.TXT PCMCIA

4.7K 01/94 PC/AT Adapter for desktop computers.

DISABLE MAIN

23K 10/93 MAC pgm. Make MXT drives MAC Compat.
Makes MXT-1240s & mxt-540Sl Macintosh compatible by disabling Unit Attention. MAC Pgm should have Extent of NIT!

DISK.ID PCMCIA

63 07/94 Correct ID file for DRUNR303.EXE.

DMOS2INS.TXT MAIN

4.4K 04/95 Installation procedure for Disk Manager and OS
Written by: David Meisner.
For reference only. Contact IBM for support.

DO-ONC14.ZIP MAIN

10K 10/92 Run a file once a day or week
Runs a file once a day or once a week on bootup, for instance; CHKDSK 1st thing in the morning or a Virus Check every Monday.

DQWIK211.ZIP MAIN

129K 08/94 DiskQwik v2.11 - D.Driver activates IDE block mode transfer.

DRS120.ZIP MAIN

114K 02/92 Data Recovery Software. Reads BAD disks.

DRVSYS.TXT PCMCIA

2.0K 11/94 Adjusting CardTalk Drv Letter Assignment
How to use DRIVER.SYS to reassign the drive letter for your PCMCIA Hardrive in a DESKRUNNER PCMCIA Adapter.

DSKPDR.EXE MAIN

69K 10/93 HDD Diagnostic Pgm V1.6 Self-extracting
Tests IDE drives, either destructive or non-destructive.
By Larry Clanton
Self-extracting Zip file.

DSK_APP.DOC PCMCIA

5.2K 11/94 Deskrunner installation tips
Troubleshooting tips for installing MobileMax 1.8" hard drive disks into Deskrunner PC/AT to PCMCIA adapter. This document is in MS Word for Windows 2.0 format.

DUGIDE10.ZIP MAIN

12K 01/93 Show the IDE disk info. Includes C source code.

DYNABOOT.ZIP MAIN

32K 10/93 Boot Mgr Pgm
Boot up management, ie: different AUTOEXEC.BAT and CONFIG.SYS files.

ESDI.ZIP MAIN

13K 08/93 Spec & Jumpers for ESDI drives
Specifications & jumpers for all ESDI drives.

ESDIDISK.EXE MAIN

63K 08/93 Compsurf Novell 2.15C w/WD1007-9 Ctlr
A version of "Compsurf" to initialize Maxtor ESDI drives for Novell Versions 2.15 to 2.2 (use this instead of the Novell supplied version of Compsurf). ESDI controllers ONLY!

ESTIM11.ZIP MAIN

22K 11/94 Estimate storage needs for back-up of files on hard disk.

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FAQ20A.ZIP MAIN
22K 07/92 Frequently Asked Questions about OS/2 v2.0

FBECCS.ZIP MAIN
11K 10/93 FBE Config Control Sys V1.5
Boot manager program.

FIPS12.ZIP MAIN
104K 11/94 FIPS: Nondestructive partition split utility.

FLEXP300.ZIP MAIN
217K 07/93 Flexiback Plus:
Hard disk backup with compression.

FRE561.ZIP MAIN
20K 01/94 Multi-drive disk space check info with graphic display.

GEOCLOCK.ZIP MAIN
103K 10/93 Colorful world clock/map
Shows world map with daylite/night time shadow.

GREENDRV.ZIP MAIN
11K 04/94 To place 7000A drives in "sleep mode".
Programmable standby mode. Cause drive to spin down and park after X amount of time with no activity. X = 20 sec. to 21.2 minutes. Energy Star compiant, AKA Green PC. (Replaces SPINDOWN.EXE).
Version 2.2 by Sean Dykstra

HIDDIR.ZIP MAIN
45K 08/93 Creates and manipulates hidden Dir's.
Creates and manipulates Hidden directories under the MS/PC DOS environment. Great for parents with curious kids, and vice versa. Doesn't show up in DOS nor in Windows, but are nonetheless still accessible. Source code included, Quick Pascal 1.0

IDE.DOC IDE
2.7K 01/94 Generic "How To" IDE installation
IDE Installation example.

IDE.EXE MAIN

59K 02/94 Self-Extracting ZIP of all IDE drives
Same as the IDE.ZIP file. All IDE drive specifications, jumpers, and parameters.

IDE.ZIP IDE

69K 09/94 Data on all Maxtor IDE drives
Specifications, parameters and jumper settings for Maxtor IDE drives.

IDE.ZIP MAIN

56K 02/94 Specs & Jumpers for all IDE Drives
Specifications & jumper settings for all IDE Drives.

IDEID150.ZIP MAIN

25K 08/93 Displays info on IDE drives.

IDEINF10.ZIP MAIN

30K 08/94 Displays info on IDE drives, including ATA-2.

IDEINFO.ZIP MAIN

3.8K 01/93 Excellent utility reads IDE firmware.

IDENTIFY.EXE MAIN

27K 03/94 To identify IDE drives, Cyl, Hds, Sect.
Identify IDE drives, finds cylinders, heads, sectors per track etc., also shows serial number.

IDE_CMOS.TXT IDE

6.7K 09/94 Parameter listing for IDE drives
List of CMOS parameter settings for all IDE drives.

IDE_CMOS.TXT MAIN

6.7K 09/94 CMOS Parameters for all IDE Drives
CMOS setup parameters for all Maxtor IDE drives.

IDE_CTLR.TXT IDE

1.9K 09/93 Maxtor IDE adapter card
Jumper settings,ANSII drawing for Maxtor IDE adapter card.

LXTLLF.EXE MAIN

37K 03/96 Low Level format program for LXT-xxxA drives.
Self-extracting file.

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LXTLLF.EXE IDE

37K 03/96 Low Level format program for LXT-xxxA drives.
Self-extracting file.

MAX-AT.ZIP MAIN

85K 10/93 Maxtor IDE test program
Maxtor IDE drive test program.

MAXBLAST.EXE MAIN

354K 05/95 Ontrack's Disk Manager v6.03.05
Max-Blast software is required to install drives larger than 528 megabytes on a standard IDE interface or on an older BIOS.
NOTE: *If you are using an EIDE interface this file is NOT required, use the drivers provided with your interface for correct installation.
* Providing your BIOS or interface support LBA.
USEAGE: MAXBLAST -d
This creates the sub-directory for OS/2

MAXOPTIC.ZIP MAIN

815 05/93 Diagnostic Utility for Maxoptic Products
Read, write, compare, low-level format any Maxoptics products - Tahiti, RXT, etc.

MAXTEST.ZIP MAIN

131K 10/93 Test/Modify SCSI Drives
This is a test program for MAXTOR SCSI drives. This program must be used with the Adaptec 154XX Or Bustek 54XX. For more information on this program call Tech Support at 1-800-2MAXTOR. (If you don't have PKZIP, DI, MAXTESTS.EXE)

MAXTESTS.EXE MAIN

134K 10/93 MAXTEST (Self-extracting ZIP)
To modify SCSI drive data table (capacity, bytes per sector, etc).
Must be used with and Adaptec 154X controller (or compatible).
Self-extracting Zip file.

MINISCRB.ZIP MAIN

56K 04/94 Text file on all MiniScribe drives
Covers all MiniScribe drives. May not cover all jumpers tho!
Call 800-262-9867, Option 3 for FAX info Miniscribe jumper setting info.

MXLINIT.EXT PCMCIA

21K 03/94 Initialize MobileMAX 105MB Drive
To initialize the MobileMAX (MXL-105) PCMCIA drive.

MXTA_53.EXE MAIN

41K 03/94 MXT540A/AL Firmware Rev 5.3
MXT540A/AL Firmware Rev 5.3 code.

MXTA_54.EXE MAIN

40K 03/94 MXT540A/AL Firmware Rev 5.3
Firmware Upgrade for MXT_540AT Drive. Use only if you have a problem, or it is recommended by a technician.
Self-extracting ZIP file.

MXTA_55.EXE MAIN

40K 03/94 MXT 540A/AL Firmware Rev 5.5
Firmware Upgrade for MXT-540AT Drive. Use only if you have a problem, should be recommended by a technician.
Self-extracting ZIP file.

MXTA_60.EXE MAIN

41K 03/94 MXT 540A/AL Firmware Rev 6.0
Firmware Upgrade for MXT-540AT Drive. Use only if you have a problem, or it is recommended by a technician.
Self-extracting ZIP file.

MXTLLF.EXE MAIN

30K 04/96 Low Level Format FOR MXT6540A/AL ONLY^M
Self-extracting zip file.

MXTLLF.EXE IDE

30K 04/96 Low Level Format FOR MXT6540A/AL ONLY
Self-extracting zip file

MXT_1-5.ZIP MAIN

205K 01/94 MXT-540/1240S Firmware Upgrade to V1.5
MXT-540S/SL MXT-1240S Firmware upgrade Version 1.5.

MXT_SPIN.ZIP MAIN

175 04/94 MXTxxxxS Spinup delay program
Spinup delay modification for MXT1240S & MXT540S/SL drives. For use if you don't have a big enough power supply to power more than one SCSI drive up at a time. Inserts a 11-13 second spinup delay between drives.

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OMNIBK.DOC PCMCIA

4.0K 11/94 MXL install tips for HP OmniBook300/430 into HP OmniBook 300/430 laptop systems. This document is in MS Word for Windows 2.0 format.

ONBOOT.ZIP MAIN

5.4K 10/93 Control autoexec program executions Have AUTOEXEC programs run daily, on Warmboot only, or on Coldboot only.

OS2IBM75.DOC PCMCIA

6.6K 11/94 MXL install for IBM Thinkpad 750 - OS/2 Tips for MXL drive install into IBM Thinkpad 750 using OS/2. This document is in MS Word for Windows 2.0 format.

OS2TOSH.DOC PCMCIA

7.1K 11/94 MXL install tips for Toshiba - OS/2 Configuration of MXL hard drive in Toshiba T4500,T4600, T4700 systems running OS/2 ver 2.1. This document is in MS Word for Windows 2.0 format

PARKIT.ZIP MAIN

9.4K 09/92 HDD Head park pgm Hard Disk Head parking utility V1.0 by Andrew Appel.

PART.ZIP MAIN

23K 01/94 Provides HD partition table & controller info.

PC-PARK.ZIP MAIN

1.1K 09/92 Head Parking Pgm from PC Mag PC Magazine HDD head parking program.

PCMATA.SYS MAIN

18K 04/95

PCMCIA.EXE PCMCIA

9.0K 01/94 Self-Extract file of all PCMCI devices Self-extracting ZIP file of all PCMCIA devices (MobileMax, MobileMax Flash, DeskRunner)

PCMCIA.ZIP PCMCIA

6.0K 01/94 ZIP file of all PCMCIA devices.

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PKUNZIP.EXE MAIN

28K 03/93 PKUNZIP.EXE V2.04G
PKUNZIP V2.04G 2.1.93.

PKZ204G.EXE MAIN

197K 03/93 Self-extracting PKZIP V2.04G 2/1/93
PKZIP V2.04G 2/1/93 self-extracting file. Contains PKZIP, PKUNZIP, etc.

PLUGNGO.TXT 3RDPARTY

1.2K 05/94 Plug N Go External Parallel IDE Adapter
Adapter to allow use of a 1" high 3.5" IDE drive in an external cabinet w/power supply, IDE to Parallel adapter and software to install.

PRESZ110.ZIP MAIN

58K 12/94 The Partition Resizer.
Safe HD repartitioning.

QDPMI101.ZIP MAIN

70K 03/93 QuarterDeck DOS Protected Mode Interface
DOS Protected Mode Interface V0.9 by QuarterDeck. A companion to QEMM386. Allows PKZIP/UNZIP to use EMS/UMB memory and speed up execution dramaticly! ZIP'd w/V2.04G.

QINFO42.ZIP MAIN

55K 10/93 Quick Info, on Drives, CPU, Speed, etc
Nice display of Drives with usage and space left, CPU type, speed, etc.

RDP391.LHA MAIN

98K 05/93 Amiga IDE read multiple fix V3.91
Latest version of RDPREP for Amiga. Fixes read multiple problems by informing the Amiga to only use 255 sector blocks instead of 256. This keeps the data intact.

REBOOTER.ZIP MAIN

3.6K 10/93 How to build an auto-builder for a BBS.
How-to-text file. If your BBS hangs while no one is around, build this device to automatically reboot the system.

RIPTM153.ZIP MAIN

584K 01/94 Ripterm v1.53
RIP graphics communication package. Try it on this BBS!

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R_UTILS.ZIP 3RDPARTY
110K 10/93 Reynolds Data Recovery Utility Demo.

SALES.ZIP MAIN
1.5K 10/93 Maxtor Nat'l sales office listing
Maxtor Sales Office Information.

SCABV112.ZIP MAIN
252K 03/94 McAfee virus scanner (Feb 1994).

SCN-216E.ZIP MAIN
364K 02/95 VirusScan for DOS new version 2.1.5
(216)02/23/95 by McAfee, Inc.
Scans and cleans PC's/LAN's for known and new viruses.
Requires DOS 3.0+

SCOPE140.EXE MAIN
99K 10/93 RS232 Data Analyzer Scope SelfExtracting
View RS232 data streams to analyze modem/comm problems.
V1.40

SCSI.DOC MAIN
1.7K 01/94 Generic "How To" SCSI Installation.

SCSI.DOC SCSI
1.7K 01/94 Generic "How To" SCSI Installation.
SCSI installation example.

SCSI.ZIP MAIN
205K 05/93 Specs & Jumpers for all SCSI Drives
Specifications & jumper settings for all SCSI Drives.

SCSI.ZIP SCSI
205K 11/93 Specs & jumpers for all SCSI Drives.

SCSI2GO.DOC PCMCIA
3.2K 11/94 MXL install for FD SCSI2GO w/Deskrunner
Configuration of Future Domain SCSI2GO PCMCIA
Controller Kit with the Mobilemax Deskrunner. This document
is in MS Word for Windows 2.0 format

SEEKTIME.TXT MAIN
3.5K 08/93 How drive seek times are determined
Document explaining seektime measurment.

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SIDE3.TXT IDE

1.8K 12/93 Acculogic sIDE-3 IDE Adapter card
IDE-3 Adapter. ANSII Drawing, jumpers, etc.

SMRTDTXT.ZIP MAIN

9.4K 09/92 Text File:MS SMARTDRIVE.SYS & DblBuffer
Text file from MicroSoft about using Smartdrive & Double Buffering

SPINUP.EXE MAIN

42K 05/93 For Panther drives to set Spinup option
For Panther PO-12S or P1-17S drives with "Origional"PCBs. This program sets the Spinup Option to spin when power is applied, or spin up by SCSI ID sequence, or spin up each drive in 13 second intervals. Panther drives with "Common" PCBs use jumpers and don't need this program.

STACK.ZIP PCMCIA

177K 05/95 Stacker files, preloaded on flashcards.

TCAL MAIN

24K 07/94 MXT-S Thermal Calib. on/off for MAC
For MXT-1240S & MXT-540SL Drives. For Macintosh computers Turn TCAL on or off for data streaming. Caution! Let drive "warm up" for about 1 hour before using. Do NOT leave TCAL disable for too long, or drive crash will result.

TCAL.EXE MAIN

24K 07/94 Turn MXT-S Thermal Calibration on/off
For MXT-1240S & MXT-540SL drives. Turn T-Cal on or off from this program. Use with caution, let drive "warm up" for leastone hour befor using. Leaving TCAL off too long (>1 hr) could crash the drive!!! Self-extracting zip file.

TFFS325.ZIP PCMCIA

533K 04/95 True Flash Driver v3.2.05
USEAGE: PKUNZIP TFFS325.ZIP

TIMEPARK.ZIP MAIN

8.9K 09/92 HDD timed head parking pgm
HDD head parking program, moves heads to parking zone after selectable period of HDD inactivity.

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UNITATTN.EXE MAIN

2.3K 0892 Checking UNIT-ATTENTION on SCSI Device
This program is for checking the Unit-Attention (enabled or disabled) on every connected SCSI device supported by the Adaptec-ASPI-Driver.

USABBS.ZIP MAIN

72K 01/95 An extensive listing of USA BBS's!

USAFAX.ZIP MAIN

48K 01/95 Over 100,000 FAX numbers! A must have!

UU520.ZIP MAIN

32K 06/94 YYENCODE/UUDECODE for DOS V5.20
For ASCII encoding and decoding of binary files. Useful for exchanging files through Internet EMail attachments when binary attachments won't work.

V10N04.ZIP MAIN

61K 10/93 PCMag 2/26/92 Incl. MBOOT Boot Manager Program
PC Magazine Vol 10, Number 4. Includes MBOOT boot manager program.

VIRSIM2C.ZIP MAIN

65K 11/94 Virus Simulator Ver 2C<ASAD><ASP>
Audit and demonstrate anti-virus protection.
Rosenthal Engineering's absolute neccessity for anyone serious about virus defense, security and training. "Unreservedly recommended!" by Computer Virus Developments Quarterly. Used in tests conducted by National Software Testing Labs for Software Digest and PC Digest. Written about in Computerworld, Virus Bulletin, Virus News Int., Telecomputing, etc.

WASTED10.ZIP MAIN

28K 12/94 Reports disk space WASTED due to cluster size.

WFWG_FIX.TXT MAIN

789 01/94 Win for WkGrps Fast File Access "Fix"
If you're having problems with Windows for Workgroups, "Fast File Access" not working or working slowly, try these changes.....

WFWIN5.ZIP MAIN

952K 03/95 IBM Driver for OS/2 for drives larger than 528

WPAPERS.ZIP PCMCIA

33K 04/94 PCMCIA White Papers (about PCMCIA)
PCMCIA Whitepapers

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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 if you have a system failure.

Computer

Make: _____
Model: _____
Serial Number: _____

Monitor

Make: _____
Model: _____
Serial Number: _____

System BIOS

Make: _____
Version: _____

Motherboard

Make: _____
Model: _____
Serial Number: _____
Bus Speed: _____
Wait States: _____
Memory Installed: _____

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Floppy Drive A

Make: _____
Model: _____
Capacity: _____
Serial Number: _____

Floppy Drive B

Make: _____
Capacity: _____
Serial Number: _____

Extended Floppy #1

Make: _____
Model: _____
Capacity: _____
Serial Number: _____

Extended Floppy #2

Make: _____
Model: _____
Capacity: _____
Serial Number: _____

Hard Drive #1

Make: _____
Model: _____
Capacity: _____
Serial Number: _____
Heads: _____
Cylinders: _____
Sectors per Track: _____

Hard Drive #2

Make: _____
Model: _____
Capacity: _____
Serial Number: _____
Heads: _____
Cylinders: _____
Sectors per Track: _____

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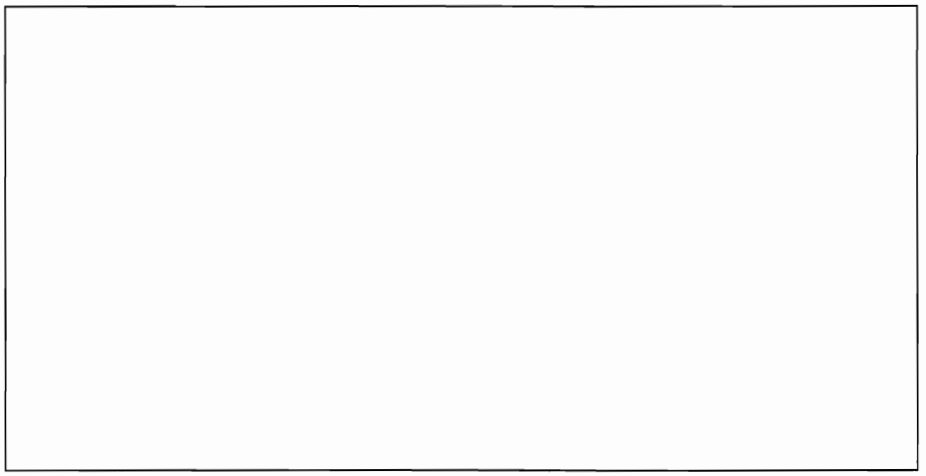
Tape Backup

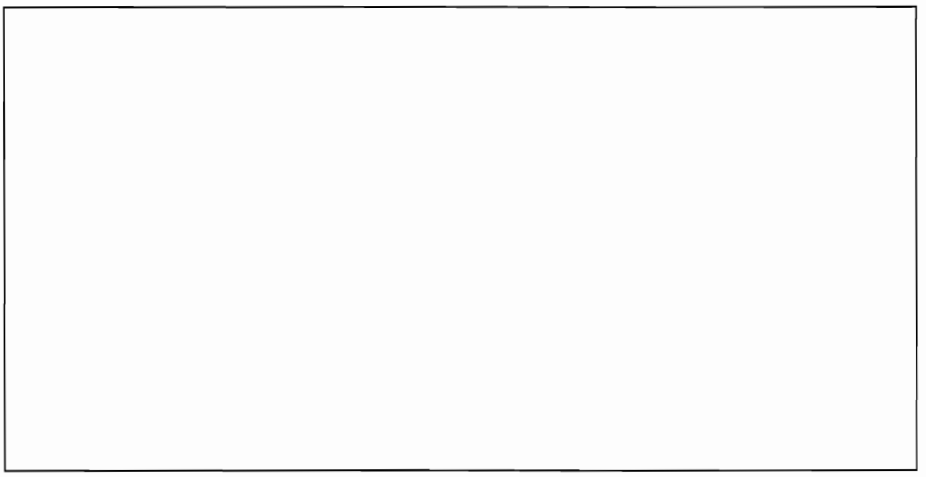
Make: _____
Model: _____
Capacity: _____
Serial Number: _____

You may use the spaces below to paste a printout of your AUTOEXEC.BAT and CONFIG.SYS files.

AUTOEXEC.BAT



CONFIG.SYS



Software

Program: _____
Version: _____
Serial Number: _____

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Program: _____
Version: _____
Serial Number: _____

Program: _____
Version: _____
Serial Number: _____

Program: _____
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Version: _____
Serial Number: _____

Program: _____
Version: _____
Serial Number: _____

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INDUSTRY PHONE NUMBERS

To the best of our knowledge these numbers are correct; but CSC cannot assume liability for their use.

#1 Components, Inc.....(800)424-6780
1776 Inc.....(310)215-1776
Tech Support.....(310)215-1776
3COM Corporation.....(800)876-3266
3D Visions-Stanford.....(800)729-4723
3E Corporation.....(800)682-5175
3G Graphics.....(800)456-0234
Tech Support.....(206)774-3518
3M Company.....(512)984-3897
3M Corporation.....(800)362-3456
Tech Support.....(800)362-3455
3M Data Products-CA.....(800)328-9438
3M Data Products-MN.....(612)736-1866
3M Electrical Prods-TX...(800)225-5373
3PM Planet, Inc.....(319)393-7932
7-Sigma.....(612)721-4280
A Bit Better Sftwr Publ..(206)627-6111
A C Technology.....(714)228-1633
A Cad-Group.....(404)315-8901
A J Computer Supplies..(714)895-5802
A-Comm Electronics.....(201)334-3017
A-Matic International.....(818)855-8888
A.C. Powerline.....(716)288-6870
A.J. Post.....(508)393-7192
A4Tech Corporation.....(714)468-0071
AA Computech.....(800)360-6801
Tech Support.....(805)257-6804
AAA International Co....(714)951-0747
Aadtech Micro Sys.....(415)659-0756
Aamazing Technologies.(714)255-1688
ABA Systems/USA, Inc...(801)561-8681
Abacus Accounting Sys .(403)489-5994
Abacus Concepts.....(800)666-7828
Tech Support.....(510)540-1949
Abacus Concepts.....(800)666-7828
Abacus Software.....(800)451-4319
Abaton-Everex Systems .(800)821-0806
Tech Support.....(800)821-0806
Abbott Systems.....(800)552-9157
Tech Support.....(914)747-4171
ABC Computer Corp.....(310)325-4005
ABC Products.....(714)373-9898
ABC Systems & Devel....(508)463-8602
Abekas Video Systems....(415)369-5111
Aberdeen.....(800)552-6868
Tech Support.....(213)725-3360
ABL Electronics Corp....(410)584-2700
Able Soft.....(800)545-9009
Above Dariana Sftwr .....(800)892-9950
Above Software.....(714)851-2283
Tech Support.....(714)851-2283
Abra MacDabra Sftwr... .(408)737-9454
Abaracadata.....(800)451-4871
Tech Support.....(503)342-3030
Abrams Creative Serv.....(818)343-6365
ABS Cmptr Technology..(800)876-8088
Tech Support.....(800)876-8088
AC & DC.....(818)336-1388
ACC-Alamo City Cmptr..(512)545-1010
ACC Microelectronics.. .(408)980-0622
Access Cmptr Compont.(800)332-3778
Tech Support.....(214)380-8010
Access Technology, Inc..(508)655-9191
Acco USA, Inc.....(708)541-9500
Accolade.....(800)245-7744
Tech Support.....(408)296-8400
Accts Microsystems.....(206)643-2050
AcctonTechnology.....(408)452-4900
Tech Support.....(800)926-9288
Accufast Products.....(800)447-9990
Acculogic.....(714)454-2441
Accurite Technologies...(408)433-1980
Ace Software Corp.....(408)232-0300
Tech Support.....(408)232-0303
Ace Technologoes, Inc...(408)734-0100
.....(800)825-9977
Acecad Inc.....(800)676-4223
Tech Support.....(408)655-9911
Acer America.....(800)848-2237
Acer Peripherals.....(609)924-1153
Acer Technologies Corp .(800)833-8241
Achieva Computer.....(800)388-2918
Tech Support.....(408)894-0200
Aci Us, Inc.....(408)252-4444
Tech Support.....(408)252-4444
ACL Inc.....(800)782-8420
ACM, Inc.....(800)342-6626
Acme Electric Corp.....(800)325-5848
Accoustic Research.....(800)225-9847
AcrossTheOcean Import .(415)660-7804
Action Communications..(612)636-3559
Action Electronics Co.. .(818)813-1500
Action Multimedia.....(800)322-3132
Action Plus Software.....(801)255-0600
Tech Support.....(801)255-0600
Activisilin.....(310)207-4500
.....(310)479-5644
Tech Support.....(310)479-5644
Actix Systems, Inc.....(800)820-1276
Acucobol, Inc.....(800)262-6585
Acumos,Inc.....(415)570-0535
Acxiom Corporation.....(501)329-6836
AD Costas Projects.....(415)462-3111
Tech Support.....(415)426-5040
Ad Lib, Inc.....(800)463-2686
Tech Support.....(418)529-6252
Ad Lib Multimedia, Inc..(418)529-9676
Ad Research.....(800)926-7365
Tech Support.....(800)873-7365
Adaptec.....(408)945-8600
Adaptive Software.....(714)729-3180
Adaptive Technologies...(805)448-8832
ADDA Technologies.....(510)770-9899
Addison-Wesley Publ.....(800)447-2226
ADDS.....(800)645-6504
AddTech Group.....(510)623-7583
AdtronTechnologyCo....(510)770-0120
Allegro MicroSystems....(508)853-5000
ADI Systems, Inc.....(800)228-0530
ADI/Execufold.....(209)683-2126
ADIC.....(800)336-1233
Adisoft, Inc.....(510)483-5605
AdjileSystems.....(800)347-7621
Adobe Systems, Inc.....(800)447-3577
Tech Support - MAC.(408)986-6500
Tech Support - PC... .(408)986-6530
AdRem Technologies.....(416)886-7899
Adtran/PTT.....(205)971-8000
Adv. Instit'l Mgmt. Sftwr..(516)496-7700
Advanced Cmptr Cable.(800)626-3608
AdvancedCmptrInnov....(716)383-1939
AdvancedCmptrTech.....(212)679-4040
Advanced Digital Info....(800)336-1233
Advanced Digital Sys.....(800)888-5244

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Tech Support.....(800)888-5244
Advanced Electr. Supp....(800)446-2377
Advanced Gravis BC.....(800)663-8558
Tech Support.....(604)431-1807
Advanced Hrdwr Arch....(208)883-8000
Tech Support.....(208)883-8001
Advance Input Devises .(208)765-8000
Adv. Integration Rsrch...(408)428-0800
Advanced Logic Rsrch...(800)444-4257
Tech Support.....(714)458-1952
Advanced Matrix Tech...(800)637-7878
Adv. Micro Cmptr Sys....(800)866-0829
Tech Support.....(302)368-9300
Adv. Micro Devices.....(408)732-2400
Adv. Micro Technology...(714)598-6124
Adv. Microcmptr Sys.....(305)784-0900
Advanced Network.....(408)779-2209
Advanced Software.....(800)346-5392
Tech Support.....(408)733-0745
Adv. Tech & Sevices.....(310)676-0487
Tech Support.....(310)676-0487
Advanced Technology....(408)942-1780
Advanced Vision Rsrch..(800)544-6243
Tech Support.....(800)544-6243
Adweeks Mktg Cmptrs..(800)722-6658
AEC Management.....(800)346-9413
Tech Support.....(703)450-2318
AEC Software.....(800)346-9413
Tech Support.....(703)450-2318
AER Energy Resources..(404)433-2127
Aeronics.....(512)258-2303
AESP, Inc.....(305)944-7710
Aetech.....(619)755-1277
Affinity.....(800)367-6771
Tech Support.....(303)442-4840
After Hours Sftwr-Aldus ...(619)558-6000
Tech Support.....(619)558-6000
AgData.....(209)784-5500
AGELogic,Inc.....(619)455-8600
Agfa Compugraphics.....(800)424-8973
Tech Support.....(800)937-7787
Agfa Division.....(914)365-0190
Agfa Division.....(800)424-8973
Ags Computers.....(908)654-4321
Agsadivision.....(508)658-5600
Ahead Systems, Inc.....(510)623-0900
A1 Today.....(304)965-5548
Aicom Corporation.....(408)453-8251
Aim Motherboard Corp .(800)786-2566
Aim Tech.....(603)883-0220
Tech Support.....(603)883-0200
AIQ Systems.....(800)332-2999
Tech Support.....(702)831-2999
Aitech International.....(800)882-8184
AJM, Inc.....(408)980-8631
AJS Publishing.....(310)215-9145
Al Expert Magazine.....(415)905-2200
Alacrity Systems, Inc.....(908)813-2400
Aladdin Sftwr Security...(516)424-5100
Aladdin Systems.....(408)761-6200
Tech Support.....(408)761-6200
Alamo Components.....(800)890-8900
Aldridge Company,The. (800)548-5019
Aldus Corp. (Adobe).....(800)628-2320
Tech Support.....(800)628-2320
Alexander Batteries.....(515)423-8955
Alf Products, Inc.....(800)321-4668
ALfa Power, Inc.....(818)937-6529
Alias Research.....(800)267-8697
Tech Support.....(800)267-8697
Aiisa Systems.....(800)992-5472
Alki Software Corp.....(206)286-2600
All Computers.....(800)387-2744
Tech Support.....(416)960-0111
All Electronics.....(818)904-0524
Allegro Microsystems....(508)853-5000
Allen Communication...(801)537-7800
Allied Cmptr Services....(319)378-1383
Allied Telesis (ATI).....(800)424-4284
Tech Support.....(206)821-2056
AllMicro.....(800)653-4933
Alloy Cmptr Products....(508)486-0900
Tech Support.....(508)486-0900
Allsop, Inc.....(206)734-9090
Allstate Office Supply....(714)692-9100
Alltech Electronics.....(714)543-5011
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ALR.....(714)581-6770
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Tech Support.....(713)353-1510
Alsys.....(617)270-0030
Altec Lansing.....(800)648-6663
Tech Support.....(800)648-6663
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Altex Electronics-Austin....(512)832-9131
Altex Electronics-Corp.....(512)655-8882
Altex Electronics-Dallas....(214)386-8882
Altex Electronics-San Ant..(800)531-5369
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Altsys.....(214)680-2060
Tech Support.....(214)680-2093
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Alumni Computer Grp..(800)387-9785
Always Technologies.....(818)597-1400
Tech Support.....(818)597-9595
Alysis.....(800)825-9747
Tech Support.....(800)825-9747
Alywa Computer Corp..(713)440-1393
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Amdahl Corp .....(800)538-8460
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American Trader's Post..(301)695-8438
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Asian Micro Sources.....(510)376-9111
AsianSource Cmptr Prod.(708)475-1900
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Ask-Me Information Ctr.(612)531-0603
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Tech Support.....(408)746-2965
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Assoc. of Shareware Prof.(317)322-2000
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Astec Co.....(201)595-7001
Astec Standard Power....(619)757-1880
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Astro Memory Prods.....(800)652-7876
Astrocom Corporation..(612)227-8651
Astrotech Int'l Corp.....(412)391-1896
Asymetrix.....(206)637-1500
AT & T Paradyne.....(800)482-3333
At&T.....(201)331-4134
AT&T Capital Corp.....(800)874-7123
AT&T Computer Sys.....(800)247-1212
AT&T Lang. Line Serv.....(800)752-6096
AT&T Microelectronics.(800)372-2447
AT&T Natl Parts Sales Ctr..(800)222-7278
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Atlas Business Solutions..(708)208-1373
Atlas Micro Distributing..(310)530-6300
Atmel Corporation.....(408)441-0311
Atrix International Inc...(800)222-6154
Attachmate Corporation.(800)426-6283
Attain.....(617)776-1110
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Attitude Inc.....(714)680-8112
ATTO Technology, Inc...(716)688-4259
Audio Digital Imaging....(708)439-1335
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Austek Microsystems.....(408)968-8556
Austin Direct, Inc.....(800)752-4171
Austin Marsh Comm.....(416)840-7840
Auto Trol Technology.....(303)452-4919
AutoDesk Inc.....(800)228-3601
Tech Support.....(800)873-3375
Autodesk Retail Prods... (800)228-3601
Tech Support.....(206)487-2934
Automap.....(800)440-6277
Tech Support.....(800)441-6277
Automated Crtrdge Lib..(800)536-2251
Automated Design Sys...(800)366-2552
Automated Tech. System..(516)231-7777
Automatic Data Process'g .(201)994-5000
Automatic Tool/Connect.(800)524-2857
Automation Technology...(800)777-6368
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Avatar/DCA.....(800)348-3221
Tech Support.....(404)740-0300
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Avery International.....(800)252-8379
Tech Support.....(214)888-2699
Avery Label.....(800)252-8379
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Tech Support.....(408)735-1437
Axion.....(800)829-4664
Axis Communications...(508)777-7957
Axonix Corporation.....(800)866-9797
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Axxis Software.....(800)394-3549
Aydin Corporation.....(215)657-7510
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Azerty Inc.....(800)888-8080
Tech Support.....(716)662-7616
Azure Technologies.....(800)233-3800
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Tech Support.....(708)506-1770
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Banctec Service Corp....(800)435-7832
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Tech Support.....(800)225-4350
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Basic Computer.....(216)873-1000
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Tech Support.....(215)296-6180
Bell Atlantic Corp.....(215)963-6000
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Bell Atlantic CTS-CA.....(800)345-7950
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BIT Computer Inc.....(800)935-0209
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Brown-Wagh Publ.....(408)378-3838
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Bruce Krobusek.....(716)258-8722
BSE Company.....(714)258-8722
BSI (Broadax Sys.).....(800)872-4547
Tech Support.....(818)442-7038
BSM Computers.....(800)888-3475
BTECH Inc.....(201)428-1779
Budget Computer.....(800)370-1212
Tech Support.....(800)370-1313
Buerg Software.....(707)778-1811
Buffalo Creek Software..(515)255-9552
Buffalo Products Inc.....(800)345-2356
Tech Support.....(800)345-2027
Bull HN Info. System.....(800)999-2181
Tech Support.....(800)226-4357
Bull Information Sys.....(800)233-2855
Bulldog Cmptr Prods.....(800)438-6039
Bullseye Software.....(702)831-2523
Bureau Development.....(201)808-2700
Tech Support.....(201)808-2700
Bureau of Elect. Publ.....(800)828-4766
Tech Support.....(201)808-2700
Burndy Corporation.....(203)838-4444
Burr-Brown Corp.....(800)227-3947
Burroughs Corp.....(800)247-5617
Bus Cmptr Systems.....(212)627-4485
Buse Communications...(800)521-1117
Business Cmptr Sys.....(800)333-2955
Tech Support.....(804)420-6658
Business Credit Leasing.(800)328-5371
Business Develop. Int'l...(201)891-1040
Business Logistics Serv...(901)395-7112
Business Sense Inc.....(801)963-1384
Business Sys. Direct.....(800)777-4068
Business Vision Mgt Sys.(414)629-3233
BusinessWare Inc.....(714)492-8958
BusinessWise, Inc.....(408)866-5960
BusLogic Inc.....(408)492-9090
Button Ware Inc.....(214)713-6370
Tech Support.....(900)555-8800
Bux Tek Corporation.....(408)492-9090
Buzzwords, Int'l.....(314)334-6317
Byte Brothers.....(206)271-9567
Byte Info. Exch (BIX).....(603)924-7681
BYTE Magazine.....(603)924-9281
Bytel Corporation.....(415)527-1157
Bytronix Corporation....(714)879-0810
C C Steven & Associates..(805)658-0207
C H Products.....(619)598-2518
C Hoelzie Associates.....(714)251-9000
C J Carrigan Ent.....(714)598-1276
C Source.....(816)478-1888
C&D Charter Pwr. Sys....(215)828-9000
C&F Associates.....(800)688-9112
C&S Sales Inc.....(800)292-7711
C-88 International Corp..(408)956-8345
C-Tech Associates Inc....(201)726-9000
C-Tech Electronics, Inc..(800)347-4017
C Itoh Electronics, Inc...(213)327-9100
C2 Micro Systems Inc....(510)683-8888
CA Retail Solutions.....(800)668-3767
CA Technology, Ltd.....(212)260-7661
Cabinets Galore Inc.....(619)586-0555
Cable Connection.....(408)395-6700
Cable Systems, Inc.....(617)389-7080
Cable-Tech.....(817)477-5013
Cables To Go.....(800)225-8646
Cabletron Systems.....(603)332-9400
CableWorks.....(619)450-1929
CablExpress.....(315)476-3000
Cache Computers Inc...(510)226-9922
CACI International Inc..(703)841-7800
CAD & Graphic Cmptrs.(800)288-1611
Tech Support.....(415)647-9671
CAD Warehouse.....(800)487-0485
Tech Support.....(216)487-0631
Cadec Systems, Inc.....(800)223-3220
Cadence Design Sys.....(408)943-1234
CADRE Technology.....(800)548-7645
Caere Corporation.....(800)535-7226
Tech Support.....(800)462-2373
CAF Technology Inc.....(800)289-8299
Cahners Publishing Co..(617)694-3030
Caig Laboratories.....(619)451-1799
Cal-Abco.....(800)669-2226
Calan, Inc.....(800)544-3392
Calcomp.....(800)541-7877
Tech Support.....(800)225-2667
Calculus.....(305)481-2334
Calculus Inc.....(305)481-2334
Calera Recognition Sys..(800)422-5372
Tech Support.....(408)702-0999
Caliper Computer Corp..(213)727-8530
California Peripherals....(213)538-1030
California Sftwr Prods....(714)973-0440
Calif. Switch & Signal.....(310)538-9830
Calluna Technology.....(408)453-4753
CalSOFT Technology.....(805)497-8054
Caltex Software.....(214)522-9840
Caltronex.....(716)359-9780
Calyx Corporation.....(800)558-2208
Tech Support.....(800)866-1008
Calzone Case Co.....(203)367-5766
Cambria Corporation....(609)665-3600
Cambridge Elect. Labs...(617)629-2805
Cameo Communication..(603)465-2940
Camintonn Corporation..(800)843-8336
Campbell Services Inc...(800)345-6747
Tech Support.....(810)559-5955
Canada, External Affairs.(613)993-6576
Canon.....(516)488-6700
Canon (Printers).....(800)848-4123
Tech Support.....(800)423-2366
Cannon-Still Video/East..(714)753-7002
Cannon-Still Video/West..(714)753-4002
Tech Support.....(714)753-4323
Canon Cmptr Systems...(800)423-2366
Tech Support.....(800)423-2366
Canon USA(East).....(800)221-3333
Tech Support.....(908)521-7000
Canon USA(Mid West)...(708)250-6200
Tech Support.....(705)250-6200
Canon USA(South East)..(404)448-1430
Tech Support.....(404)448-1430
Canon USA(South West).(214)830-9600
Tech Support.....(214)830-9600
Canon USA(West).....(714)753-4200
Tech Support.....(714)753-4200
CanTech.....(800)255-3999

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Capricorn Systems.....(804)355-9371
Capstone Technology.....(510)438-3500
Tech Support.....(305)373-7770
Cardiff Software Inc.....(800)659-8755
Cardinal Technologies....(717)293-3049
Tech Support.....(717)293-3124
Caritech Cmptr Corp.....(915)584-9817
Carlisle Memory Prods..(800)433-7632
CarNel Enterprises Inc..(800)962-1450
Carroll Touch.....(512)244-3500
Cartridge Technologies..(800)869-8570
Carvey Databook, Inc....(716)889-4204
Casady & Green.....(800)359-4920
Tech Support.....(408)484-9228
Case Logic Inc.....(303)530-3800
Casecom Inc.....(408)942-5416
Casecom Technology.....(510)490-7122
Caseworks, Inc.....(800)635-1577
Casio.....(201)361-5400
Tech Support.....(201)361-5400
Castelle.....(408)496-0474
Tech Support.....(408)496-0474
Catalyst Seminconductor..(408)748-7700
Catalytix.....(617)738-1516
Catspaw.....(719)539-3884
Cayman Systems.....(800)473-4776
Tech Support.....(617)932-1100
CBM America Corp.....(800)421-6516
Tech Support.....(310)767-7838
CC:Mail.....(800)448-2500
Tech Support.....(800)448-2500
CCI.....(604)465-1540
CD Systems.....(909)595-5736
CD Technologies.....(408)752-8500
Tech Support.....(408)752-8499
CD-ROM Direct.....(800)332-2404
CDB Systems, Inc.....(303)444-7463
CDC (Imprimis).....(800)852-3475
CDCE Inc.....(714)630-4633
CE Software.....(515)224-1955
Celestica.....(800)461-2913
Cellular Data Inc.....(415)856-9800
Cellular Dig. Packet Data.(206)828-8691
Cellular Product Dist.....(310)312-0909
CenTech.....(800)255-3999
Centel Corporation.....(800)323-2174
Centon Electronics Inc..(714)855-9111
Centennial Technology..(508)670-0646
Central Cmptr Prods.....(800)456-4123
Tech Support.....(805)524-4189
Central Data.....(800)482-0315
Central Point.....(800)445-4208
Tech Support.....(503)690-8080
Centrepoint S-W Tech....(613)235-7054
Centron Software.....(800)848-2424
Tech Support.....(800)848-2424
Century Cmptr Mktg.....(310)827-0999
Century Data Systems...(919)821-5696
Century Microelect.....(408)748-7788
Century Software.....(801)268-3088
Tech Support.....(801)268-3088
CERA Inc.....(800)966-3070
Ceres Software.....(800)877-4292
Tech Support.....(503)245-9011
Cermetek Microelect.....(408)752-5000
Cerner Corporation.....(816)221-1024
Certified Mgt Software..(801)534-1231
Certus Int'l-Semamtic.....(800)441-7234
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CH Products.....(800)624-5804
Tech Support.....(619)598-2518
Chain Store Guide.....(800)927-9292
Champion Bus. Sys.....(303)792-3606
Champion Duplicators..(800)752-2145
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Chancery Software Ltd..(604)294-1233
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Tech Support.....(408)727-8096
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Chatsworth Prods. Inc...(818)882-8596
CheckFree.....(614)899-7500
CheckMark Software.....(800)444-9922
Tech Support.....(303)225-0387
Checkmate Technology.(602)966-5802
CheckSum.....(206)653-4861
ChemCorp.....(510)226-6280
Chemimnics Inc.....(800)645-5244
Tech Support.....(800)424-9300
Chen & Associates.....(504)928-5765
CHEQsys.....(416)475-4121
Cherry Electrical Prods.(708)662-9200
Cheyenne Software.....(800)243-9832
Tech Support.....(800)243-9832
CHI/COR Info. Mgmt.....(312)322-0150
Chic Technology Corp...(206)833-4836
Chicago Case Company...(312)927-1600
Chicony America Inc.....(714)380-0928
Chinon America.....(800)441-0222
Tech Support.....(800)441-0222
Chips & Technology.....(408)434-0600
Chips For Less.....(214)250-0009
Tech Support.....(214)250-9335
ChipSoft, Inc. (Intuit).....(619)453-4446
Tech Support.....(619)550-5009
Chisholm.....(800)888-4210
Chloride Power Elect....(800)333-0529
Choice Courier Sys.....(212)370-1999
Choice Technical Serv....(714)522-8123
CHRONOS Software.....(415)626-4244
Chrysler 1st Commercial.(215)437-8680
Chuck Atkinson Prog.....(800)826-5009
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Cincinnati Milacron Inc.(513)841-8100
Cincom Systems Inc.....(513)662-2300
CIO Publishing.....(508)872-8200
Ciprico Inc.....(800)727-4669
Circle Computer Inc.....(617)821-4114
Circo Computer Sys.....(800)678-1688
Circuit Repair Corp.....(508)948-7973
Circuit Test.....(510)463-2432
Cirris Systems Corp.....(800)441-9910
Cirrus Logic.....(510)623-8300
.....(800)424-7787
Cirvis Inc.....(714)891-2000
Citel America Inc.....(800)248-3548
Citizen America.....(800)556-1234
Tech Support.....(310)453-0614
Citrix Systems.....(800)437-7503
Tech Support.....(800)437-7503
CJF Enterprises Inc.....(305)491-1850
Clarify Inc.....(408)428-2000
Clarion Software.....(800)354-5444
Tech Support.....(305)785-4556
Claris Corporation.....(800)325-2747
Tech Support.....(408)727-9054
Clarity.....(800)235-6736
Clark Development Co..(801)261-1686
Clary Corporation.....(818)359-4486
Clear Software.....(800)338-1759
Tech Support.....(617)965-5019
Cleo Communications...(800)233-2536
Tech Support.....(313)662-4194
Cliff Notes.....(800)228-4078
Tech Support.....(402)421-8324
Clipper Products.....(513)528-7011
Clone Technologies.....(314)365-2050
Clovis.....(508)486-0005
CMD Technology Inc.....(800)426-3832
CMG Computer Prods...(512)329-8220
CMI Communications...(800)825-5150
CMO.....(800)233-8950
Tech Support.....(800)221-4283
CMP Publications.....(516)562-5000
CMS Enhancements.....(714)222-6000
.....(800)555-1671
Tech Support.....(714)222-6000
CMX.....(800)668-6413
Tech Support.....(800)285-2699
CNet Technology.....(800)486-2638
Tech Support.....(408)954-8800
CNS.....(800)843-2978
CNS Inc.....(201)625-4056
Coactive Computing.....(415)802-2882
Tech Support.....(415)802-2882
Coast Computer Power.(800)822-2587
Coastal Electronics.....(912)352-1444
Cobalt Blue.....(404)518-1116
Coconut Computing.....(619)456-2002
Coda Music Software.....(612)854-1288
Tech Support.....(612)854-9649
Codenoll.....(914)965-6300
Coefficient Systems.....(800)833-4220
Cognitech-Shopwr Help....(800)487-4275
Tech Support.....(800)487-4275
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Cognitronics Corp.....(800)243-2594
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Color Age Incorporated...(800)873-4367
Colorado Memory.....(303)669-8000
Tech Support.....(303)635-1501
Colorado Tech Designs..(303)449-0963
Colorage.....(800)437-3336
Tech Support.....(508)663-8213
Columbia Data Systems.(407)869-6700
Columbia Power/Data...(206)576-5045
Tech Support.....(800)791-1181
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Tech Support.....(303)752-1422
Command Cmptr Corp.(201)288-7000
Command Sftwr Sys.....(407)575-3200
Command Technology...(800)336-3320
Commax Technologies..(800)526-6629
Tech Support.....(408)435-8272
Commadore Bus. Mach..(614)666-7950
Common Cents Sftwr....(719)481-4682
Comnwlth of Puerto Rico.(212)245-1200
Commstar, Inc.....(612)941-8188
Comm. Automation.....(215)776-6669
Comm. Research Group....(504)923-0888
Comm. Tech Group.....(800)626-2715
Comm. Test Design.....(800)223-3910
COMP USA.....(800)541-7638
COMPAC Microelect.....(510)656-3333
Compact Disk Products..(908)290-8087
Tech Support.....(212)737-8400
Compaq.....(800)888-5858
Tech Support.....(800)345-1518
Compatible Systems.....(800)356-0283
CompEd Inc.....(800)456-5338
Compeq USA Ltd.....(800)852-0105
Tech Support.....(714)404-1619
Compex Technology.....(818)855-7988
Compex, Inc.....(714)630-7302
Complementary Solutions.(404)454-8033
Complete Computer.....(415)549-3153
Complete PC, The.....(407)997-9683
Complex, Inc.....(714)630-7302
Tech Support.....(714)630-5451
Complus.....(510)623-1000
Compo Group Inc.....(203)222-1335
Component Sales Corp.(408)894-1870
Comport.....(408)437-2404
Comprehensive Sftwr....(213)318-2561
Tech Support.....(213)214-1461
Compro Cmptr Services.(412)255-3616
Compsee, Inc.....(407)724-4321
Compteck Research, Inc.(716)842-2700
Compton's NewMedia...(619)929-2626
Tech Support.....(619)929-2626
Comptronics.....(919)779-7268
Compu-D International.(818)787-3282
Compu-Gard Inc.....(508)761-4520
Compu-Tek International.(800)531-0190
Tech Support.....(214)994-0193
CompuAdd Corp.....(800)925-3000
Tech Support.....(800)925-0995
CompuCase.....(800)255-9617
CompuClassics.....(800)733-3888
CompuClean.....(800)444-9038
Compucom Systems.....(609)848-2300
CompuCover.....(800)874-6391
Tech Support.....(904)863-2200
CompuD International..(800)929-9333
Tech Support.....(818)787-3282
Compudyne.....(800)486-8810
Tech Support.....(800)447-3895
CompuLan Technology..(800)486-8810
Tech Support.....(408)954-8864
Compulaw.....(800)559-4991
Tech Support.....(800)533-7839
CompuLink Mgt. Ctr.....(310)212-5465
Tech Support.....(310)212-5465
Compulits Inc.....(317)581-7600
CompuMedia Techn.....(510)656-9811
Compumetrics Inc.....(212)323-8150
CompuRegister Corp.....(314)365-2050
CompUSA, Inc.....(800)266-7872
CompuServe.....(800)848-8199
Tech Support.....(800)848-8199
Compusol Inc.....(714)253-9533
ComputAbility Cons.....(800)588-0003
Compute Publications...(212)496-6100
Computeach.....(206)885-0517
Tech Support.....(206)885-0517
Cmptr & Control Sol.....(800)782-3525
Cmptr & Monitor Maint..(800)466-4411
Computer Aided Mgt.....(707)795-4100
Computer Analysis.....(808)848-4878
Computer Assistance.....(503)895-3347
Computer Associates.....(706)505-6000
Computer Assoc. Int'l.... (800)531-5236
Tech Support.....(406)432-1764
Cmptr Automation.....(714)833-8830
Cmptr Auxillary Prods...(714)465-0911
Computer Bay.....(414)357-7705
Computer Boards.....(508)261-1123
Computer Book Club....(717)794-2191
Cmptr Bus. Services.....(800)343-8014
Tech Support.....(317)758-9612
Cmptr Buyers Guide.....(212)807-8220
Cmptr Buying World.....(617)246-3800
Cmptr Cable & Conn....(201)993-9285
Computer Care.....(703)528-8700
Computer Care Inc.....(800)552-4283
Computer Channel Inc..(516)921-5170
Computer Classifieds.....(206)643-2316
Computer Clipboard.....(800)777-4932
Cmptr Comm Specials...(404)441-3114
Cmptr Commodities Int'l.(800)365-3475
Cmptr Comm.....(800)421-1178
Cmptr Compnent Source.(800)356-1227
Cmptr Compnents.....(800)356-1227
Computer Connection...(800)552-2331
Cmptr Connection Corp.(612)884-0758
Computer Control Sys...(904)752-0912
Cmptr Covers Unltd.....(800)722-6837
Computer Coverup.....(312)327-9200
Computer Craftsmen.....(414)567-1700
Computer Currents.....(415)547-6800
Computer Data Sys.....(301)921-7000
Computer DataVault.....(714)362-3839
Computer Design Mag..(800)225-0556
Computer Dis. Wrhse....(800)726-4239
Tech Support.....(706)291-7575
Computer Doctor.....(512)467-9355
Computer Doctors.....(301)474-3095
Computer Dynamics.....(803)877-8700
Computer Exchange.....(404)446-7960
Computer Expressions..(800)443-8278
Cmptr Factory Outlet....(800)486-9975
Tech Support.....(602)829-7751
Computer Field Serv.....(617)246-4090
Computer Fixer.....(215)568-1100
Computer Friends, Inc...(800)547-3303
Computer Fun.....(619)279-1919
Computer Gate Int'l.....(408)730-0673
Cmptr Hand Holding.....(415)882-0517
Cmptr Horizons Corp....(800)847-4092
Computer Hot Line.....(214)233-5131
Computer Hotline Mag..(800)866-3241
Cmptr Identics Corp.....(800)343-0846
Computer Ind. Almanac.(800)377-6810
Computer Innovations...(908)542-5930
Tech Support.....(201)542-5920
Computer Intelligence...(619)450-1667
Tech Support.....(609)450-0255
Computer Labs Inc.....(315)635-7236
Computer Lang. Mag.....(800)525-0643
Computer Law & Tax.....(212)879-3325
Cmptr Law Strategist.....(212)741-8300
Computer Law Sys.....(800)328-1913
Computer Library.....(212)503-4400
Cmptr Locators Int'l.....(407)627-7797
Computer Logic Ltd.....(800)359-0599
Computer Logistics Ltd.(216)349-8600
Computer Maint. Plus....(303)427-5181
Computer Maint. Serv....(800)333-4267
Cmptr Maint. Training....(800)952-5977
Computer Mgt Service..(510)732-0644
Computer Marketplace.(800)858-1144
Computer Media & Serv..(800)798-9078
Computer Modules Inc.(408)496-1881
Cmptr Mnthly/Reseller..(205)988-9708
Cmptr Music Supply.....(714)594-5051
Tech Support.....(714)594-6821
Cmptr Netwrk Serv-CNS.(303)682-0090
Cmptr Network Tech.....(800)638-8324
Computer Parts Outlet...(800)475-1655
Cmpter Parts Unlimited.(818)879-1100
Cmptr Periph. Repair.....(407)486-0011
Computer Place, The.....(602)962-1030
Computer Power, Inc.....(800)526-5088
Tech Support.....(908)638-8600
Computer Products.....(305)974-5500
Computer Prods Corp...(800)338-4273
Cmptr. Prods. Plus (CP+).(800)274-4277
Tech Support.....(800)274-4277
Computer Publishers.....(708)390-7000
Computer Publ. & Adv...(914)833-0600
Computer Publ. Ent.....(619)576-0353
Computer Recyclers.....(800)466-6449
Cmptr Ref. Products.....(206)869-7840
Computer Renaissance..(612)942-5062
Cmptr Repss Assn.....(407)788-3666
Computer Research.....(800)245-2710
Cmptr Reseller News Mag.(516)562-5000
Computer Reset.....(214)276-8072
Computer Resources,.....(800)662-0034
Cmptr Retail Week Mag.(516)562-5000
Computer Sales Prof.....(800)950-6660
Cmptr Sciences Corp....(213)615-0311
Cmptr Service & Maint...(619)944-1228
Computer Service Ctr....(201)843-6290
Computer Service Exp..(502)366-3188
Computer Serv. Labs.....(800)220-6860
Computer Serv. Supply...(800)255-7815
Computer Serv. Tech.....(214)241-2662
Computer Serv. Group...(212)819-0122
Cmptr Shopper Mag.....(305)269-3211
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Cmptr Support Prods....(506)281-6554
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Computer Sys Assoc.....(704)871-8367
Computer Sys. News.....(516)365-4600
Computer Sys. Repair.....(310)217-8901
Computer Task Group...(716)882-8000
Cmptr Techn. Review.....(310)208-1335
Computer Techn Serv....(714)855-8667
Cmptr Terminal Serv.....(916)368-4300
Cmptr Time of America.(800)456-1159
Tech Support.....(614)759-0100
Computer Trade Exch....(201)226-1528
Computer Trading Int'l..(818)764-0615
Computer Trend Inc.....(205)442-6376
ComputerEasy Int'l.....(602)829-9614
ComputerGear.....(800)234-3434
Computerland Corp.....(510)734-4000
Tech Support.....(800)922-5263
ComputerLand Corp.....(201)575-7110
Cmptrlnd Depot Repair..(800)445-6879
Computers For Less.....(800)634-1415
Tech Support.....(714)975-0542
Computers Inc.....(800)637-4832
Computers Plus.....(401)434-9180
Computervision.....(619)535-1527
Computerwise Inc.....(913)829-0600
Computerworld.....(508)879-0700
Computime Inc.....(800)423-8826
Computone.....(800)541-9915
Computone Corp.....(800)241-3946
Tech Support.....(404)475-2725
Computrac, Inc.....(214)234-4241
CompuTrend Sys. Inc....(818)333-5121
Comshare.....(313)994-4800
Comtech Publishing.....(800)456-7005
Comtrade.....(800)969-2123
Tech Support.....(800)8994508
Comtrol Corporation.....(800)926-6876
Concentric Data.....(800)325-9035
Tech Support.....(800)325-9035
Concept Omega Corp...(800)524-9035
Conceptual Software.....(713)667-4222
Concurrent Computer...(908)758-7000
Concurrent Computer...(908)870-4128
Concurrent Controls.....(800)487-2249
Conde Systems.....(800)826-6332
Tech Support.....(205)633-3876
Conductive Containers..(800)327-2329
Conley.....(212)682-0162
Conlux USA Corporation.(800)792-0101
Connect.....(415)435-7446
Connect Software.....(800)234-9497
Tech Support.....(800)234-9497
Connect Tech Inc.....(519)836-1291
Connect-Air Int'l.....(800)247-1978
Connectix Corporation.(800)950-5880
Tech Support.....(800)950-5880
Connector Rsrce. Unltd.(408)942-9077
Conner International.....(408)456-4415
Conner Peripherals.....(408)433-3340
.....(408)456-3200
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Consolidated Electr.....(513)252-5662
Consultex.....(800)243-3338
Consulting Spectrum.....(214)484-9330
Consultronics.....(800)267-7255
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Consumers Software.....(604)688-4548
Contact East.....(800)225-5334
Contact Software Int'l....(800)365-0606
Tech Support.....(800)365-0606
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Continental Info. Sys.....(315)437-1900
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Convex Corporation.....(800)642-0602
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Cooper Industries.....(317)983-5200
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Copia International.....(706)682-8898
Copy Technologies.....(714)975-1477
Cordata.....(213)603-2901
Core International.....(407)997-6044
Tech Support.....(407)997-6033
Core Software Inc.....(713)292-2177
Corel Systems Corp.....(800)772-6735
Tech Support.....(613)726-1990
Corim Int'l Corp.....(212)883-0030
Cornell Computer Sys...(800)886-7200
Cornerstone Data Sys....(714)772-5527
Cornerstone Imaging....(408)435-8900
Tech Support.....(408)435-8900
Cornerstone Technology..(800)562-2552
Tech Support.....(408)435-8900
Corollary Inc.....(714)250-4040
Coromandel Industries..(800)535-3267
Tech Support.....(718)793-7966
Corporate Mgt. & Mktg..(201)989-0229
Corporate Microsystems.(603)448-5193
Corporate Software.....(617)821-4500
Corporate Systems Center.(408)734-3475
Cortex Corporation.....(612)894-3354
Corvus Systems, Inc.....(800)426-7887
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Cosmic Enterprises.....(800)292-6967
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CoStar.....(800)426-7827
Tech Support.....(203)661-9700
Costas Systems.....(510)443-2332
Costem Inc.....(408)734-9235
Cougar Mountain Sftwr.(800)388-3038
Tech Support.....(800)727-9912
Counter Peripherals.....(800)222-5871
Courseware Technology..(800)736-1936
.....(619)452-2726
Courtland Group Inc.....(410)730-7668
CPE Inc.....(214)313-1133
CPI.....(805)499-6021
Cpt Corporation.....(612)937-8000
CPU Products.....(316)788-3749
Cranel Inc.....(800)727-2635
Cray Research.....(612)452-6650
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Creative Controllers.....(800)950-6224
Creative Data Products..(800)366-1020
Creative Labs.....(405)742-6622
Creative Multimedia.....(503)241-4351
Tech Support.....(503)241-1530
Creative Programming...(214)416-6447
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Crescent Software.....(203)438-5300
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Crisis Computer Corp...(800)726-0726
Tech Support.....(800)729-0729
CRM Cmptr Parts-ON....(800)284-2865
CRM Cmptr PartsFL.....(800)759-5539
Crosby Creations.....(800)842-8445
Crosfield Dicomed.....(612)895-3000
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Crosstalk Comm.....(404)442-4000
CrossTies.....(214)732-9060
Tech Support.....(214)732-9060
Crown Mats & Matting..(800)628-5463
Crump Electronics.....(303)936-4407
Crutchfield-Hardware....(800)537-4050
Crutchfield-Software.....(800)538-4050
Crystal Computer Sys....(310)946-1447
Crystal Semiconductor..(512)445-7222
Crystal Services.....(604)681-3435
Tech Support.....(604)681-3435
CrystalGraphics Inc.....(408)496-6175
CS Electronics.....(714)259-9100
CSC CompuSource.....(919)460-1234
CSP Inc.....(617)272-6020
CSR.....(201)671-7711
CSS Laboratories, Inc.....(714)852-8161
CST Inc.....(214)241-2662
CTC Corporation.....(510)770-8787
CTI.....(703)264-8900
CTS Services.....(508)528-7720
CTSI International Inc...(516)467-1281
CTX International.....(800)282-2205
Tech Support.....(800)282-2205
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Cuesta Systems Corp.....(800)332-3440
CUI.....(800)458-6686
Tech Support.....(408)988-2703
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Cumulus.....(216)464-2211
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Curtis Mfg. Company.....(800)955-5544
Tech Support.....(603)532-4123
Custom Application.....(508)667-8585
Tech Support.....(508)663-8213
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Cybex Corporation.....(205)534-0011
Cyborg Corporation.....(617)964-9020
Cycare Systems.....(800)545-2483
Cyclades Corporation....(510)770-9727
Cyco International.....(800)323-2926
Cylix Corporation.....(805)379-3155
Cyma Systems Inc.....(800)292-2962
Cypress Research.....(408)752-2700
Tech Support.....(408)752-2700
Cyrix Corporation.....(800)462-9749
Tech Support.....(800)462-9749
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Tech Support.....(713)333-2099
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Da Vinci Systems.....(919)781-5924
DacEasy, Inc.....(800)322-3279
Tech Support.....(214)248-0205
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Dairyland Cmptr Cnsult...(800)323-6987
Daisy Disc Corporation...(800)537-3475
Daisycom.....(214)881-4700
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DakTech Inc.....(800)325-3238
Dalco Electronics.....(800)445-5342
Tech Support.....(800)543-2526
Dallas Digital Corp.....(800)842-6333
Dallas Fax Inc.....(214)699-8999
Dallas Semiconductor....(214)450-0400
Damark International.....(800)729-9000
Dana Commercial Credit..(313)689-7000
Danish Consulate Gen...(213)387-4277
Danpex Corporation.....(408)437-7557
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Dantz Development.....(510)849-0293
Tech Support.....(510)849-0293
Danwill Industrial Ltd....(818)810-8880
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Tech Support.....(714)236-1380
Darius Technology Inc...(206)483-8889
Dash Computer Inc.....(408)773-1488
Dat Entry Inc.....(407)339-5062
Data 3 Systems.....(707)528-6560
Data Access Corp.....(800)451-3539
Tech Support.....(305)232-3142
Data Accessories Cor.....(416)292-9963
Data Base Solutions.....(800)336-6060
Data Code.....(516)331-7848
Data Communications...(212)512-6950
Data Comm. 2000.....(714)255-7090
Data Connections.....(800)225-1855
Data Depot.....(800)767-3424
Tech Support.....(800)775-3825
Data Engineering.....(603)893-3374
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Data Envelope & Pkg.....(800)544-4417
Data Exchange Corp.....(805)388-1711
Data General Corp.....(508)366-8911
Data I/O.....(800)332-8246
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DataMate North America..(310)316-5161
Data Pad Corporation....(800)755-8218
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Data Pro.....(908)756-7300
Data Pro Acctg Software...(800)836-6377
Tech Support.....(813)888-5847
Data Processing Security..(817)457-9400
Data Quest Hawaii.....(808)545-5482
Data Race.....(210)558-1900
Tech Support.....(210)558-1900
Data Recording Prods....(310)633-7198
Data Retrieval Serv-FL....(800)952-7530
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Data Services Corp.....(404)246-3700
Data Set Cable Co.....(800)344-9684
Data Shield.....(312)329-1601
Data Solutions.....(714)637-5060
Data Spec.....(800)431-8124
Tech Support.....(818)772-9977
Data Storage Mktg-CO...(800)543-6090
Tech Support.....(800)543-6098
Data Storage Mktg-NJ.....(800)424-2203
Data Storage Mktg-TX ...(800)654-6311
Data Sys/Micro Connect. .(800)445-3282
Data Technology.....(408)942-4000
Tech Support.....(408)942-4000
Data Transforms.....(303)832-1501
Data Translation.....(508)481-3700
Tech Support.....(508)481-3700
Data Viz.....(800)733-0030
Tech Support.....(203)268-4000
Data Watch.....(919)549-0711
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Data-Cal Corporation.....(800)223-0123
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Tech Support.....(512)928-8926
Data/Ware Devel. Inc.....(619)453-7660
Database Applications....(609)924-2900
Database Prog. & Design..(415)905-2200
Dataability Sftwr Sys.....(212)807-7800
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Datacap Systems, Inc.....(215)699-7051
Datacom Technologies..(800)468-5557
Datadesk International..(804)477-3473
Tech Support.....(503)692-9601
DataEase International...(800)243-5123
Tech Support.....(203)374-2825
DataExpert Corp.....(408)737-0880
Datafix Inc.....(501)562-3554
Datagate Inc.....(408)946-6222
Dataguard Recvry Serv..(800)325-3977
DataJets International....(714)630-6662
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Datamar Systems.....(800)223-9963
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Datamation.....(617)964-3030
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Datapro Info. Serv.....(609)764-0100
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Dataquest/Ledgeway.....(506)370-5555
Datashield/Tripp Lite.....(312)329-1777
Tech Support.....(312)329-1602
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DataSpec/ORA Electr.....(800)431-8124
Datastor.....(714)833-8000
Datastorm Technologies..(314)443-3282
Tech Support.....(314)875-0530
Datasure Technologies...(510)935-9899
DataSym Inc.....(519)758-5800
Datatech Depot Inc.....(714)970-1600
Datatek Periph. Services..(800)829-2099
Datatran Corporation....(303)778-0870
DataTrek Corporation...(219)522-8000
Datatronics Inc.....(713)367-0567
Dataviz.....(800)733-0030
Tech Support.....(203)268-0030
Dataware.....(800)426-4844
Datawatch.....(919)549-0711
DATEC (WA).....(800)525-9905
DATEC (OR).....(503)641-6644
Datel.....(508)339-3000
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David Smith Software....(508)249-9056
David Systems, Inc.....(800)762-7848
Tech Support.....(408)541-6884
Davidson & Associates...(800)545-7677
Tech Support.....(310)793-0600
Davox Corporation.....(508)667-4455
DayFlo Software.....(714)474-1364
Dayna Communications..(801)269-7200
Tech Support.....(801)269-7200
DayStar Digital.....(800)962-2077
Tech Support.....(800)960-2077
DBMS.....(415)358-9500
DC Battery Products.....(612)616-7478
DCA.....(404)740-0300
Tech Support.....(404)740-0300
DCA/Crosstalk Comm...(800)348-3221
Tech Support.....(404)442-3210
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DCM Data Products.....(817)870-2202
DCSI.....(703)823-8886
DD & TT Ent. USA.....(213)780-0099
Tech Support.....(213)780-0099
DDC Publishing.....(800)528-3897
Tech Support.....(800)528-3897
DEVC Professional.....(215)957-1500
Decision Inc.....(903)586-0556
Decision Industries.....(215)674-3300
Dee One Systems.....(800)831-8808
Dee Van Enterprise USA..(800)878-0691
Deerfield Systems Inc....(800)356-8170
Dees Comm. Eng.....(604)946-8433
Delkin Services Inc.....(619)571-1234
Dell Computer Corp.....(800)426-5150
Tech Support.....(800)624-9896
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Delphi.....(800)695-4005
Delphi Data.....(800)335-7445
Delrina Technology.....(800)268-6082
Tech Support.....(800)268-6082
Delta Computer Inc.....(201)440-8585
Delta Phase Int'l.....(714)768-6842
Delta Products.....(706)487-1037
Delta Technology Int'l...(715)832-7575
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Deltec Corporation.....(800)854-2658

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Desco Industries.....(714)598-2753
DeScribe, Inc.....(800)448-1586
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Design Science.....(800)827-0685
Tech Support.....(213)433-6969
DesignCAD.....(918)825-4844
Desk Top Graphics.....(817)346-0556
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DEW Int'l Corp.....(800)326-7114
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DFM Systems, Inc.....(800)922-4336
DH Serv.....(800)548-7862
DH Technology.....(619)451-3485
DI/AN Controls.....(800)878-3134
Diagnostic Technology..(416)542-8674
DiagSoft Inc.....(800)342-4763
Tech Support.....(408)438-8247
Diamond Cmptr Sys.....(408)736-2000
Tech Support.....(408)736-2000
Diamond Data Mgt.....(800)955-3330
Diamond Flower Inst....(916)568-1234
Diamond Systems.....(904)241-4550
Dianachart Inc.....(201)625-2299
DIC Digital.....(201)224-9344
Dick Berg & Associates..(619)452-2745
Diebold.....(216)489-4110
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Digi-Key Corporation....(800)344-4539
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Tech Support.....(612)943-9020
Digicom Systems Inc.....(800)833-8900
Digit Head Inc.....(703)524-0101
Digital Comm. (DCA)....(800)348-3221
Digital Computer Serv...(215)358-6045
Digital Data Systems.....(800)762-7811
Digital Dynamics.....(714)529-6328
Digital Engineering.....(713)271-5200
Tech Support.....(713)271-5200
Digital Equip. Corp-MA..(800)332-7378
Digital Equip. Corp-MA..(800)332-4636
Digital Equip. Corp-MA..(800)354-9000
Digital Equip. Corp-MA..(508)841-3627
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Digital Data Recovery....(414)353-1219
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Digital News & Reviews.(617)964-3030
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Digital Review.....(617)964-3030
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Digital Sys. Research.....(714)455-1620
Digital Typeface Corp....(612)944-9264
Tech Support.....(612)941-8652
Digital Vision.....(617)329-5400
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Digitalk.....(800)531-2344
Tech Support.....(714)513-3000
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Direct Drives.....(708)481-1111
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Disc & Tape Services.....(603)889-5722
Disc Distributing Corp..(800)688-4545
Disc Manufacturing Inc.(302)479-2500
Disc Tec.....(407)671-5500
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Discis Knowledge Rsrch.(800)567-4321
Discount Micro.....(800)574-3325
Tech Support.....(714)827-7090
Discoversoft Inc.....(510)814-1690
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Tech Support.....(416)250-6537
Disk Drive Repair.....(206)575-3181
Disk Software.....(800)635-7760
Disk Technologies.....(407)645-0001
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Disk's & Labels To Go....(800)426-3303
Diskette Connection.....(800)654-4058
Diskettes Unlimited.....(800)364-3475
Disks & Labels To Go....(609)265-1500
Disney Cmptr Software.(818)841-3326
Tech Support.....(818)841-3326
Display Technologies.....(708)931-2136
Distinct Corporation.....(408)741-0781
Distr. Logic Corp.....(714)476-0303
Distr. Processing Tech....(407)830-5522
Distributed Technology.(206)395-7800
Ditek International.....(416)479-1990
DiVA.....(800)949-2843
Diverse Business Grp....(604)596-6088
Diversified Case Co.....(315)736-3028
Diversified Technology..(800)443-2667
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DM.....(800)821-3354
DNA Networks, Inc.....(800)999-3622
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Document Storage Sys...(303)757-1455
DocuPoint Inc.....(510)770-1189
Dolch Computer Sys.....(800)538-7506
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DotShop Inc.....(800)487-6025
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Dovetail Comm.....(800)432-1414
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DP Tech.....(713)492-1894
DP-Tek, Inc.....(800)727-3130
DPT-Distr. Process Tech..(407)830-5522
Tech Support.....(407)830-5522
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Dragon Systems Inc.....(617)965-5200
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Tech Support.....(909)945-5600
Drexler Technology.....(415)969-7277
Drive Repair Serv. Co.....(510)430-0595
DSA Systems.....(508)477-2540
DSC Communications...(214)519-3000
DSE Inc.....(808)578-0237
DSG Communications...(306)665-6107
DSK Inc.....(801)224-4828
DSP Solutions.....(415)494-8086
Tech Support.....(415)494-8088
DST Systems.....(816)221-5545
DTK Computer Inc.....(818)810-6880
Dual Group, Inc.....(310)542-0788
Duble-Click Software....(800)359-9079
Tech Support.....(800)266-9525
Dudley Software.....no main number
Tech Support.....(615)966-3667
Duffy Consulting Grp....(416)966-4015
Dukane Corporation.....(708)584-2300
Dumont Oscilloscope...(201)575-8666
Duplication Technology.(303)444-6157
Duracell Inc.....(203)796-4000
Durham Off. Mach. Spec..(408)462-4989
Dustin Discount Sftwre.(800)274-6611
DW Smith & Associates.(415)349-7725
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Dyna Micro, Inc.....(408)943-0100
Dynamic Electronics Inc..(714)855-0411
Dynamic Pathways.....(714)720-8462
Dynamic Power System..(800)422-0708
Dynatech Cmptr Power.(800)638-9098
Dynatech Corporation...(617)272-6100
DynaTek Auto. Systems..(416)636-3000
Dynaware USA.....(415)349-5700
Dytel Inc.....(708)519-9850
E-Cam Technology Inc...(602)443-1949
E-Comms.....(800)247-1431
E-Machines.....(800)344-7274
Tech Support.....(800)344-7274
E-Systems.....(214)661-1000
E-Tech Research Inc.....(408)988-8108
E-Toor Corporation.....(818)333-5521
E-WARE.....(714)236-1380
Tech Support.....(714)236-1380
Eagle Electronics.....(800)992-3191
Eagle Perform. Software..(214)539-7855
Eagle Technology.....(800)733-2453
Tech Support.....(800)726-5267
Easel Corporation.....(617)221-2100
Eastern Time Designs....(603)645-6578
Easterntech Corp.....(800)289-8128
Tech Support.....(800)685-5006
Eastman Kodak.....(716)724-4000
Easy Automation Sys.....(800)627-3274
Tech Support.....(404)840-0475
EAZY.....(412)746-5500
EBS Consulting.....(215)493-7315
Eclipse Marketing Inc....(800)284-0779
Tech Support.....(506)598-9640
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Educational Systems.....(800)553-2212
EECO Inc.....(714)835-6000
EF Industries.....(310)523-2290
EFA Corp. of America ....(301)670-6166
EFAR Microsystems Inc.(408)452-1888
Efficient Field Service....(800)257-4745
Effron Sales .....(714)962-1016
EFI Electronics.....(800)877-1174
Tech Support.....(800)877-1174
Egghead Discount Sftwr..(206)391-0800
Eicon Technology .....(514)631-2592
EID Center.....(408)733-5501
Eight Hundred Sftwr .....(800)888-4880
EJ Bilingual Inc.....(310)320-8139
EKD Cmptr Sales/Supp. (516)736-0500
El Camino Rsrcs Ltd .....(818)226-6600
Elan Computer Grp.....(415)964-2200
Elan Software Corp.....(800)654-3526
Tech Support.....(310)459-1222
Elcee Computek, Inc. ....(407)750-8061
Elco.....(818)284-2181
.....(814)643-0700
.....(818)284-7018
.....(800)653-3526
Elecom Computer Prod..(310)802-0077
Electrified Discounters..(800)678-8585
Electro Media Publ .....(408)374-9804
Electro Products Inc.....(800)423-0646
Electro Rent Corp.....(818)787-2100
Electro Standards Lab....(401)943-1164
Electro Static Techn .....(207)795-6416
Electro Tech Industries..(619)745-3575
Electro-Tech Systems.....(215)887-2196
Electrodata Inc.....(800)441-6336
Electrografics Int'l.....(215)443-5190
Tech Support.....(215)443-9564
Electrohome Projection..(519)744-7111
Electromatic.....(708)882-5757
Electronic Arts Distr .....(800)448-8822
Tech Support.....(415)572-2787
Electronic Assist. Corp...(817)778-7978
Electronic Associates.....(908)229-1100
Electronic Buyers' Mag..(516)562-5000
Electronic City.....(602)622-1173
Electronic Data Assoc....(816)966-0669
Electronic Eng.Times.....(516)562-5000
Electronic Ind.Assoc.....(202)457-4500
Electronic Mktg. Grp.....(800)955-2688
Electronic News .....(800)883-6397
Electronic Prods. Mag....(516)227-1300
Electronic Prods Serv....(404)448-0748
Electronic Services .....(313)341-1821
Electronic Specialists.....(508)655-1532
Electronic Speech Sys ...(510)783-3100
Electronics of Salina .....(913)827-7377
Electronics Unlimited....(216)835-0520
Electroservice Labs.....(800)336-4375
Elegant Graphics Corp..(303)879-4334
Elek-Tek, Inc.....(800)395-1000
Elektro Assemblies.....(800)533-1558
Elenco Electronics.....(708)541-3800
Elesys.....(800)637-0500
Eletch Electronics, Inc...(714)385-1707
Elgar Corporation.....(619)450-0085
Elisa Technology Inc.....(510)651-5817
Elite.....(310)370-2762
Elite Microelectronics....(408)943-0500
Elitegroup Cmptr Sys ....(510)226-7333
Tech Support.....(510)226-7333
Elographics, Inc.....(615)482-4100
ELSA America Inc.....(415)615-7799
ELT Systems of CA.....(510)226-9057
Eltrex Industries Inc. .....(716)454-6100
Elvo.....(914)241-1008
Elxsi Corporation.....(408)994-9301
EMAC/EVEREX .....(510)498-4411
Tech Support.....(510)498-4411
Emax International Inc..(310)637-6380
EMC Corporation.....(800)222-3622
Emerald Intelligence.....(313)663-8757
Emerald Systems.....(800)767-2587
Tech Support.....(800)366-4349
Emerging Techn. Cons...(303)447-9495
Emerson Cmptr Corp....(800)222-5877
Emerson Cmptr Pwr .....(800)222-5877
Tech Support.....(800)222-5877
Emerson Electric .....(314)553-2000
Emery World Wide.....(800)443-6379
EML Associates.....(617)341-0781
Empac Int'l Corp.....(510)683-8800
Empress Software Inc....(301)220-1919
Emulex Corporation.....(800)368-5393
Enable Software.....(800)888-0684
Tech Support.....(518)877-8236
ENCAD.....(619)578-4070
Enclosure Technologies....(313)481-2200
Encore Computer Corp...(508)460-0500
Endl Publications.....(408)867-6642
Enertronics Research.....(314)427-7578
Engage Comm.....(408)688-1021
Engineered Data Prods..(800)432-1337
Eng. Computers & Apps...(800)950-1217
Engineering Services.....(800)525-5608
English Knowledge Sys.(408)438-6922
Enhance Memory Prods...(800)343-0100
Tech Support.....(818)343-3066
Enigma Logic Inc.....(415)827-5707
Enlight Corporations.....(310)693-8885
Enterprise Sys. Journal...(214)343-3717
Entrepreneur.....(714)261-2325
Entropy Engineering .....(301)770-6886
Envelope Manager.....(415)321-2640
Environgen.....(714)863-7474
Tech Support.....(714)863-7474
Envisions Sol.Techn.....(800)365-7226
Tech Support.....(415)692-9067
EO (AT&T).....(800)458-0880
Tech Support.....(800)458-0880
EOS Distributing.....(913)827-7377
EOS Technology.....(408)727-0111
EPE Technologies, Inc....(714)557-1636
EPrinceton Cmptr Supp...(609)921-8889
Epsilon Data Mgmt.....(800)225-3333
Epson America, OEM Div.(213)782-0770
Epson America, Inc.....(800)289-3776
Tech Support.....(800)922-8911
Epson Direct.....(800)374-7300
Tech Support.....(800)922-8911
Equilibrium.....(415)332-4343
Tech Support.....(415)332-4343
Equinox.....(305)255-3500
Equinox Systems Inc.....(800)275-3500
Tech Support.....(305)255-3500
ERA.....(312)649-1333
Ergo Computing, Inc. ....(508)535-7510
Ergo Management Co....(800)348-8633
Ergo Systems Inc.....(203)282-9767
Ergodyne.....(612)642-9889
Ergotron.....(800)888-8458
ErgoView Technologies.(212)995-2673
ERM/Crazy Bob's.....(800)776-5865
Tech Support.....(617)662-2046
Ero Surge Inc. .....(908)776-4220
ERS Electr. Repair Serv...(210)623-4420
Escaa Corporation.....(206)822-6800
ESCOD Industries.....(800)533-4736
Esico-Triton.....(203)526-5361
Esker.....(415)341-9065
Tech Support.....(415)341-9065
ESoft Product Support...(303)699-6565
ESP Inc. .....(800)338-4353
Etak Inc. .....(415)328-3825
ETC Computer Inc.....(510)226-6250
ETCON Corporation .....(708)325-6100
Eteq Microsystems, Inc..(408)432-8147
ETN Corporation.....(800)326-9273
ETS Incorporated.....no main number
Tech Support.....(801)265-2490
European Cmptr Mkt ....(619)929-0955
European Cmptr Source .(708)475-1900
Evans & Sutherland Co .(801)582-5847
Everest Cmptr Corp.....(408)997-1674
Everex .....(800)821-0806
Tech Support.....(510)498-4411
Everfit Cmptr Supply.....(408)894-9003
Evergreen Technologies...(800)733-0934
Evolution Computing....(800)874-4028
Tech Support.....(800)874-4028
Evtek Corporation.....(216)267-8499
Ex Machina Inc.....(718)965-0309
Ex-Cel Solutions.....(402)333-6541
Exabyte.....(800)445-7736
Tech Support.....(913)492-6002
Excalibur Comm.....(918)496-7881
Excel, Inc.....(800)624-2001
Excelan (Novell).....(408)434-2300
Tech Support.....(800)638-9273
Excelta Corporation.....(805)686-4686
Executive Systems Inc...(805)541-0604
EXFO Electro-Optical.....(800)663-3936
Exide Electronics Grp....(919)870-3285
Exima International.....(408)970-9225
ExMachina.....(718)965-0309
EXP Computer.....(516)496-3703
Experience in Software.(800)678-7008
Experience Software.....(303)796-0790
Expert Software.....(305)567-9990
ExperVision Inc. .....(800)732-3897
Tech Support.....(408)428-9234
Expo Tech.....(800)284-3976
Exponent Corporation..(201)808-9423
Tech Support.....(201)808-9423
Express Cmptr Supply...(800)342-4542
Exsel Inc.....(800)624-2001

INDUSTRY PHONE NUMBERS

Tech Support.....(800)624-2001
Exsys.....(505)256-8356
Extech Instruments.....(617)890-7440
Extended Systems Inc...(800)235-7576
Exxus Direct.....(800)557-1000
Tech Support.....(800)557-4000
EyeTel Comm. Inc.....(604)984-2522
EZI America Corporate..(805)987-5885
EZX Publishing.....(713)280-9900
F Systems Industries.....(800)432-8051
Facit, Inc.....(603)647-2700
Fairchild Defense.....(301)428-6677
Faircom.....(314)445-6833
Tech Support.....(800)234-8180
Fairhaven Software.....(800)582-4747
Tech Support.....(617)341-1969
Falcon Systems.....(800)326-1002
Falltech Electronics.....(714)543-5011
Fam. & Home Off. Comp..(212)505-3580
Family Scrapbook.....(904)247-0062
Farallon Computing.....(510)814-5000
Tech Support.....(510)814-5000
Fargo Electronics Inc.....(800)327-4622
FarPoint Comm.....(805)726-4420
FAST Electronic U.....(508)655-3278
FAX-Stor Corporation....(408)287-2700
Faxback Inc.....(503)645-1114
FDK America, Inc.....(408)432-8331
FDP Corporation.....(305)858-8200
FEC.....(714)692-1170
Fedco Electronics, Inc...(703)689-7711
Federal Computer Week.(703)876-5100
Fellowes.....(708)893-1600
Fessenden Technology...(417)485-2501
FFE Software.....(510)232-6800
Fiber Instrument Sales...(800)445-2901
FiberOptic Netwrk Sol..(508)842-4744
Ficus Systems.....(617)938-7055
Tech Support.....(617)938-7055
Fidelity International.....(908)828-7948
Fidelity Prof Develpmnt...(612)897-3875
Fieldpiece Instruments..(714)992-1239
Fieldtex Products Inc....(716)473-5237
Fifth Generation Sys.....(800)873-4384
Tech Support.....(800)766-7283
Fifth Generation Sys.....(504)291-7221
Tech Support.....(504)291-7221
Filenet Corporation.....(714)966-3400
Finalsoft Corporation.....(800)232-8228
First Byte.....(800)545-7677
Tech Support.....(800)556-6141
First Financial Mgt.....(404)321-0120
First Int'l Computer.....(510)475-7885
First Source Int'l.....(800)535-5892
First United Leasing Corp..(708)615-0992
Fischer International.....(813)643-1500
Fiserv, Inc.....(800)558-8413
FIT Software.....(408)562-5990
Tech Support.....(408)562-5990
Flagship Accounting.....(214)248-0305
Flagship Group, The.....(214)342-2801
Flagstaff Engineering.....(602)779-3341
Flambeaux Software.....(800)833-7355
Fleetmasters-Comtech...(310)539-7900
Fleming Software.....(703)591-6451
Flexistand Inc.....(908)421-6868
Flexstar Technology.....(510)440-0170
Flight Form Cases.....(206)435-6688
Flip Track One.....(800)424-8668
Floating Point Sys Co.....(503)641-3151
Tech Support.....(503)641-3151
Fluke, John Mfg.....(800)443-5853
Flytech Techn. Co. Ltd....(408)727-7373
Focus Electronics Corp.(714)468-5533
Focus Info. Sys.....(510)657-2845
Focus Microsys.....(408)436-2336
Folex Film Systems.....(800)631-1150
Folio Corporation.....(801)375-3700
Footprint Software.....(416)860-0477
Fora Inc.....(408)944-0393
Forbin Project.....(319)266-0543
Foresight Resources.....(800)231-8574
Tech Support.....(816)891-8418
FormalSoft.....(800)962-7118
FormGen Corporation...(416)857-4141
Formgen, Inc.....(602)443-4109
Tech Support.....(602)443-4109
Formax Cmptr Corp.....(908)874-7122
Fort's Software.....(913)537-2897
Forte Computer Serv.....(708)985-7222
Fortron/Source Corp.....(510)373-1008
Forval America Inc.....(408)452-8887
Forval America, Inc.....(801)561-8080
Fotec Inc.....(800)537-8254
Foundationware.....(216)752-8181
Fountain Technology.....(908)563-4800
Four Seasons Publ.....(212)599-2141
Fourgen Software, Inc....(800)333-4436
Tech Support.....(800)444-3398
Fourth Party Maint.....(416)479-1910
Fox Software.....(419)874-0162
Foxconn Int'l, Inc.....(408)749-1228
Fractal Design Corp.....(408)688-8800
Tech Support.....(408)688-5300
Frame Technology.....(408)975-6000
Tech Support.....(408)975-6466
Franklin Datacom.....(805)373-8688
Franklin Electr. Publ.....(609)261-4800
Franklin Quest Co.....(804)975-9999
Tech Support.....(801)975-9999
Frederick Engineering...(410)290-9000
Free Cmptr Techn.....(408)945-1118
FreeSoft Company.....(412)846-2700
French Expositions in US.(212)265-5676
Fresh Technology Grp...(602)497-4200
Tech Support.....(602)497-4235
Fridays Electronics.....(800)488-6575
Tech Support.....(408)294-5295
Friendly Software Store.(800)848-0486
Tech Support.....(415)593-8275
Frontline Network Sys...(508)393-1911
Frontline Systems.....(800)451-0303
Frontline Test Equip.....(708)653-8570
Frost & Sullivan, Inc.....(800)435-1080
FRS Inc.....(916)928-1107
Fry's Electronics.....(415)496-6100
Frye Computer.....(800)234-3793
FTG Data Systems.....(800)962-3900
FTP Software Inc.....(508)685-4000
Fuji.....(510)438-9700
Fuji Photo Film USA.....(914)789-8100
Fujikama USA.....(708)832-1166
Fujikura America, Inc.....(404)956-7200
Fujitsu America.....(800)626-4686
Tech Support.....(408)432-1300
Fujitsu Computer Prod..(800)626-4686
Tech Support.....(408)894-3950
Fujitsu Microelectronics...(800)637-0683
Tech Support.....(800)642-7616
Fujitsu Personal Sys.....(408)982-5900
Tech Support.....(408)764-9388
Fullmark International...(800)233-3855
FuncKey Enterprises.....(800)255-4433
Funk Software.....no main number
Tech Support.....(617)497-6339
Futaba Corp of America..(714)455-9888
Future Graphics Inc. .....(818)341-6314
Future Soft Eng. Inc.....(713)496-9400
Tech Support.....(713)496-9400
Future Solutions.....(800)886-1278
Tech Support.....(510)440-1210
FutureComm, Inc.....(203)932-4881
FutureSoft Inc.....(713)496-9400
Futurmaster USA.....(305)371-4555
Futurus Corporation .....(800)327-8296
G & H Ribbons, Inc. .....(215)953-1970
G C I.....(505)522-4600
Tech Support.....(800)874-2383
Galacticomm Inc.....(305)583-5990
Galaxy Appl. Eng.....(415)347-9953
Galaxy Cmptr Serv.....(612)688-7454
Galaxy Computers .....(800)771-4049
Galizia Inc.....(310)763-2184
Gallant Intellgnt Cmptrs...(800)848-8088
Tech Support.....(818)575-3781
Gama Computers Inc....(602)741-9550
Gamatek.....(800)927-4263
Tech Support.....(800)927-4263
GammaLink.....(408)744-1400
Tech Support.....(408)745-2250
Gandalf.....(708)517-3615
Gandalf Premier.....(310)312-9522
Gandalf Technologies....(613)723-6500
Gap Development.....(714)496-3774
Gartech .....(612)379-7930
Gates Distributing.....(800)332-2222
Gates FA Distributing....(800)332-2222
Gateway 2000.....(800)846-2000
.....(605)232-2000
Gateway Book Binding...(204)663-9214
Gateway Electronics-MO..(314)427-6116
Gateway Electronics-CO...(303)458-5444
Gateway Electronics-CA...(619)279-6802
Gazelle Systems.....(800)786-3278
Tech Support.....(801)377-1289
GBC Technologies .....(800)229-2296
GBM Design/COS.....(310)677-8801
GC/Thorsen.....(800)435-2931
GCC Technologies.....(800)422-7777
Tech Support.....(617)275-1795
GDT Softworks.....(800)663-6222
Tech Support.....(604)299-3379
GE Rental/Lease.....(800)437-3687
GEC Plessey Semicond..(408)438-2900
Geller Software Labs.....(201)746-7402
Gemini Inc.....(800)533-3631
Gemplus Card Int'l.....(301)990-8800
Gen 2 Ventures.....(408)446-2277

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Genamation Industries..(416)475-9434
Genemax Monitor'g Sys..(416)923-9000
General Cmptr Corp.....(800)521-4548
Genl Datacomm Ind.....(203)574-1118
Genl Diagnostics Inc.....(310)715-1222
General Disk Corp.....(408)432-0505
General Electric.....(800)543-0440
General Parametrics.....(510)524-3950
General Power Corp.....(800)854-3469
General Ribbon.....(800)423-5400
General Sales Equip.....(310)828-2577
General Semicond. Ind..(602)968-3101
Genl Services Admin.....(202)472-2205
General Signal Corp.....(203)357-8800
Generic Software, Inc....(800)228-3601
Genesis Develpmnt Corp..(801)568-1212
Genesis Integrated Sys..(612)544-4445
Genesis Technology.....(510)782-4800
Genesoft.....(714)394-0010
Genicom.....(800)535-4364
Tech Support.....(703)949-1031
Genigraphics Corp.....(800)638-7348
Tech Support.....(203)925-1919
Genisco Techn. Corp.....(619)661-5100
Genoa.....(408)432-9090
Genovation, Inc.....(714)833-3355
Genus Microprgram.....(800)227-0918
Tech Support.....(713)977-0680
Geocomp.....(800)822-2669
Georgans Industries.....(800)255-5350
GeoSystems.....(717)293-7500
GeoWorks.....(510)814-1660
Tech Support.....(510)644-0883
Gerber Scientific.....(203)644-1551
GETC.....(604)684-3230
Gibson Research.....(800)736-0637
Tech Support.....(714)362-8900
Giga-Byte Techn. Co.....(818)854-9334
Gigatek Memory Sys.....(619)438-9010
GigaTrend Inc.....(619)931-9122
Tech Support.....(619)931-9122
Gilmore Systems.....(805)379-3210
Gimpel Software.....(215)584-4261
Gizmo Technology.....(510)623-7899
Glenco Engineering.....(800)562-2543
Tech Support.....(708)808-0315
Glendale Technology.....(708)305-9100
Glenn A Barber & Assoc...(818)951-4744
Global Cmptr Supply....(800)845-6225
Global Eng. Documents...(800)854-7179
Global Specialties.....(800)345-6251
Global Village Comms.....(800)736-4821
Tech Support.....(415)390-8300
Globalink, Inc.....(800)255-5660
Globe Manufacturing....(800)227-3258
Tech Support.....(908)232-7301
GlobeTech Int'l.....(800)654-7314
GMC Techn. Corp.....(818)401-3743
GMP.....(215)357-5500
GN Navtel.....(800)262-8835
GN Navtel Limited.....(800)262-8835
Go Corporation.....(415)345-7400
GO Technology.....(702)831-3100
Tech Support.....(702)832-7762
Gold Disk.....(310)320-5080
Gold Disk, Inc.....(800)465-3375
Tech Support.....(416)602-4357
Gold Hill Computers.....(617)621-3300
GoldDisk (AMI).....(800)465-3375
Tech Support.....(905)602-4357
GoldDisk (MAC).....(800)465-3375
Tech Support.....(905)602-0395
GoldDisk (PC).....(800)465-3375
Tech Support.....(900)602-5292
Golden Bow Systems....(800)284-3269
Golden Coast Electr.....(619)268-8447
Golden Image Techn.....(800)327-4482
Golden Power Sys.....(805)582-4400
Golden Ribbon.....(303)443-6966
Golden Star Inc.....(800)821-2792
Golden Triangle.....(800)326-1858
Golden-Lee Book Distr....(718)857-6333
Goldstar Precision Co...(619)268-8447
Goldstar Techn. Corp.....(800)777-1192
Tech Support.....(800)777-1192
Good Software.....(214)713-6370
Tech Support.....(214)713-6370
Gorrell's Cmptr Serv.....(606)299-8468
Gotoless Conversion.....(214)625-2323
Gould Inc.....(216)328-7000
Governmnt Cmptr News..(301)650-2000
GRACE Electr. Materials...(617)935-4850
Gradco Inc.....(714)770-1223
GrafPoint.....(800)426-2230
Graham Magnetics Inc....(817)868-5000
Granite Corporation.....(818)887-5533
Grapevine LAN Prods....(206)869-2707
Tech Support.....(206)836-8822
Graphic Ent. of Ohio.....(800)321-9874
Tech Support.....(216)456-5107
Graphic Software Sys....(503)641-2200
GRAPHIC TECH.....(413)536-7800
Graphic Utilities, Inc.....(800)669-4723
Graphics Development...(800)969-4434
Graphics Simulations.....(214)699-7400
Tech Support.....(214)699-7400
Graphsoft.....(301)461-9488
Graybar Electric Co.....(800)825-5517
Graymark.....(800)854-7393
Great Amer. Software.....(603)889-5400
Great Eastern Techn.....(800)875-0025
Great Falls Cmptr.....(703)759-5570
Great Plain Software.....(701)281-0550
Tech Support.....(800)456-0025
Great Software Ideas.....(800)486-7800
Tech Support.....(714)261-9744
Great Tek Inc.....(408)943-1005
Great Wave Software.....(408)438-1990
Tech Support.....(408)438-1990
Greatlink Electr. USA.....(510)683-0655
Greco Systems.....(800)234-7326
Greengage Dvlpmnt Corp.(408)243-8960
Greenleaf Int'l Inc.....(408)734-8888
Greenleaf Software.....(800)524-9830
.....(800)523-9830
Greystone Peripherals...(408)866-4739
GRID Systems.....(800)326-4743
Grolier Electr. Publ.....(800)356-5590
Tech Support.....(800)356-5590
Group 1 Software.....(301)731-2300
Tech Support.....(301)731-2300
Group 4 Electronics.....(800)229-7189
Group One Elec. Co.....(818)993-4575
Group Technologies.....(800)476-8781
Tech Support.....(703)841-4357
Group Three Electronics...(310)781-9191
Gruber Industries Inc....(602)863-2655
Gryphon Software.....(619)536-8815
Tech Support.....(619)536-8815
GST, Inc.....(714)739-0106
GTCO Corporation.....(301)381-6688
GTE Corporation.....(203)965-2000
GTE Electr. Repair Serv...(714)945-2313
GTE Supply Electr. Repair..(214)615-7599
GUIS America, Inc.....(714)590-0801
Gupta Technologies.....(800)876-3267
Tech Support.....(415)321-4484
GW Computer Sys.....(604)244-7118
H & H Enterprises.....(702)876-6292
H&J Electronics Int'l.....(800)275-2447
H.Allen & Company.....(708)769-4040
H. Co. Memory Prods....(714)833-3222
H. Co. Mem. Upgrades...(800)726-2477
Tech Support.....(714)833-3364
Ha-Lo Adv. Specialtie.....(708)676-5305
Hadron, Inc.....(703)359-6201
Hahn & Company.....(503)248-0262
Halcyon Software.....(408)378-9898
Haliburton NUS Environ...(301)258-6000
Haltek Electronics.....(415)969-0510
Hamilton Dig. Controls....(315)797-2370
Hamilton Tel.....(800)363-7626
Hampton Bus. Mach.....(800)974-2402
Hand Held Products.....(704)541-1380
Handok Company, Ltd...(408)736-3191
Hands On Learning.....(617)272-0068
Handtop Computers.....(818)884-4076
Hanson Data Sys.....(800)879-1371
Harbor Electronics.....(203)438-9625
Hard Drive Assoc.....(503)233-2821
Hard Drive Super Source...(800)252-9777
Tech Support.....(408)739-4110
Hard Drive Whsle.....(408)559-1773
Hard Drives Int'l.....(800)927-7848
Hardigg Cases.....(413)665-2163
HARDISK Technology...(408)374-5157
Hardware House-AR.....(501)225-4477
Hardware House-IN.....(317)842-8244
Hardware House-KY.....(502)425-1402
Hardware House-NE.....(402)498-5677
Hardware House-OH.....(513)489-0668
Hardware Hse-Memphis...(901)756-6677
Hardware Hse-Nashville....(615)356-2888
Harley Systems Inc.....(800)237-2885
Harmony Computers....(718)692-2828
Tech Support.....(800)441-1144
Harris Adacom Network..(214)386-2000
Harris Corporation.....(407)727-9100
Harvard Bus. Systems.....(800)288-7750
Tech Support.....(310)207-7750
Harvard Softworks.....(513)748-0390
Hauppauge Cmptr Works..(800)443-6284
Tech Support.....(516)434-3197
HavenTree Software.....(800)267-0668
Tech Support.....(613)544-6035
Hawaii Sftwr Serv. Ctr....(808)733-2042
Hawk Computers.....(408)436-8999
Hawk Data Systems.....(805)371-1764

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Hayes Microcomp. Prod..(800)874-2937
Tech Support.....(404)441-1617
HB Cmptr Techn. Co.....(310)644-2602
HCI.....(800)486-0001
HCR Corporation.....(416)922-1937
Tech Support.....(800)567-4357
HD Computer.....(800)347-0493
Tech Support.....(800)676-0164
HDC Computer Corp....(800)321-4606
Health Care Keybrd Co.(414)253-4131
Health Software, Inc.....(216)759-2103
Healthkit.....(800)253-0570
HEI FastPoint Light Pens..(612)443-2500
Helix Software Co.....(800)451-0551
Tech Support.....(718)392-3735
Helix Technologies.....(800)364-4354
Tech Support.....(200)451-0551
Help Desk Institute .....(800)248-5667
Hercules Cmptr Techn ..(800)532-0600
Tech Support.....(510)623-6050
Heritage Cmptr Parts.....(800)828-8266
Hermann Marketing.....(800)523-9009
Hermeneutika.....(206)824-9673
Hersey Micro Consult ...(313)994-3259
Hetra Cmptr & Comm ..(800)327-0661
Hewlett-Packard Co.....(800)544-9976
Hewlett-Packard Wldwide..(415)986-5600
H-P, Disk Memory.....(208)396-6000
Tech Support.....(208)323-2551
Hexacon Electric Co.....(908)245-6200
Hi Tech Expressions .....(800)216-1750
Tech Support.....(305)581-4240
Hi-Tech Asset Recovery.(805)966-5454
Hi-Tech Cmptr Prods.....(800)950-6991
Hi-TECH Connections...(215)372-1401
Hi-Tech USA.....(800)831-2888
Tech Support.....(408)956-8285
Hi-Techniques Inc.....(800)248-1633
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Larson-Davis Info Sys.....(801)375-8855
Laser Computer, Inc.....(708)540-8086
Laser Digital Inc.....(408)737-2666
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Laser Master Corp .....(800)950-6868
Laser Precision.....(800)443-6154
Laser Printers Access.....(619)485-8411
Tech Support.....(619)486-8411
Laser Source.....(315)463-6090
Laser Supply.....(800)422-0080
Laser Tek Industries.....(800)322-8137
Laser's Edge, Inc.....(515)472-7850
LaserByte.....(800)619-9200
LaserCard Systems.....(415)969-4428
Laserex Inc.....(800)225-5503
LaserGo, Inc.....(619)450-4600
LaserMaster Corp-MAC..(612)944-9330
Tech Support.....(612)944-8008
LaserMaster Corp-PC.....(619)944-9330
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LCS Industries.....(201)778-5588
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Lead Technologies.....(704)549-5532
Leader Instrument Corp. .(800)645-5104
Leader Technology.....(714)757-1787
Tech Support.....(505)822-0700
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Lectronix Cmptr Serv....(304)736-8035
Lectronix Distrib. & Serv. .(800)325-3348
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Leisure Products.....(408)448-7020
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Level Computers.....(714)974-6427
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Liant-Ryan McFarland-MA.(800)237-1874
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Libra Corporation.....(800)453-3827
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Lifeboat Software Grp...(904)825-0220
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Tech Support.....(503)585-4174
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Logical Sys. Corp.....(813)885-7179
Logicode Technology.....(805)388-9000
Tech Support.....(805)388-9000
Logicon, Inc.....(213)373-0220
Logitech.....(800)231-7717
Tech Support.....(510)795-8100
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Longshine Technology...(408)942-1746
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Tech Support.....(800)223-1662
Lotus Publishing.....(617)494-1192
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Magic Software Ent.....(714)250-1718
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Mainstay Software.....(805)484-9400
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Maintech.....(800)426-8324
Maintenance Etc.....(713)520-6567
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Market Intelligence.....(415)961-9000
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Marshall Industries.....(800)522-0084
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Martin Info Systems.....(808)733-2003
Martin Marietta Corp.....(301)897-6000
Masque Publishing.....(800)765-4223
Mass Memory Systems..(800)347-5722
Mass Micro Systems.....(800)522-7970
Tech Support.....(800)522-7970
Masstor Systems Corp...(408)955-0160
Master Bond Inc.....(201)343-8963
Masterclip Graphics-IMSI..(305)983-7440
Tech Support.....(305)983-7440
Mastersoft.....(800)624-6107
Mastertronics.....(714)833-8710
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Mathematica.....(813)682-1128
Tech Support.....(813)682-1130
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Tech Support.....(617)577-1778
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Tech Support.....(514)685-0270
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McArthur Associates.....(914)279-8049
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McDonnell Douglas.....(314)232-0232
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McGraw-Hill Cmptr Publ...(415)513-6800
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Media Cybernetics.....(800)992-4256
Media Factory.....(800)879-9536
Tech Support.....(408)456-9182
Media Products.....(408)432-1711
Media Resources.....(714)256-5048
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Media Value.....(800)845-3472
Media Vision Resource...(800)845-5870
Tech Support.....(800)638-2807
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MediaShare Corp.....(619)931-7171
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Tech Support.....(310)970-8000
Mega Drive Systems.....(310)847-0006
Mega PC Technology.....(714)850-1044
Megadata Corporation...(516)589-6800
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Tech Support.....(713)333-1944
Megahertz.....(800)527-8677
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Meltek Inc.....(408)438-4986
Memorex Cmptr Supp...(408)957-1000
Memorex Telex Corp.....(918)627-2333
Memory Express.....(800)877-8188
Memory Media Prods....(714)669-1800
Memory Prods & More .(714)753-1200
Memory Technology Inc..(303)786-8080
Memsoft Inc.....(407)997-6655
Menai.....(415)617-5730
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Mentor Electronics.....(216)951-1884
Mentor Graphics Corp..(503)685-7000
Mentor Market Research..(408)268-6333
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Metrix Cust. Supp. Sys...(414)798-8560
Metrix Network Sys.....(603)888-7000
Metro Data-Vac.....(914)357-1600
Metro Software.....(602)292-0313
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Metropolis Software.....(415)322-2001
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MetroVision Microsys....(800)875-2099
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Micro Data Base Sys.....(317)463-2581
Micro Design Inc.....(215)884-1112
Micro Design Int'l, Inc...(800)241-1853
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MicroTac Software.....(800)366-4170
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Microtech Conversn Sys...(800)223-3693
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NRG Data Corporation..(408)727-9700
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Okidata Corporation.....(800)654-3282
Tech Support.....(609)273-0300
Okna.....(201)909-8600
Olduvai.....(800)822-0772
Tech Support.....(305)670-1112
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Tech Support.....(800)654-2661
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Omni CEO.....(508)937-5004
Omni Labs.....(800)706-3342
Tech Support.....(415)788-1345
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Tech Support.....(604)988-2616
Pentax Technologies.....(303)460-1600
Pentel of America Ltd....(310)320-3831
Penton Publishing.....(216)696-7000
PenWare, Inc.....(415)858-4920
Tech Support.....(415)858-4922
Peoplesmith Software....(617)545-7300
Peradata Techn Corp.....(516)588-2216
Perception Technology..(617)921-0320
Perceptive Solutions.....(214)954-1774
Perco, Inc.....(503)344-1189
Percom Technology.....(510)656-2866
Percon, Inc.....(800)873-7266
PereLine Data Systems...(408)364-2770
Perfect Data Corp.....(805)581-4000
Pericomp Corporation..(508)655-7660
Peripheral Cmptr Supp.(408)263-4043
Peripheral Land Inc.....(800)288-8754
Tech Support.....(800)288-8754
Peripheral Maintenance..(201)227-8411
Peripheral Parts Supp....(617)890-9101
Peripheral Repair Corp.(800)627-3475
Peripheral Serv Prods....(800)247-4733
Peripheral Solutions.....(408)425-8280
Peripheral Vision.....(800)441-0933
Peripherals Plus.....(800)444-7369
Tech Support.....(908)363-6270
Periscope.....(800)722-7006
Perkin-Elmer Corp.....(203)762-1000
Perma Power Electr.....(800)323-4255
Persoft.....(800)368-5283
Tech Support.....(608)273-4357
Persona Technologies....(415)871-6000
Personal Cmptr Prods...(619)485-8411
Personal Cmptr Sol.....(214)661-8144
Tech Support.....(214)661-8144
Personal Cmpting Tools...(800)767-6728
Pers Library Software....(301)926-1402
Personal Publishing.....(708)665-1000
Personal Tex.....(415)388-8853
Personal Training Sys.....(800)832-2499
Tech Support.....(800)832-2499
Personal Travel Techn....(516)538-1234
Personics Corporation...(800)445-3311
Tech Support.....(508)658-0040
Perspective Software.....(313)537-6168
Peter Norton Cmpting..(310)453-4600
Phar Lap Software.....(617)661-1510
Pheecom Technology....(714)668-9550
PHIHONG USA.....(408)263-2200
Philips PDO Media.....(800)235-7373
Phillips Consumer Electr..(615)521-4316
Phillips Corporation.....(310)217-1300
Phillips ECG.....(800)526-9354
Phillips Key Modules.....(714)453-7373
Phillips Labs.....(800)628-0363
Philtek Power Corp.....(800)727-4877
Phoenix Contact Inc.....(717)944-1300
Phoenix Technologies...(617)551-4000
Physician Micro Sys .....(206)441-8490
Physiotronics Corp USA...(212)887-9555
PI Manufacturing Corp..(714)596-3718
Pick Systems.....(714)261-7425
Pico Electronics.....(800)431-1064
PictureWare, Inc.....(215)667-0880
Piiceon .....(800)366-2983
Tech Support.....(408)432-8030
Pilot Corp of America....(203)377-8800
Pilot Software Inc.....(800)944-0094
Pine Computer Sys.....(619)569-7463
Pinnacle Data Systems...(614)487-1150
Pinnacle Micro.....(800)553-7070
Tech Support.....(714)727-3300
Pinnacle Publishing.....(800)231-1293
Tech Support.....(206)251-3513
Pinnacle Software.....(514)345-9578
Pinpoint Publishing.....(800)788-5236
Pioneer Commun.....(201)327-6400
Pioneer Computer, Inc..(510)623-0808
Pioneer Magnetics.....(800)233-1745
Pioneer New Media Tech..(310)952-2111
Tech Support.....(310)952-2111
Pioneer Software.....(800)876-3101
Pioneer Standard Electr...(216)587-3600
Pitney Bowes Inc.....(203)351-7226
Pivar Computing Serv....(800)266-8378
Pixar.....(800)888-9856
Tech Support.....(800)937-3179
PKware, Inc.....(414)354-8699
Plainview Batteries Inc..(800)642-2354
Plamer Systems.....(503)690-1100
Plasmaco, Inc.....(914)883-6800
Plasmon Data Systems...(408)432-0570
Plastic Systems Inc.....(508)485-7390
Platinum Desktop Sftwr....(714)727-3775
Tech Support.....(714)727-2110
Platinum Software.....(714)727-1250
Plato Products Inc.....(818)965-8044
Platt Luggage.....(800)222-1515
Plesman Publications.....(416)497-9562
PLI.....(800)288-8754
Tech Support.....(800)288-8754
Plotworks.....(619)457-5090
Pluma Software.....(602)696-9441
Tech Support.....(602)969-9441
Plus 5 Engineering Ltd..(301)977-4048
Plus Development.....(800)624-5545
Tech Support.....(900)740-4433
Plustek USA, Inc.....(800)685-8088
PMR Corporation .....(800)456-6480
Point 4 Data Corp.....(714)259-0777
Polar Instruments.....(800)328-0817
Polaris Service Inc.....(800)541-5831
Polaris Software.....(800)338-5943
Tech Support.....(619)592-7400
Polaroid Corporation.....(800)225-2770
Tech Support.....(800)225-1618
Policy Mgmt Systems.....(803)735-4000
Polygon, Inc.....(314)432-4142
Tech Support.....(314)432-4142
Polytele Cmptr Prods....(408)745-1540
Polytronics.....(318)797-2952
Polywell Computers.....(415)583-7222
Popking Sftwr & Sys.....(212)571-3434
Popular Programs, Inc....(800)447-6787
Poqet Computer Corp...(800)624-8999
Porelon, Inc.....(615)432-4042
Portable Warehouse.....(714)993-1095
Tech Support.....(714)993-1096
Portacom Technologies..(415)390-8507
Portfolio Systems.....(800)729-3966
Tech Support.....(800)434-6300
Positive Software Sol.....(310)301-8446
Postcraft International...(805)257-1797
Tech Support.....(416)641-0768
Power Clinic Inc.....(214)245-4016
Power Computing.....(516)938-0506
Power General.....(617)828-6216
Power Integrity Corp....(800)237-6260
Power Line.....(800)234-2444
Power Plus.....(800)875-5530
Power Pros.....(800)788-0070
Power Up! Software.....(800)851-2917
Tech Support.....(415)345-0551
Powercard Supply .....(305)251-5855
Powercom America.....(714)252-8241
Powercore Inc.....(800)237-4754
Tech Support.....(800)237-4754
PowerPro Software.....(415)345-9278
PowerTek Industries.....(303)680-9400
Powervar Inc.....(800)369-7179
PQ Systems.....(513)885-2255
Practical Peripherals.....(800)442-4774
Tech Support.....(805)496-7707
PriarieTek Corporation..(800)825-2511
PRC.....(703)556-1000
Pre-Owned Electronics..(800)274-5343
Precise Power Corp.....(813)746-3515
Precision Data Prods.....(800)968-0888
Precision Line Inc.....(612)475-3550
Precision Methods.....(703)752-2800
Precision Micro Rsrch...(408)727-9697
Precision Motion.....(805)546-8294
Precision Plus Software.(519)657-0633
Preferred Cmptr Serv....(708)268-9150
Preh Electr. Industries....(708)438-4000
Prema Precision Electr..(800)441-0305
Prentice Hall Cmptr Pub...(317)573-2500
Prentice Hall, Inc.....(201)767-5937
Prescience.....(415)543-2252
Tech Support.....(415)543-2252
Present Techn Comp.....(503)641-1370
Prestance Corporation..(206)448-5052
Priam Corporation.....(408)946-4600
Priam Systems.....(408)441-4180
Prima International.....(408)727-2600
Primages Inc.....(516)585-8200
Primavera Systems, Inc..(800)423-0245
Tech Support.....(215)668-3030
Primax Electronics.....(800)338-3693
Prime Portable Mfr.....(800)966-7237
Prime Solutions.....(619)274-5000
Tech Support.....(619)272-4000
PrimeService.....(508)620-2800
Princeton Technology...(714)847-2477
Principia Products.....(215)429-1359
Print Products Int'l.....(800)638-2020
Printech Enterprises.....(800)346-2618
Printech Ribbons Inc.....(514)684-8450
Printer Connection.....(800)622-7060
Printer Products.....(617)254-1200
Printer Source.....(215)538-3188
Printer Systems Corp ....(301)258-5060
Printer Works.....(800)225-6116
Printers Plus.....(800)562-2727
Printers Plus Natl Sales..(800)877-4683
Tech Support.....(800)258-2661

INDUSTRY PHONE NUMBERS

Printing Techn Center....(800)285-6496
Tech Support.....(216)524-1291
Printronix, Inc.....(714)863-1900
Tech Support.....(714)863-1900
Prism Imaging Systems..(510)490-9360
Pro Active Software.....(415)691-1500
Pro Tools Inc.....(800)743-4335
Pro-C Ltd.....(519)725-5173
Pro-Mation, Inc.....(801)566-4655
Pro-Serv Development...(302)234-2733
Pro-Tech Cases.....(800)638-3789
ProTecT Cmptr Prods....(801)295-7739
ProBoard International..(612)537-8655
Processing Telecom Tech...(205)971-8001
Processor Magazine.....(800)247-4880
Processor, The.....(800)247-4880
Procom Technology.....(714)852-1000
Tech Support.....(714)852-1000
Procomp USA, Inc. .....(216)234-6387
Prod-Art Marketing-USA....(516)223-9800
Prodatel Comm.....(800)561-4019
Prodem Techn America .(408)984-2850
Prodigy Services Co.....(800)333-5779
Tech Support.....(800)284-5933
Product Safety Eng .....(813)989-2360
Productivity Enhancmnt..(714)348-1011
Productivity Software....(212)818-1144
Professional Cmptr Serv...(404)998-7776
Professional Mgmt Inst..(800)383-1296
Professional MicroCare..(513)223-2348
Profit Press.....(800)843-7990
Profitability of Hawaii....(808)536-6167
Progen Technology Inc..(714)549-5818
Prognostics.....(415)424-8711
Programmer's Paradise..(908)389-8950
Programmer's Shop.....(800)421-8006
Programmer's Wrhse.....(602)443-0580
Tech Support.....(602)443-7667
Progress Software Corp.(617)275-4500
Progressive Cmptr Serv.(504)831-9717
Progressive Micro Sys....(800)220-9888
Tech Support.....(800)220-9898
Progressive Ribbon.....(800)800-7426
ProHance Technology....(408)746-0950
Prolink Computer Inc....(213)780-7978
ProMaccomputers Inc...(503)691-0304
Promark Ltd. .....(505)345-7701
ProMax Technology.....(800)977-6629
Prometheus Products....(800)477-3473
Tech Support.....(503)692-9601
Promise Technology.....(408)452-0948
ProSoft.....(818)765-4444
Prosonus .....(800)999-6191
ProSource Power.....(800)949-4797
Protec Microsystems.....(514)630-5832
Protech Inc. .....(210)614-1690
Protective Closures Co..(716)876-9855
Protek Inc.....(201)767-7242
Proteon, Inc. .....(800)666-4400
Tech Support.....(508)898-3100
Protolab.....(804)785-5000
Proton Corporation.....(714)952-6900
ProtoView Development.(908)329-8588
ProVUE Development...(714)892-8199
Tech Support.....(714)892-8599
Proworks.....(503)567-1459
Tech Support.....(503)567-8836
Proxim Inc. .....(415)960-1630
Tech Support.....(415)960-1630
Proxima Corporation.....(800)447-7694
Tech Support.....(800)447-7694
PS Solutions, Inc. .....(214)980-2632
PSI Integrations.....(800)622-1722
Tech Support.....(800)774-4965
Psion Inc. .....(506)371-0310
PSN.....(212)696-9476
PSSI Plug-In Stor Solutions.(800)231-5952
Psygnosis Limited.....(800)438-7794
Tech Support.....(617)497-7794
PTI Industries.....(408)438-3900
PTN Publishing.....(516)845-2700
Public Brand Software...(800)426-3475
Public Software Library. (800)242-4775
Publishers Group West..(510)658-3453
Publishing Perfection ....(800)782-5974
Publishing Technology ..(512)246-2835
Pulizzi Engineering Inc..(714)540-4229
Pulse Metric Inc.....(619)546-9461
Pup-Pak.....(310)568-1790
Purart.....(603)772-9907
Pure Data.....(800)661-8210
Tech Support.....(800)661-8210
Puretek Industrial Co ....(510)656-8083
Pycon Inc.....(800)949-0349
Pyramid Data.....(800)972-7972
Tech Support.....(415)312-7080
Pyramid Techn. Corp .....(415)965-7200
Q/Media Sftwr Corp.....(604)679-6886
Qantel Business Sys.....(510)887-7777
QDI Computer Inc. .....(310)906-1029
QMS Inc. .....(800)523-2696
Tech Support.....(205)633-4500
QSound Ltd.....(403)291-2492
Qtronix Corporation.....(408)954-8040
Qtronix Inc. .....(213)383-8068
Quadbase Systems.....(408)738-6989
Quadram Corporation...(404)923-6666
Quadrant Components..(510)656-9988
Quadtel Corporation.....(714)440-8000
Quaid Software Limited.(416)961-8243
Qualitas .....(800)676-8386
Tech Support.....(301)907-7470
Quality Cmptr Access....(818)964-3398
Quality Power Prods .....(800)525-7502
Quality Repair Services.(510)651-8486
Quality Software Prods..(310)410-0303
Quality Systems, Inc. ....(714)731-7171
Qualstar Corporation.....(818)882-5822
Qualtec Data Prods .....(800)628-4413
Tech Support.....(800)628-4413
Quanta.....(800)682-1738
Quantum Corporation ..(800)345-3377
Tech Support.....(800)826-8022
Quantum Data .....(708)888-0450
Quantum Software Sys..(613)591-0931
Quark Inc.....(303)894-8888
Tech Support.....(303)894-8899
Quarter-Inch Cartr. Dr. Std .(805)963-3853
Quarterdeck Office Sys.(800)354-3260
Tech Support.....(310)392-9701
Quatech, Inc.....(216)434-3154
Que Corporation.....(800)428-5331
Que Sftwr/Prentice Hall..(800)992-0244
Tech Support.....(317)571-3833
Questronics Inc. .....(801)262-9923
Quick Comm .....(408)956-8236
Quickpath Systems.....(510)440-7288
Quicksoft .....(800)888-8088
Quintar Comp.....(310)320-5700
Quintas Corporation.....(800)542-1283
Quixale America Inc.....(815)399-3608
Qurnax Corporation.....(408)954-8040
Qume.....(408)262-7700
.....(408)942-4140
.....(408)942-4000
Quotron Systems, Inc.....(310)827-4600
QVS, Inc. (MI).....(800)622-9606
QVS, Inc. (NV).....(800)344-3371
R & D Business Sys.....(604)872-1118
R & K Supply Co.....(800)362-6780
R & R Electronics.....(800)736-3644
Tech Support.....(404)368-1159
R Co.....(310)441-0447
R Company.....(310)441-0447
R&K Supply.....(800)362-6780
R's Data Services.....(818)700-8766
R.J. Swantek & Assoc .....(203)953-0236
R.R. Software.....(608)251-3133
Rabbit Software.....(800)445-4357
Racal-Datacom Inc.....(800)572-2255
Racal-Interlan .....(800)526-8255
Tech Support.....(800)526-8255
RaceCom.....(800)638-8068
Racore Cmptr Prods.....(800)635-1274
Tech Support.....(801)596-0265
Radiant Communications .(201)757-7444
Radio Shack.....(817)390-3011
Radiometrics Midwest...(708)932-7262
Tech Support.....(708)932-7262
Radius Inc. .....(800)227-2795
Tech Support.....(408)434-1012
Radix Group Int'l.....(310)338-2525
RAG Electronics Inc. .....(818)998-6500
Raima.....(206)747-5570
Tech Support.....(206)562-2622
Rainbow Technologies ..(800)852-8569
Ralin Wholesaler.....(800)752-9512
RAM Mobile Data.....(212)303-7800
Ram Solutions.....(602)759-5520
Ramp Industries.....(607)729-5256
Ramtek Corporation.....(408)954-2700
Tech Support.....(408)954-2750
Rancho Technology.....(714)987-3966
Rand Information Sys....(415)391-2213
Random House Inc.....(301)848-1900
Tech Support.....(301)857-9460
Randomex Inc. .....(310)595-8301
Raosoft Inc.....(206)525-4025
Rapid Systems Inc.....(206)547-8311
Rapid Technology Corp.(716)833-8533
RARE Systems Inc.....(214)991-7273
Raster OPS .....(800)729-2656
Tech Support.....(801)785-5750
Rational Data Systems. ..(415)499-3354
Rational Systems.....(508)653-6194
Ratliff Software .....(818)546-3850
Ray Dream.....(415)960-0768
Tech Support.....(415)960-0768

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INDUSTRY PHONE NUMBERS

Raynet Electronics.....(713)578-3802
Rayovac Corporation.....(608)275-3340
Raytheon (MA).....(617)862-6600
Raytheon (RI).....(401)847-8000
Rayton Comm-USA.....(800)472-9866
Rayven Inc. .....(800)627-3776
RC Electronics.....(800)882-3475
RCI.....(908)874-4072
RDN & Associates.....(800)647-6747
Reach Software.....(800)624-5356
React Computer Serv....(800)662-9199
Reactor.....(312)573-0800
Tech Support.....(312)573-0800
Read/Right Prods Div....(201)327-9100
Real Applications Ltd.....(818)226-6600
Realia.....(312)346-0642
Reality Technologies.....(800)521-2471
Tech Support.....(800)521-2471
RealWorld Corporation .(800)678-6336
Tech Support.....(603)288-3432
Recognita Corp / America.(408)749-9935
Recognition Equipment..(214)579-6000
Recordex Corporation...(619)467-9068
Recoton.....(800)223-6009
Recovery Management..(508)486-8866
Recovery Plus Plan. Prod..(800)356-7586
Recovery Resources.....(407)851-7657
Red Wing Business Sys..(800)732-9464
Redysoft Software.....(714)626-4070
Reference Software.....(800)872-9933
Tech Support.....(415)541-0226
Reflection Systems.....(408)432-0943
Reflection Technology...(617)890-5905
Regent Peripherals.....(509)662-8848
Relational Courseware...(617)262-4933
Relax Technology.....(510)471-6112
Relay Technologies.....(203)798-3800
Rlse 1.0/Edventure Hold...(212)924-8800
Relialogic Corporation..(510)770-3990
Relisys.....(408)945-9000
REM.....(408)655-1111
Remote Control Int'l.....(800)992-9952
RenaSonce Group Inc...(619)287-3348
Renewable Resources...(800)832-1400
Rent-A-Computer.....(408)727-7800
Repeat-O-Type Mfg.....(800)288-3300
Reply Corporation.....(800)955-5295
Reseller Management....(201)292-5100
Reset Inc. .....(805)584-4900
ResNova Software Inc...(714)379-9000
Resource Spectrum.....(214)484-9330
Retix.....(310)828-3400
Revelation Technology..(800)262-4747
Tech Support.....(203)973-1011
Revolution Software.....(908)879-7038
Rexon Corporation.....(805)583-5255
RFF Electronics.....(303)663-5767
RFG Onyx.....(800)946-8324
Tech Support.....(800)766-2711
RG Software Systems ....(602)423-8000
RGB Spectrum.....(510)848-0180
Tech Support.....(510)848-0180
Ribbon Tek USA.....(719)578-0506
Ribbon Tree USA Inc.....(800)862-9499
Richmond Technology...(714)794-2111
Ricks RamStar, Inc.....(800)327-2303
Ricoh Corporation.....(714)259-1310
Tech Support.....(714)566-3584
Rimage Corporation.....(800)445-8288
Tech Support.....(612)934-5432
Rinda Technologies.....(312)736-6633
Ring King Visibles, Inc...(800)272-2366
Tech Support.....(800)553-9647
Ripe C&C Technology...(408)492-9585
Riser-Bond Instruments.(800)688-8377
RISO, Inc.....(508)777-7377
Rite-Off Inc.....(800)645-5853
River Data.....(818)222-7191
Rix Softworks, Inc.....(800)345-9059
RJ Steams Associates.....(508)263-3426
RMS Computer Corp.....(212)840-8666
RO Associates.....(208)772-2781
Road Scholar.....(800)243-7623
Tech Support.....(713)266-7623
Robec Distributors.....(800)223-7087
Robec Distrib-East PA....(800)223-7081
Tech Support.....(800)223-7087
Robec Distrib-West.....(800)433-5061
Robert J. Victor & Assoc.(201)875-3600
Roberts Express.....(800)762-3787
Robitron Software.....(404)684-5855
Rochelle Commun .....(800)542-8808
Tech Support.....(512)794-0088
Rockwell Int'l (IL) .....(708)960-8000
Rockwell Int'l (CA).....(714)833-4700
Roctec Electronics Ltd. .(408)379-1713
Tech Support.....(408)379-1713
Rodax Inc.....(206)885-9999
Rodime Systems, Inc.....(800)227-4144
Rohde & Schwartz Inc..(301)459-8800
Roland Corporation US.(213)685-5141
Roland Digital Group ....(714)975-0560
Tech Support.....(714)975-0670
Rorke Data.....(800)328-8147
Rose Electronics.....(713)933-7673
ROSH Intelligent Sys.....(800)677-7674
Rotating Memory Repair...(714)472-0159
Rotating Memory Serv...(916)939-7500
Tech Support.....(916)939-7500
Roundhill .....(708)690-3737
Royal Computer.....(818)333-7628
Tech Support.....(818)330-2717
Royal Seating Corp.....(817)697-6421
Roykore Inc. .....(415)563-9175
RPA.....(800)879-5860
RQDQ Corporation.....(315)437-2631
RT&C Systems Inc.....(510)655-1993
Rundel Products.....(800)547-7061
Rupp Techn Corp-AZ ....(602)224-9922
Tech Support.....(602)224-9922
Rupp Techn Corp-CA ....(800)852-7877
Tech Support.....(602)224-0897
Ryan McFarland.....(512)343-1010
Rybs Electronics.....(303)444-6073
S & W Cmptrs & Electr....(800)874-1235
Tech Support.....(212)463-8330
S-MOS Systems Inc. .....(408)922-0200
S1 Computers.....(800)886-3210
Tech Support.....(818)912-0166
S3 Inc.....(408)980-5400
Saber Software.....(800)338-8754
Tech Support.....(800)526-8086
Sabina International.....(800)272-2462
Safeware Insure Agency....(800)848-3469
SAG Electronics .....(800)989-3475
Tech Support.....(800)899-5752
Sager Computer.....(800)669-1624
SAIC Imaging Solutions.(800)442-7242
Salient.....(800)766-7283
Samna Corporation .....(800)831-9679
Tech Support.....(404)256-2272
Sampo Corp of America...(404)449-6220
Sampson MIDI Source...(214)328-2730
SAMS .....(317)581-3500
Samsonite Corporation..(303)373-2000
Tech Support.....(303)373-6666
Samsung.....(800)446-0262
Tech Support.....(800)446-0262
Samsung Electr America...(800)446-0262
Tech Support.....(201)691-6214
Samsung Info Sys America.(800)446-0262
Tech Support.....(800)446-0262
Samtron.....(714)522-1282
Tech Support.....(714)522-1282
Sankyo Seiki (America) .(714)724-1505
Santa Cruz Operations ..(408)425-7222
Tech Support.....(800)347-4381
Santos Technology Inc...(310)320-8888
Sanyo Business Systems.(800)524-0048
Tech Support.....(201)440-9300
Sanyo Energy Corp.....(619)661-6620
Sapro-Impact Software (800)369-8649
Tech Support.....(714)541-2202
SaRonix.....(415)856-6900
SAS Electronics Inc.....(408)245-5000
SAS Industries.....(800)245-4657
SAS Institute, Inc.....(919)677-8000
Tech Support.....(919)677-8008
Save Rite Technologies..(800)668-7972
Savin Corporation .....(203)967-5000
Sayett Technology, Inc....(800)836-7730
Tech Support.....(800)836-7730
SBE, Inc.....(510)680-7722
Tech Support.....(800)827-2245
SBT.....(415)331-9900
Tech Support.....(415)332-9308
Scan-Optics, Inc. .....(800)854-8412
Scandinavian PC Sys.....(301)294-7450
Tech Support.....(301)294-7453
Scandura Intelligent Sys ...(215)664-1207
Scantech Computer Sys...(818)960-2999
Sceptre Technologies.....(714)993-9193
Scherrer Resources Inc. (215)836-1830
Tech Support.....(215)836-1805
Schlumberger Ltd. .....(212)350-9400
Schlumberger Technology..(800)225-5765
Schnellmann America....(408)441-6026
Scholastic, Inc. .....(314)636-5271
SCI Systems, Inc.....(205)882-4755
SCI/CAD Scan Inc.....(505)881-4872
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SCS/Compute, Inc.....(314)966-1040
SDA Corporation.....(800)833-5020
SDB Systems .....(813)481-0224
Seagate Technologies.....(800)468-3472
Tech Support.....(408)438-8222
Seagull Scientific Sys.....(800)758-2001
Searchlight Software.....(216)631-9290
Seco Industries .....(213)726-9721
Sector Computer Serv...(216)524-5858
Secura Technologies.....(714)248-1544
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Secured Communication..(416)888-1580
Security Microsystems ..(800)345-7390
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SEI (National FSI Inc.) ...(214)689-3200
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Tech Support.....(800)553-5312
Seiko Instruments USA .(408)922-1917
Tech Support.....(408)922-1917
Seikosha America Inc. ...(201)327-7227
Tech Support.....(201)327-7227
Sejin America .....(408)752-8447
Selecterm, Inc. .....(800)877-7586
Tech Support.....(800)767-7586
Selective Software.....(408)423-3556
Tech Support.....(800)423-3556
Selectronics & Microlytics.(716)248-9150
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Semware.....(404)641-9002
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Sensible Software.....(313)528-1950
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Sercomp Corporation....(800)428-2635
Tech Support.....(800)428-2635
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Serigraph Inc.....(414)335-7200
Serius (Novell).....(800)876-6847
Tech Support.....(800)876-6847
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Server Technology.....(800)835-1515
Tech Support.....(408)988-0142
Service 2000.....(800)466-2000
Service InfoSystems.....(716)334-9126
Service Management.....(603)882-7783
Service Management Grp .(410)992-9975
Service Partner Inc.....(201)770-4949
Service Systems Int'l.....(913)661-0190
Serviceland/Upstate NY...(716)427-0880
ServiceScope Corp.....(203)265-2624
ServiceWare .....(716)842-1611
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Tech Support.....(317)842-2077
Shape Corporation .....(403)463-3330
Tech Support.....(403)463-3330
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Shapeware.....(800)446-3335
Shared Medical Systems.(215)296-6300
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Tech Support.....(503)626-2022
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Shining Technology .....(310)802-3081
Shiva.....(800)458-3550
Tech Support.....(617)270-8400
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Shugart Corporation.....(714)770-1100
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Tech Support.....(510)623-8876
SI Dynamics In.....(619)322-2761
Sicon International Inc..(408)432-8585
Tech Support.....(408)432-8585
Sidco Software Int'l .....(212)627-4475
Sidon Data Systems .....(714)553-1131
Sidus.....(416)882-1600
Siecor Corporation.....(800)633-7432
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Tech Support.....(617)273-0480
Siemon Company.....(203)274-2523
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Sierra On-Line .....(800)757-7707
Tech Support.....(209)683-8989
Sigen.....(408)737-3904
Sigma Data .....(800)446-4525
Sigma Designs.....(800)845-8086
Tech Support.....(510)770-0100
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Tech Support.....(212)373-8500
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Simple Software.....(914)297-5858
Tech Support.....(914)297-5868
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Sound Ideas .....(416)886-5000
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Tech Support.....(805)494-9996
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Source Service Corp.....(800)877-8896
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SpectraFAX.....(800)833-1329
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Tech Support.....(510)522-1164
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Spindrift Laboratories....(708)255-6909
Spinnaker Software .....(800)325-8088
Tech Support.....(800)223-8088
Spirit Technology.....(800)945-5549
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Tech Support.....(800)547-7766
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Tech Support.....(619)431-8355
Stac Electronics-OS/2 ....(800)522-7822
Tech Support.....(619)431-8201
Stac Electronics-PC/Win .(800)522-7822
Tech Support.....(619)431-6712
Staco Energy Products...(513)253-1191
Stallion Technologies.....(800)347-7979
Tech Support.....(800)347-7979
Standard Cmptr Corp....(800)662-6111
Standard Microsys Corp..(800)762-4968
Tech Support.....(800)638-5323
Standard Rate&Data Serv...(708)256-6067
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Star Micronics America..(800)447-4700
Tech Support.....(714)768-3192
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Tech Support.....(517)332-1256
Star Software Systems ...(310)533-1190
Tech Support.....(800)443-5737
Star-Tek Inc. .....(508)393-9393
StarGate Computers.....(800)945-0202
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Starware Publishing.....(800)354-5353
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Tech Support.....(800)242-1519
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STB Systems Inc.....(800)234-4334
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STI-Certified Products....(800)274-3475
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Tech Support.....(408)894-1325
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Strategic Simulations.....(408)737-6800
Tech Support.....(408)737-6850
Strategic Solutions.....(203)221-1334
Stratus Computer, Inc....(508)460-2000
Strawberry Tree.....(408)736-8800
Street Electronics.....(805)684-4593
Tech Support.....(805)684-4593
Streetwise Software.....(310)829-7827
Stride Software, Inc. .....(213)433-6977
Strohl Systems .....(800)634-2016
Structural Dynamics Rsrch.(513)576-2400
Structured Sftwr Sols.....(214)985-9901
STSC.....(301)984-5000
Tech Support.....(301)984-5489
Studebaker-Worthington...(800)645-7242
Sub Systems.....(617)438-8901
SubLOGIC.....(217)359-8482
Tech Support.....(800)637-4983
Success Trainers Inc.....(800)229-4708
Summagraphics .....(800)729-7866
Tech Support.....(800)729-7866
Summatec Computer....(800)335-7573
Summit Memory Sys.....(800)523-4767
Tech Support.....(408)438-7897
Summit Micro Design....(408)739-6348
Tech Support.....(408)739-6348
Summus Corporation....(713)492-6611
Sun Country Software...(505)873-2220
Sun Microsytems Techn..(800)643-8300
Tech Support.....(800)872-4786
Sun Moon Star.....(408)452-7811
Tech Support.....(408)452-7811
Sun Remarketing.....(800)821-3221
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Suncom Technologies....(708)647-4040
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Supercomputer Sys .....(715)839-8484
Superior Electric.....(203)582-9561
Superior IS.....(713)662-8500
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Tech Support.....(408)252-5700
Symbios Logic.....(800)862-7729
Symbol Technologies.....(516)563-2400
Symbolics Inc.....(617)221-1000
Symbologic Corporation..(800)448-9292
Tech Support.....(800)448-9292
Symmetry Software.....(800)624-2485
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Symphony Laboratories..(408)986-1701
SymSoft .....(702)832-4300
Symtech .....(619)569-6800
Synchronics .....(901)761-1166
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Synergetics Int'l.....(303)678-5200
Synergy Cmptr Services..(416)273-9565
Synergy Software.....(215)779-0522
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Synergy Solutions .....(602)545-9797
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SynOptics Communicatn..(800)776-8023
Tech Support.....(800)473-4911
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Syquest Technology.....(800)245-2278
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Sys Technology, Inc.....(213)493-6888
Sys-Com.....(800)343-0100
Sysgen, Inc. .....(800)821-2151
Sysgration USA Inc. .....(415)306-7860
Tech Support.....(415)348-5663
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Tech Support.....(408)725-4667
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System Security Techn...(702)454-7009
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Tech Support.....(501)220-5653
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Systems and Software....(714)833-1700
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Systems Compatability...(800)333-1395
Tech Support.....(312)527-4357
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Sys Integration Assoc.....(312)440-1275
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Tech Support.....(800)422-2115
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Unit Tech America Inc...(310)602-2392
United Barcode Ind.....(301)210-3000
United Bus Machines.....(800)722-7703
Tech Support.....(909)279-1298
United Cmptr Express...(800)448-3738
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United Networks Inc.....(408)433-0900
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US Computer Maint.....(800)473-8650
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US Paging Corporation..(201)305-6000
US Technologies.....(201)288-8200
USA Electronics.....(214)631-1574
Tech Support.....(214)631-1693
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Tech Support.....(708)351-7172
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Wespercorp.....(714)261-0606
Westbrook Technology..(800)742-2442
Tech Support.....(203)399-7111
Western Digital .....(800)832-4778
Tech Support.....(800)832-4778
Western Eng Consultants..(805)375-4025
Western Micro .....(800)634-2248
Western Scientific.....(800)443-6699
Western Telematic Inc...(800)854-7226
Tech Support.....(800)854-7226
Western Union Corp.....(201)818-5000
Western Wares .....(303)327-4898
Westinghouse Electric...(412)244-2000
Westlake Data Corp.....(512)328-1041
Tech Support.....(512)328-1043
Wetex Int'l (USA).....(800)759-3839
Tech Support.....(213)728-3156
Weyerhauser Recovery..(800)654-9347
White Pine Software.....(603)886-9050
Tech Support.....(603)886-9050
White Plains Software ...(603)886-9050
Whitewater Group .....(708)328-3800
Wicat Systems, Inc.....(801)224-6400
Wilcom Inc. .....(800)222-1898
Williams & Macius.....(509)235-2012
Willies Cmptr Software.(800)966-4832
Tech Support.....(713)963-9427
Willow Creek Techn.....(519)836-1532
Willow Peripherals.....(800)444-1585
Tech Support.....(800)444-1585
Wilson Laboratories.....(714)998-1980
Wilson WindowWare.....(206)937-9335
WIN Group.....(213)903-1440
Wincom Int'l Network..(909)594-2218
Windows User Mag.....(212)302-2626
WindSoft Inc.....(201)586-4400
Windsor Technologies...(415)456-2200
Wink Data Products .....(206)742-4145
Winners Only Inc. .....(619)549-2249
WinSoft .....(800)275-7638
Winsryg Corp, The.....(602)431-9118

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Wintec Indrustries Inc. .(510)770-9239
Wintime Corporation....(310)375-5930
WinWare .....(214)458-0540
WIP Technology.....(800)743-2318
Wise Components.....(800)543-4333
Wise-Ware .....(714)556-6523
WIT .....(408)433-0188
Wizardworks.....(612)559-5140
Tech Support.....(612)544-8581
Wolff Forbes & Assoc ....(914)478-5048
Wolfram Research, Inc...(800)441-6264
Wollongong Group.....(415)962-7100
Wonder Corporation.....(617)965-8400
Wonderware .....(714)727-9779
Wong's Int'l USA.....(415)967-1111
Word Star International.(800)227-5609
Tech Support.....(812)323-8814
Wordata Inc.....(800)543-1922
WordPerfect Corp.....(800)451-5151
Borland Office .....(800)661-2722
Competitor's Suite .....(800)861-2721
ConvertPerfect .....(801)228-9934
DataPerfect .....(800)861-2132
Developer's Tool Kit....(801)228-9508
Edultainment .....(801)228-9939
Envoy.....(801)228-9929
Extend Ann Supp-Classic.(800)861-3380
Extend Ann Supp-Priority.(800)861-2220
French.....(800)321-6844
Gateways.....(800)861-2135
Grammatik DOS/WIN.(801)228-9933
Hard Disk-Gift Shop.....(801)228-3783
Hard Disk-Kitchen.....(801)228-3788
Hard Disk-Specials.....(801)228-3780
Hearing Impaired-TDD...(800)321-3256
InfoCentral.....(801)228-9938
Informs.....(800)861-2133
InfoShare (FAX).....(800)228-9960
Intellitag (DOS).....(801)228-9925
Intellitag (UNIX).....(801)228-9935
Language Modules.....(800)321-7431
Letter/Elect/Dict/Clip Art (801)228-9933
NAS.....(800)321-0034
NAS, CAP.....(800)228-9505
Office UNIX.....(800)861-2134
Office/Priority Service (800)861-2136
Piracy-BSA.....(801)688-2721
Piracy-WordPerfect.....(800)222-4449
PlanPerfect.....(800)321-3248
Presentations (DOS)....(800)861-2060
Presentations (WIN)....(800)861-2050
Quattro Pro (DOS).....(800)861-3773
Quattro Pro (WIN).....(800)861-2774
Sales, French Speaking.(800)321-2318
Sales, Certification .....(800)993-3700
Sales, Cust Registration....(801)222-4500
Sales, Direct Sales.....(800)321-4566
Sales, Easy Move/Spec Lic.(800)228-5040
Sales, Hearg Impaird-TDD.(800)321-3256
Sales, International.....(801)222-4200
Sales, Mini-Main Info/Ord.(800)321-3280
Sales, Orders on Acct...(800)321-3220
Sales, Orders Resolution.(800)321-2319
Sales, Sftwr Subscriptn (800)282-2892
Sales, Workgroup/Office..(800)861-2507
Shell 4.0.....(801)228-9937
Shell 4.0 Macros.....(801)228-9928
Soft Shoppe .....(800)526-6215
Spanish.....(800)321-8492
Suite Consulting.....(800)861-2721
WP5.1 DOS, Fax.....(800)861-2316
WP5.1 DOS, Features...(800)861-2164
WP5.1 DOS, Graph/Tabl..(800)861-2101
WP5.1 DOS, Installation .(800)861-2055
WP5.1 DOS, Macro/Merg.(800)861-2745
WP5.1 DOS, Network..(800)861-2116
WP5.1 DOS, Prn-Dot Matx(800)861-2333
WP5.1 DOS, Prn-Laser/PS .(800)861-2351
WP5.2 WIN, Features...(800)228-1029
WP5.2 WIN, Graphics..(800)228-6013
WP5.2 WIN, Installatn..(800)228-6076
WP5.2 WIN, Macro/Merg.(800)228-1032
WP5.2 WIN, Networks.(800)228-6066
WP5.2 WIN, Prn-Dot Matx(800)228-1017
WP5.2 WIN, Prn-Laser/PS..(800)228-6076
WP6.0 DOS, Fax.....(800)228-2066
WP6.0 DOS, Features...(800)228-9038
WP6.0 DOS, Graph/Tabl...(800)228-9006
WP6.0 DOS, Installatn..(800)228-9012
WP6.0 DOS, Macro/Merg.(800)228-9013
WP6.0 DOS, Networks.(800)228-9019
WP6.0 DOS, Prn-Dot Matx(800)228-9032
WP6.0 DOS, Prn-Laser/PS .(800)228-9027
WP6.0 WIN, Features...(800)228-9907
WP6.0 WIN, Graph/Tabl...(800)228-8720
WP6.0 WIN, Installatn..(800)228-7610
WP6.0 WIN, Macro/Merg .(800)228-2021
WP6.0 WIN, Networks.(800)228-8807
WP6.0 WIN, Prn-Dot Matx(800)228-6646
WP6.0 WIN, Prnt-Laser/PS.(800)228-1023
WP Communications...(801)228-9915
WP DOS, Fax.....(800)861-2480
WP DOS, Features.....(800)861-2410
WP DOS, Graph/Tabl...(800)861-2420
WP DOS, Installation....(800)861-2460
WP DOS, Macro/Merge(800)861-2430
WP DOS, Networks.....(800)861-2470
WP DOS, Prn-Dot Matrx..(800)861-2450
WP DOS, Prn-Laser/PS .(800)861-2440
WP MAC 2.1 x.....(800)336-3614
WP MAC 3.0.....(800)228-2875
WP MAC French Speak.(800)321-2173
WP Macintosh.....(800)861-2070
WP Magazine, Info.....(800)228-9656
WP Magazine, Subscript..(800)228-9626
WP Mfg, Receptionist..(801)861-5049
WP Mfg, Research.....(800)446-4652
WP Mfg, Research-US...(800)526-6215
WP OS/2.....(800)321-1230
WP System 370.....(801)222-5100
WP UNIX, Features.....(800)861-2030
WP UNIX, Print.....(800)861-2040
WP UNIX/Xenix Feature.(801)226-5333
WP UNIX/Xenix Print .(801)228-9903
WP VAX/Dec.....(800)861-2010
WP VAX/VMS All in One .(801)226-4180
WP WIN, Features.....(800)861-2310
WP WIN, Graph/Tabl ...(800)861-2320
WP WIN, Installation....(800)861-2360
WP WIN, Macro/Merg..(800)861-2330
WP WIN, Networks.....(800)861-2370
WP WIN, Prn-Dot Matrix.(800)861-2350
WP WIN, Prn-Laser/PS .(800)861-2340
WP Works DOS/WIN...(801)228-9936
WordStar International..(800)227-5609
Tech Support.....(800)227-5609
Wordstar USA.....(617)494-1200
WordTech Systems, Inc. (510)254-0900
WorksWare.....(818)989-2298
Tech Support.....(818)969-2298
Worlco Data Systems.....(215)630-9500
World Richman Corp ....(708)298-1188
Worldata.....(407)393-8200
Worldcomm.....(800)472-0438
Worldnet Marketing .....(714)545-7118
Worldwide Cmptr Serv .(201)694-8876
Worldwide Technology .(800)457-6937
Tech Support.....(215)922-4640
Worldwide Video.....(201)491-5147
Worthington Data Sol....(800)345-4220
Wrist Pro.....(800)348-8633
WV Computronics .....(304)882-3086
WWIV Software Serv.....(210)631-6090
Wyle Laboratories.....(213)322-1763
Wynit.....(800)999-9648
Wyse Technology.....(800)438-9973
Tech Support.....(800)800-9973
X Ceed .....(800)642-7661
Tech Support.....(800)642-7661
X-10 (USA) Inc.....(201)784-9700
X3 Secretariat, CBEMA ..(202)737-8888
XBR Communication ....(514)489-1001
Xcel Computer Systems(508)799-9494
XDB Systems Inc. .....(301)317-6800
Xeltek.....(800)541-1975
Xentek Inc. .....(619)727-0949
Xerox Corp (CA).....(800)832-6979
Xerox Corp (CT).....(203)968-3000
Xerox Corp (NY).....(716)423-5078
Xerox Imaging Systems.(800)248-6550
Tech Support.....(800)248-6550
Xerox Int'l Partners.....(415)813-7700
Xerox/X-Soft .....(800)334-6200
Xidex Corporation .....(408)970-6574
Xinetron.....(408)727-5509
Xircom .....(800)874-7875
Tech Support.....(800)874-4428
Xistor.....(702)824-7777
XL/Datacomp Inc.....(800)323-3289
XOR Corporation .....(612)831-8640
Tech Support.....(612)831-8640
Xpect Trading Corp.....(800)332-5555
XScribe Corporation .....(619)457-5091
Xtend Micro Products...(800)232-9836
XtraCom Inc. .....(416)427-6612
XTree Co-Central Point .(800)964-2490
Tech Support.....(800)964-2490
Xtron Cmptr Equipment..(201)798-5000
Xuron Corporation.....(207)283-1401
XXCAL, Inc.....(800)879-9225
Xxera Technologies .....(818)286-5569
Xylogics, Inc.....(800)225-3317
Tech Support.....(617)272-8140
XXQuest.....(508)671-0888
Y-E Data America Inc. ....(404)446-8655
Y.E.S. Systems Corp.....(510)657-8886
Yamaha LSI.....(800)543-7457
Yamaha Sys Technology.(800)543-7457

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Yamaichi Electronics.....(408)452-0797
Yangs Int'l Corporation.(510)651-4305
Yokogawa Corp/America.(800)258-2552
Young Micro Systems....(310)946-3450
Yuasa-Exide Inc.....(215)378-0333
Z Soft.....(404)428-0008
Z-International, Inc .....(816)474-8400
Z-Mar Technology.....(704)841-8845
Z-Ram.....(800)368-4726
Z-Soft.....(800)444-4780
Z-World.....(916)753-3722
Z/Max Cmptr Solution..(315)635-1882
Zaptec Int'l Corp.....(714)792-2229
Zedcor.....(800)482-4567
Tech Support.....(602)881-2310
Zemaitis, Inc.....(408)436-1530
Zenith Data Systems.....(800)553-0331
Tech Support.....(800)227-3360
Zenographics, Inc.....(800)366-7494
Tech Support.....(714)851-2191
Zenon Computer Sys ....(800)899-6119
Tech Support.....(800)229-7898
Zentao Corporation.....(708)350-9040
Zentek Storage/America...(408)946-4464
Zeny Cmptr Systems.....(510)659-0386
Zeos International .....(800)423-5891
Zericon, Inc.....(800)727-8380
Zi-Tech Instrument.....(415)326-2151
Ziff Davis Techn Info Sys...(617)393-3200
Ziff-Davis Publ Co.....(212)503-5446
Zippertubing.....(310)527-0488
Zirco .....(303)421-2013
Zirco Inc.....(303)421-2013
Zitel Corporation.....(408)946-9600
Zoltrix Inc.....(510)657-1188
Zoom Telephonics .....(617)423-1072
Tech Support.....(617)423-1076
Zom Industries.....(603)894-4950
Zortech.....(617)937-0696
ZSoft Corporation.....(800)444-4780
Ztest Electronics.....(416)238-3543
Zykronix Inc.....(303)799-4944
ZyLAB Corporation.....(800)544-6339
ZyMOS Corporation.....(408)730-5400
Tech Support.....(800)422-7369
Zytec Corporation.....(612)941-1100
ZyXEL USA.....(800)255-4101

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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 28.8K baud.

To the best of our knowledge, these numbers are correct; but CSC cannot assume liability for their use.

3Com Corporation.....(408)980-8204
3rd Planet Software.....(213)841-2260
Abacus Concepts..... (616)698-8106
Abacus Software..... (616)698-8106
Able Soft.....(804)898-8686
Above Software.....(714)851-5102
Access Software..... (801)364-7449
Accton Technology.....(408)452-8828
Acculogic Inc.....(714)454-8124
Acer America.....(408)428-0140
..... (800)833-8241
Acer Technologies.....(800)833-8241
Activision..... (310)820-1276
Adaptec.....(408)945-7727
Adobe Systems, Inc..... (408)562-6839
Advanced Digital Info.. (206)883-3211
Advanced Gravis Cptr.. (604)431-5927
Advanced Logic Rsrch. (714)458-6834
Agfa Compugraphics...(508)694-9577
All Computers.....(416)960-8679
Alloy Computer Prods. (508)486-4044
Alpha Software Corp.. (617)229-2915
Altsys.....(214)680-9696
Always Technology.....(818)597-0275
Amdek Corporation.... (408)922-4400
American Cybermetic..(602)968-1082
Amer. Small Bus Cptr ...(918)825-4878
APCU(Assoc PC Grps) (408)439-9367
Apogee Software.....(508)365-2359
Appian.....(206)454-0511
Appoint..... (510)803-9018
Arabesque Software.... (206)881-0905
Archive Software.....(407)263-3502
Arco Electronics.....(305)925-2791
Areal Technology.....(408)954-0360
Arsenal Computer..... (913)234-9395
Artful Applications..... (416)538-3107
Artisoft, Inc..... (602)884-8648
Artist Graphics.....(612)631-7669
Ascii Computer Ent.....(209)836-2402
AskSam Systems.....(904)584-8287
Aspen Peripherals.....(503)286-9620
AST Computer.....(714)727-4723
AST Research..... (714)727-4132
AST Research Canada..(905)512-8558
Asymetrix.....(206)451-1173
AT&T Computer Sys... (908)769-6397
ATI Technologies.....(905)764-9404
..... (416)764-9404
Attachmate Corp.....(206)649-6660
Aurora Terra..... (301)230-1214
AutoDesk Inc..... (415)289-2270
Autumn Hill Software. (303)494-8868
Avatar/DCA..... (404)740-9428
Award (BIOS)..... (415)968-0249
Award Software Inc.... (408)371-3139
Baker & Taylor Labels...(800)775-4200
..... (415)257-3070
Beagle Bros..... (801)226-1605
Best Power Tech.....(608)565-7424
Bestgift Service..... (813)978-3044
Bethesda Softworks.....(301)990-7552
Big State Doors..... (512)376-5644
Bit Software, Inc.....(510)490-6637
Blackmond Software...(505)589-0319
Boardwatch Magazine.(303)973-4222
Boca Research.....(407)241-1601
Borland.....(408)439-9096
Bottom Line Ind.....(214)394-4170
Bourbaki.....(208)342-5823
Brightbill Roberts.....(315)472-1058
Brightwork Dvlpmnt...(914)667-4759
Broderbund Software..(415)883-5889
Brown Bag Software... (408)371-7654
Bruce Krobusek..... (716)924-4193
BTC Corporation.....(510)657-1859
Buerg.....(707)778-8944
Buffalo Creek Sftwre...(515)225-8496
Bureau of Elect Publ... (201)808-0085
Button Ware, Inc..... (206)454-7875
C Source.....(816)478-0944
CalComp..... (714)236-3045
Calera Recognition.....(408)773-9068
Campbell Services Inc .(313)559-6434
Canon Computer Sys..(714)438-3325
Capstone.....(305)471-8962
Cardinal Technologies..(717)293-3074
Cardz.....(604)734-5400
Castelle.....(408)496-1807
Catspaw.....(719)539-4830
CBIS, Inc.....(404)446-0485
CC:Mail, Inc.....(415)691-0401
CDB Systems, Inc..... .(303)642-7463
CDC.....(408)438-8771
Central Point Software (503)690-6650
Certus International....(503)484-6669
CH Products.....(619)598-3224
Cheyenne Software.....(516)484-3445
Chinon..... (310)320-4160
Chips & Technology....(408)456-0721
ChipSoft Inc. (Intuit)...(619)550-5018
Chwatal Develpment.. (318)487-0800
Citizen America.....(310)453-7564
Citrix Systems..... (305)346-9004
Clarion Software..... (305)785-2594
Claris Corporation..... (408)987-7421
Clark Develpment Co. .(801)261-8976
Clary Corporation.....(801)261-8976
Clear Software.....(617)965-5406
CMS Enhance.....(714)222-6601
CNet Technology, Inc.. (408)954-1787

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Columbia Data Prods..(407)862-4724
Compaq Computer.....(713)378-1418
Complex, Inc.....(714)630-2570
Comprehensive Video..(201)767-7990
Compton's NewMedia.(619)929-2597
Compulink Mgmt Ctr..(310)212-5850
Computer Classifieds..(206)643-2874
Computer Coverup.....(312)327-9078
Computer Design Mag (508)392-2265
Computer Support.....(214)404-8652
Computers Intl.....(213)823-3609
Computone Corp.....(404)343-9737
Comtrol Corporation..(612)631-8310
Conner International..(408)456-4415
Conner Peripherals.....(408)456-4415
.....(407)263-3502
Core International.....(407)438-8771
Corel Systems, Inc.....(613)728-4752
Cornerstone Imaging..(408)435-8943
Cornerstone Technlgy..(408)435-8943
Corvus Systems, Inc....(408)972-9154
CoStar.....(203)661-6292
Creative Labs, Inc.....(405)742-6660
Creative Programming.(214)418-0059
Cross Comm.....(303)444-9003
Crosstalk Comm.....(404)740-8428
CrossTies.....(714)732-6754
Crystal Services.....(604)681-9516
CSC Tech Support.....(408)541-8455
CSS Laboratories.....(714)852-9231
CTX International, Inc .(909)594-8973
Cubix Corporation.....(702)882-8737
Cumulus.....(216)464-3019
Cyco International.....(404)634-1441
Cyrix Corporation.....(214)680-3187
DAC Software.....(214)931-6617
DacEasy, Inc.....(214)931-6617
Dak Industries, Inc.....(818)715-7153
Dariana Software.....(714)236-1388
Darius Technology.....(714)994-7410
Darwin Systems.....(301)251-9206
Data Access Corp.....(305)238-0640
Data Base Solutions.....(619)270-2042
Data Technology Corp .(408)942-4010
Data Watch.....(919)549-0042
Datadesk International.(503)691-5199
DataEase International.(203)374-6302
Dataman.....(407)649-3159
Dataproducts.....(818)887-8167
Datawatch.....(919)549-0042
Dayna Comm.....(801)269-7398
DCA.....(404)740-8428
DCA/Crosstalk Comm.(404)740-8428
DEC PC Support.....(508)496-8800
Dell Computer Corp...(512)728-8528
Delphi.....(800)365-4636
DeltaComm Devel.....(919)481-9399
Diagnostic Technlgy....(905)607-6570
DiagSoft Inc.....(408)438-8997
Diamond Comptr Sys..(408)524-9301
Digiboard, Inc.....(612)943-0812
Digicom Systems, Inc..(408)262-1412
Digital Dynamics.....(714)529-5313
Digital Research.....(408)429-7785
Digital Theatre.....(404)446-0485
Digital Vision.....(617)329-8387
Disk Technician Corp..(619)272-9240
Disk Technologies.....(407)671-6099
Disney Cptr Software..(818)567-4027
Dist. Logic Corp.....(407)831-6432
DNA Networks, Inc.....(215)296-9558
Dove Computer.....(919)343-5616
DPT(DistProcess Tech) (407)831-6432
DSP Solutions.....(415)494-1621
DTK Computer (CA)...(818)333-6548
DTK Computer(TX)....(713)568-9941
Dudley Software.....(615)966-3574
Dynamic Microprocsr. .(516)462-6638
E-Machines.....(408)541-6190
E-Tech Research Inc....(408)988-3663
E-WARE.....(714)236-1388
Eagle Technology.....(408)453-0734
Eagle Soft.....(812)479-1310
EDS Development.....(812)423-3394
Elan Software Corp.....(310)459-3443
Elite Business Apps.....(410)987-2335
EMAC/EVEREX.....(510)226-9694
Emerald Systems.....(619)673-4617
Emulex Corporation...(714)662-1445
Enable Software.....(518)877-6316
Envisio.....(612)633-0051
Epson Amer, OEM Div. .(408)946-8777
Epson Amer, Inc.....(310)782-4531
Equinox.....(305)378-1696
Equinox Systems, Inc..(305)791-1633
Ergo Computing, Inc...(508)535-7228
ESoft Product Support .(303)699-8222
ETS Incorporated.....(801)265-0919
Everex.....(510)226-9694
Evergreen Technology.(503)757-8869
Exabyte Corporation...(913)492-8751
Excalibur.....(408)244-0813
Excalibur Comm., Inc. .(918)496-8113
ExperVision Inc.....(408)456-0280
EZX Publishing.....(713)280-8180
Family Scrapbook.....(904)249-9515
Farallon Computing....(510)865-1321
FCC Public Access.....(301)725-1072
Fifth Generation Sys....(504)295-3344
Fifth Generation Sys....(504)295-3344
Flytek Technology Co..(408)727-0737
Foresight Resource.....(816)891-8465
Frame Technology.....(408)433-4841
FreeSoft Company.....(412)846-5312
Frontline Systems.....(415)327-7319
Fujitsu America, Inc.....(408)944-9899
Fujitsu Comptr Prods..(408)944-9899
Future Soft Enginr'g....(713)588-6870
FutureSoft, Inc.....(713)588-6870
Galacticomm Inc.....(305)583-7808
GammaLink.....(408)745-2216
Gap Development.....(714)493-3819
Gateway 2000.....(605)232-2109
Gateway BBS.....(605)232-2109
Gazelle Systems.....(801)375-2548
GEcho.....(316)263-5313
General Datacomm.....(202)596-0593
Genicom.....(703)949-1576
GEnie Info Service.....(800)638-8369
Genoa.....(408)943-1231
Gensoft Development.(206)562-9407
GeoClock.....(703)241-7980
GeoWorks.....(510)814-4262
Gibson Research.....(714)362-8848
Gigatrend Inc.....(619)931-9469
Gilmore Systems.....(805)379-3450
Global Village Comm..(415)390-8334
GoldDisk (AMI).....(905)602-7534
GoldDisk (MAC).....(905)602-7534
Gold Disk (PC).....(905)602-7534
Gotoless Conversion...(214)625-6905
Graphic Workshop.....(416)729-4609
Great Amer. Software...(603)889-7292
Greenleaf Software.....(214)250-3378
Gwynn's Comm.....(703)494-0096
Hamilton Tel.....(819)682-7771
Hayes Microcptr Prod..(404)446-6336
.....(800)874-2937
Hazard Soft.....(405)243-3200
HDC Computer Corp..(206)869-2418
Headland Technology..(510)656-0503
Helic Software.....(718)392-4054
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GLOSSARY

A-CABLE A 50-wire cable used for 8-bit SCSI-1 buses. There are two types of A-cable connectors: high- and low-density. The low-density A-cable connector is also known as a Centronics-type connector.

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.

ACTIVE TERMINATION A type of termination used to reduce bus noise, particularly on the SCSI bus. Active terminators use less power than passive terminators, and are recommended when using long SCSI cables.

ACTIVE TERMINATOR A terminator that can compensate for variations in the terminator power supplied by the host adapter through means of a built-in voltage regulator. Also see forced-perfect terminator; passive terminator.

ACTUATOR 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. *See* HEAD POSITIONER.

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ADAPTER A card that communicates with and controls a device or system.

ADD-ON Something added to the computer to expand it's functionality. Commonly refers to cards that are plugged into the computer.

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.

ADVANCED SCSI PROGRAMMING INTERFACE Formerly called the Adaptec SCSI Programming Interface, ASPI was developed by Adaptec as a standard way for programs to send commands and data between SCSI host adapters and devices. ASPI standards exist for DOS, Windows, Win 95, Win NT, OS/2 and Novell.

ANSI American National Standards Institute. The organization that promotes standards for hardware and software including those used in PCs. SCSI is an ANSI standard.

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API Application Programming Interface. A software module that provides a consistent set of commands that programs can use to perform tasks. ASPI and CAM are examples of SCSI APIs.

APPLICATION PROGRAM A sequence of programmed instructions that tell the computer how to perform an end 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 a disk), and track density is radially measured.

ASCII American Standard for Coded Information Interchange.

ASME American Society of Mechanical Engineers.

ASPI *See* ADVANCED SCSI PROGRAMMING INTERFACE.

ASYNCHRONOUS DATA Data sent usually in parallel mode without a clock pulse. Time intervals between transmitted bits may be of unequal lengths.

ASYNCHRONOUS TRANSFER A method of sending data that requires an acknowledgment from the receiver for each byte of data that is sent before the next on is sent. Asynchronous transfers are slower than synchronous transfers.

AT INTERFACE Disk drive interface on the IBM PC-AT computer and compatibles, sometimes called the IDE (Integrated Drive Electronics Interface).

ATAPI/IDE An extended command set standard which permits CD-ROM drives, tape drives, and other non-hard drive peripherals to share the IDE bus. ATAPI commands are modeled after SCSI standard commands.

AUTOMATIC BACK UP OF FILES This gives a user the security to make changes to a file without worrrying 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.

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AUTODETECTION The ability of the computer to check the identity and configuration of a device without user intervention.

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 Average track access time, calculated from the end of the CONTROLLER commands to access a drive, to drive Seek complete time averaged over all the possible track locations at the start 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.

B-CABLE A 68-wire cable used for 16-bit SCSI-2 buses.

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.

BACKWARD COMPATABILITY The ability of newer technology to work with older technology without any modification.

BAUD RATE A variable unit of data transmission speed equal to one bit per second.

BBS *See* BULLETIN BOARD SYSTEM.

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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. Software stored in a chip used for a variety of purposes. In a PC, the BIOS contains code that communicates with devices such as the floppy drive, keyboard and video output.

BIOS ADDRESS The memory address that is used to access code stored in the BIOS chip.

BIT Binary digit. The smallest unit of data used by digital computes and devices. A bit can be either on or off. The two states are referred to as 1 and 0, true and false, high and low, to name a few.

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" (Bits Per Inch), bit density defines how many bits can be written onto one inch of 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.

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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 Transfer of a disk operating system program from storage on diskette or hard disk drive to computer's working memory. Also called BOOTUP.

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.

BUILT-IN A peripheral or device that is manufactured as a part of the computer, not added by the user.

BULLETIN BOARD SYSTEM A computer or group of computers that provide services such as E-Mail and file transfer via modem or the Internet. These are commercial (CompuServe, America Online, Prodigy) as well as private. Also called BBS.

BURST SPEED The rate at which data can be transferred for a short period of time. Burst speeds are generally higher than sustained speeds.

BUS A length of parallel conductors that forms a major interconnection route between the computer system CPU and it's peripheral subsystems. Depending on it's design, a bus may carry data to and from a peripheral's addresses, power and other related signals. ISA, EISA, VL-Bus and PCI are examples of PC buses. SCSI is also a bus.

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BUS MASTERING A method of transferring data through a bus in which the device takes over the bus and directly controls the transfer of data to the computer's memory. Bus mastering is a method of DMA transfer. Also known as first-parity DMA.

BUS SLOTS Also known as expansion slots or simply slots, bus slots are connectors inside the computer that are used for attaching add-on cards and devices to a bus.

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.

CAM Common Access Method. The proposed ANSI software interface for SCSI devices and a part of the SCSI-3 standard.

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.

CASCADING DRIVERS Drivers that can connect to, and thereby work with, other drivers.

CCS *See* Common Command Set.

CD *See* Compact Disk.

CDB *See* Command Desciptor Block.

CD-R Compact Disk Recordable. A special type of CD that can be written to once. It is primarily used for making a master disc to be mass-produced.

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CD-ROM Compact Disc Read Only Memory is a standard format for optical disks which stores 650MB per disk and uses a standard software format (ie. High Sierra) which is interchangeable between various platforms.

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.

CHANGER A robotic device which automatically loads disk into a drive. CD-ROM and erasable optical drive changers are the most common.

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 need-

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ed. 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".

COMMAND CHAINING Combining multiple SCSI commands into a single group in order to reduce the overhead of many individual commands.

COMMAND DESCRIPTOR BLOCK (CDB) A block of SCSI information containing the command, parameter, and address information needed by the target to carry out a certain task.

COMMON ACCESS METHOD *See* CAM.

COMMON COMMAND SET (CCS) A standard set of commands for communicating with SCSI devices.

COMPACT DISC An optical disc capable of storing the equivalent of hundreds of floppy disks. *See* CD-ROM.

CONSOLE (CRT) A device from which a computer can be operated; often includes a monitor and a keyboard. Also called a terminal.

CONTROLLER CARD A circuit board that plugs into the motherboard on the computer. Controller cards allow the computer to communicate and control devices. SCSI and IDE cards are examples of hard disk controller cards. Some printers and scanners also require controller cards, called printer controller cards and scanner controller cards, respectively.

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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.

CPU Central Processing Unit. The main microprocessor in a computer. The CPU carries out the primary functions of the computer.

CRASH A malfunction in the computer hardware or software, usually causing loss of data.

CROSS-PLATFORM Cross-platform hardware or software can function on more than one type of computer (i.e. PC, Macintosh, or Sun) or operating system (i.e. DOS, Windows, or UNIX).

CROSS SECTION An illustration that shows what something looks like after being cut.

CROSS TALK Interference between two wires caused by the signal from one wire appearing on the other.

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 verically stacked discs. 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 are head number and sector number.

D-SUB CONNECTOR A widely used family of connectors probably deriving its name from its "D" shape. Specific connectors are denoted by a letter for its size and a number for its pin configuration. For example, a DB-15 connector is a D-sub connector of size B with pin configuration number 15.

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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 fiedld 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 sppecifies a horizontal or radial address component of the data area. ROTATIONAL: once a head and cylinder have been addresses, 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. For example 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.

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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* NZR, MFM and RLL.

DATA TRACK Any of the circular tracks magnetized by the recording head during data storage.

DATA TRANSFER RATE A measure of how quickly informatiuon can be passed between the computer and another device or between devices. The higher the data transfer rate, the less you'll have to wait for data to get to where it needs to go.

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 fpr 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.

DEVICE Usually refers to equipment that can be connected to the computer, such as printers, hard disks, scanners and modems. Devices can also be interface cards, such as video cards, SCSI cards and sound cards. The computer itself may also be referred to as a device.

DEVICE DRIVER A software module that communicates with and transfers data to a controller or other device.

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DEVICE ID *See* SCSI ID.

DIFFERENTIAL A SCSI bus configuration in which each signal is sent on two wires. The signal is derived by taking the difference in voltage between the two wires, effectively eliminating unwanted noise in the wire. *See* SINGLE-ENDED.

DIGITAL Any system that processes the 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.

DIRECT MEMORY ACCESS A method of transferring data from a device to the computer's memory without intervention by the CPU. DMA is handled by a DMA controller chip in the computer (third- party DMA) or by the device itself (bus mastering or first-party DMA).

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.

DISCONNECT/RECONNECT The ability of a device to remove itself from a bus to perform a task (such as tape drive fast-forwarding) and then connecting itself back to the bus after completion of the task.

DISK CACHE Memory used to temporarily store data read from and/or written to a floppy or hard disk to increase performance.

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 A single-tasking operating system for the PC. The most common version of DOS is developed by Micosoft.

DISK PACK A number of metal disks package 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,

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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.

DLL *See* DYNAMIC LINK LIBRARY.

DMA *See* DIRECT MEMORY ACCESS.

DOS *See* DISK OPERATING SYSTEM.

DOS PROTECTED MODE INTERFACE An API that allows programs to used memory beyond the 640K limitation imposed by DOS. Also called DPMI.

DOUBLE-CLICK Pressing a mouse button twice in rapid succession.

DOUBLE-SPEED SCSI *See* FAST-20.

DOUBLE WIDE SCSI A 32 bit implementation of the SCSI. Transfers data at 40-80 Mbytes/sec

.

DPMI *See* DOS PROTECTED MODE INTERFACE.

DRIVE A computer memory device with moving storage MEDIA (disk or tape).

DRIVER *See* DEVICE DRIVER.

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

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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-holes (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). Disc stack more compactly than drums.

DYNAMIC LINK LIBRARY A windows file, that contains code that can be added to a Windows program while it is running.

E-MAIL Electronic Mail. Messages sent by modem or other electronic means, which enables people to communicate over long distances in minutes as opposed to days. *See* SNAIL-MAIL.

ECC *See* ERROR CORRECTION CODE.

EIDE *See* Enhanced IDE.

EISA *See* Extended Industry Standard Architecture.

ELECTRO-STATIC DISCHARGE 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 and printed circuit board edge connectors should never be touched. Also called ESD.

EMBEDDED SERVO SYSTEM Servo data is embedded or superimposed along with data on every cylinder.

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END USER You. A person who uses hardware and software.

ENHANCED IDE The second generation of IDE technology that improves the data throughput of IDE hard disks and adds the capacity of connecting CD-ROM drives to the same interface card as hard disks.

ENHANCED SMALL DISK INTERFACE A high-speed hard disk bus interface used in the 1980's that has been superceded by SCSI due to ESDI's limitation of supporting only hard drives.

ERASE To remove previously recorded data from magnetic storage media.

ERROR *See* HARD ERROR and SOFT ERROR.

ERROR CHECKING Any one of a number of methods used to verify that data sent from one place to another arrives at its destination without errors.

ERROR CORRECTION CODE A method used on hard disks to detemine if an error has occurred in the data stored on the drive. Also called ECC.

ESCON An IBM standard interface between mainframes and disk storage units. Also used by Fujitsu, Amdahl, Storage Tech, and Hitachi.

ESDI *See* Enhanced Small Device Interface.

EVEN PARITY *See* PARITY CHECKING.

EXCLUSIVE OR *See* OR and XOR.

EXECUTE To perform a data processing operation described by an instruction or a program in a computer.

EXTENDED INDUSTRY STANDARD ARCHITECTURE A 32-bit computer bus introduced in 1988 that enhanced the capabilities and performance of the ISA bus standard.

EXTERNAL CLOCK RATE The frequency at which peripherals outside the CPU operate.

FCI *See* FLUX CHANGES PER INCH.

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FACE PLATE The front cover (usually plastic) of a device such as a hard disk or CD-ROM drive.

FAST-20 A SCSI-3 transfer mode that is capable of sending data at 20 MB/sec. Also known as DoubleSpeed SCSI and UltraSCSI.

FAST-40 A SCSI-3 transfer mode that is twice as fast as Fast-20, capable of sending data at 40 MB/sec.

FAST SCSI A SCSI-2 transfer mode that operates at 10 MB/sec, twice as fast as regular SCSI.

FAST WIDE SCSI Wide SCSI operating at twice the rate of regular Wide SCSI.

FAULT TOLERANCE Able to recover from errors or other failures without loss or corruption of data.

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.

FIBRE CHANNEL A new ANSI standard that specifies high-speed serial communication between devices. Fibre Channel is used as one of the bus architectures in SCSI-3.

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 A file consists of a group of logically related records that, in turn, are made up of groups of logically related fields. *See* DISK FILE.

FILE ALLOCATION TABLE (FAT) What the operating system 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.

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FILESERVER A computer used primarily for storing files on a network.

FIREWIRE *See* IEEE 1394.

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.

FIRST-PARITY DMA *See* BUS MASTERING.

FIXED DISK A disk drive with disks that cannot be removed from the drive by the user, i.e. WINCHESTER DISK DRIVE.

FLAT-RIBBON CABLE *See* RIBBON CABLE.

FLOPPY DISK A magnetic disk used to store computer data. FLOPPY DISKS generally exhibit slow ACCESS TIME and smaller CAPACITY compared to WINCHESTER DRIVES, but feature removable disks.

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 Linear recording density defined as the number of flux changes per inch of data track. Also called FCI.

FM Frequency modulation CODE scheme, superceded by MFM, which is being superceded by RLL.

FORCED-PERFECT TERMINATOR A type of terminator containing a sophisticated circuit that can compensate for variations in the power supplied by the host adapter, as well as variations in bus impedance of complex SCSI systems. Also called FPT. *See* PASSIVE TERMINATOR and ACTIVE TERMINATOR.

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 is formatting the disks. While the unformatted

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size may be 24 M bytes, only 20 M bytes of storage may be actually available to the user after formating.

FPI *See* FLUX CHANGES PER INCH.

FPT *See* FORCED-PERFECT TERMINATOR.

FREE-AIR CHARACTERISTIC IMPEDANCE The average impedance of air.

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.

FRPI The number of Flux Reversals per inch. *See* FLUX CHANGES PER INCH.

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 read/write 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.

GB Gigabyte. One gigabyte equals 1,073,741,824 bytes.

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GENERIC PACKETIZED PROTOCOL A method for transferring groups of data that is independent of the type of hardware used, hence the name "Generic". Also referred to as GPP.

GROUP CODE ENCODING Data encoding method. Also called GCR. *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.

HANDSHAKE The communication that occurs between devices in order to determine the method and speed of data transfer to be used.

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, that 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).

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HDA *See* HEAD/DISK ASSEMBLY.

HD (HIGH-DENSITY) CONNECTOR A connector in which the pins are closely packed in order to save space. High-density A-cable connectors have just as many pins as low-density A-cable connectors but are smaller than the low-density ones.

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 betweem them. Head crash is a catastrophic failure condition and causes permanent damage and loss of data.

HEAD/DISK ASSEMBLY A sealed Winchester assembly including disks, heads, filter and actuator assembly.

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 = 20, C = 30, D = 40, E = 50, F = 60).

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HOST The computer that contains the SCSI host adapter.

HOST ADAPTER The controller card used to communicate with and control devices. A SCSI host adapter is used to attach and communicate with SCSI devices.

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 *See* INTEGRATED DRIVE ELECTRONICS

IEEE Institute of Electrical and Electronics Engineers. An organization that promotes electrical and electronics standards.

IEEE 1394 Called Firewire by Apple, IEEE 1394 is a serial bus that runs at 100 MB/sec and doesn't require any terminators. A special feature of IEEE 1394 is asynchronous transfer mode.

IMAGE-BACKUP MODE Used with streaming tpae, image-backup mode records an exact copy of the disk, including unused sectors and bad tracks.

IMPEDANCE A measure of a material's resistance to the transfer of electricity.

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.

INDUSTRY STANDARD ARCHITECTURE An 8-bit computer bus introduced by IBM (International Business Machines) in 1983 and later expanded to 16-bit for the IBM AT computer. The ISA bus is also known as the AT bus.

INITIATOR A device that is in control of the bus and sends commands

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to a target.

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. Also called I/O.

INTEGRATED DRIVE ELECTRONICS A hard disk technology that puts the communication control and related circuitry on the drive itself (using one microprocessor for both functions saves costs and eliminates the need for an intelligent controller card.). Older technologies such as MFM had some of the electronics on the drive and the rest on the interface card. Popular electronic interface standard for hard drives used in IBM XT and AT compatable computers. Also called IDE. *See* also EIDE.

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.

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.

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Interleaving is used to improve the system throughout based on overhead time of the host software, the disk drive and the controller. Thus, 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 the interleave factor of 3 will prevent wasting an entire disk revolution between ACCESSES.

INTERNAL CLOCK RATE The frequency at which a microprocessor operates internally.

INTERRUPT A signal, usually from a peripheral device to a CPU, to signify that a commanded operation has been completed or cannot be completed.

INTERRUPT REQUEST A signal used by devices to indicate that they need attention from the CPU. Computers have several IRQ channels so that many devices can be attached, each one to its own IRQ, and serviced by the CPU.

I/O PROCESSOR Intelligent processor or controller that handles the input/output operations of a computer.

IRQ *See* INTERRUPT REQUEST

ISA *See* INDUSTRY STANDARD ARCHITECTURE.

ISOCHRONOUS TRANSFER A method of sending data that guarantees that the data will arrive at its destination at a specified period of time. Isochronous transfers are important for sending data such as video and audio, since they are dependent on time.

JUMPER A small plastic and metal connector used to bridge the gap between two or more pins. Jumpers are commonly used for configuring devices and add-on cards.

KILOBIT One kilobit equals 1,024 bits of 128 bytes. Also called Kb.

KILOBYTE 1) 1,024 bytes (two to the tenth power, this is the normal definition). 2) 1,000 bytes (this definition is used by disk drive companies to bolster the specified capacity of their drives.

LADDR *See* LAYERED DEVICE DRIVER.

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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 a disk revolution.

LAYERED DEVICE DRIVER A SCSI device driver architecture used in early versions of OS/2. Also called LDD.

L-CABLE A 110-wire cable used for 32-bit SCSI-3 buses.

LOCAL BUS A computer bus that allows devices to transfer data directly to the CPU. VL-Bus and PCI are common types of local bus.

LOGIC Electronic circuitry that switches on and off ("1" and "0") to perform digital operations.

LOGICAL UNIT Usually the medium used by a device to store or retrieve data. A CD-ROM drive is a device and the disk in the drive is a logical unit.

LOGICAL UNIT NUMBER A 3-bit value identifying a logical unit in a device. Also called LUN.

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 *See* 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..

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MAGNETIC RECORDING The use of a head, recording head, recording media (tape or disk) and associated electronic circuitry for storing data, sound or video.

MAGNETO-OPTICAL A storage medium similar to CD-ROM, except that magneto-optical discs can be erased and rewritten thousands of times. Also called MO.

MAINFRAME COMPUTER An extremely large (occupying the space of entire rooms) and costly computer used for supporting many users running programs similtaneously. *See* MINICOMPUTER, MICROSOMPUTER and RANDOM-ACCESS MEMORY.

MASTER DRIVE The primary (or first) IDE drive installed on a system. For example, Drive C:.

MAX OUT Slang term meaning to use fully.

Mb *See* MEGABIT.

MB *See* MEGABYTE.

MCA Micro Channel Architecture. *See* MICRO CHANNEL.

MEAN TIME BEFORE FAILURE 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 The average time to repair a given unit. Limited to a qualified technician with proper equipment. Also called MTTR.

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 One million bits. Not to be confused with megabyte (see below). There are usually 8 bits in a bit.

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MEGABYTE 1) 2 to the 20th power (1,024K). 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 .

MICRO CHANNEL A 32-bit computer bus developed by IBM for its PS/2 series of computers.

MICROCOMPUTER A computer whose central processor unit (CPU) is manufactured as a chip or a small number of chips. The PC and Macintosh are examples of microcomputers.

MICROINCH One-millionth of an inch (uin).

MICROSECOND One-millionth of a second (us).

MILLISECOND One-thousandth of a second (Msec).

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.

MO *See* MAGNETO-OPTICAL.

MODIFIED FREQUENCY MODULATION 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 bit of data with each flux reversal. *See* NRZ and RLL.

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MOTHERBOARD The main circuit board in a computer on which the CPU, main memory, system BIOS and any other built-in electronics reside.

MULTIPROCESSOR A computer containing two or more processors.

MULTITASKING The ability of a computer system to execute more than one program or program task simultaneously. Windows 95, OS/2 and UNIX are examples of multitasking programs.

MULTIUSER The ability of a computer system to execute programs for more than one user at a time.

NETWARE A network operating system developed by Novell Corporation.

NEXUS The link between initiator, target and logical unit used to identify and I/O process. An I_T_L (initiator, target, logical unit) nexus is the most basic type of SCSI link. To send multiple I/O processes to the same target and logical unit, an I_T_L_Q (initiator, target, logical unit, queue) nexus is used.

NOISE Unwanted and usually interfering elctrical 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 or synchronization clock to define each cell time unlike MFM or RLL recording.

ODD PARITY *See* PARITY CHECKING.

OFF LINE Processing or peripheral operations performed while not connected to the system CPU via the system bus.

ONE-OFF A master CD-R usually intended for duplication purposes.

ONLINE Existing on a BBS.

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OPEN COLLECTOR A type of output structure found in certain bipolar logic families. The device has 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.

OR A binary operation that compares two bits and yields a 1 if at least one of the bits being compared is set to 1.

OS/2 A multitasking operating system for the PC developed by IBM Corporation.

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.

OVERHEAD Time lost during an operation due to error checking or other tasks that hinder the completion of the operation.

PARALLEL Sending bits in groups. *See* SERIAL.

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 a 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.

PARITY CHECKING *See* PARITY.

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 the power to the drive is shut off. Other drives require the user to run some kind of parking software to park the heads.

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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.

PASSIVE TERMINATION The most common way of reduceing noise on a cable. Network cables and SCSI cables use resistive passive termination.

PASSIVE TERMINATOR A terminator that provides a fixed-value impedance match between the end of the SCSI bus and the cable. Passive terminators are comprised only of resistors and are susceptible to variations in the power supplied by the host adapter. *See* ACTIVE TERMINATOR and FORCED-PERFECT TERMINATOR.

PATH The DOS term "path" has three definitions and each 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.

P-CABLE A 68-wire cable used for 16-bit SCSI-3 buses. P-cables can be used with Q-cables for 32-bit SCSI-3 buses.

PCI *See* PERIPHERAL COMPONENT INTERCONNECT.

PERIPHERAL COMPONENT INTERCONNECT A 32-bit local bus developed by Intel that allows peripherals to communicate directly with the CPU.

PERIPHERAL EQUIPMENT Auxiliary memory, displays, printers, disk drives and other equipment usually attached to a computer systems' CPU by controllers and cables (they are often packaged together in a desktop computer).

PIO *See* PROGRAMMED INPUT/OUTPUT.

PIPELINE A channel used to transfer commands, data or signals.

PLATED THIN FILM DISKS Magnetic disk memory media having its surface plated with a thin coating of metallic alloy instead of being coated with oxide.

PLATTER The round magnetic disk surfaces used for read/write operations in a hard disk system.

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PLUG-AND-PLAY An Intel/Microsoft standard for configuring add-on cards and other devices so that user intervention is minimized. No more switches, jumpers and wheels to fiddle with.

PLUG-IN CARD *See* ADD-ON.

POLLING A technique that discerns which of several devices on a connection is trying to get the processor's attention.

POSTSCRIPT A printer language used to describe the text and graphics to be be printed.

PRECOMPENSATION Applied to write data by the controller in order to partially alleviate bit shift which causes adjacent 1's written on magnetic data 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.

PREVENTATIVE 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 A circuit board IC and other components, like the one attached to a drive. Also called PCB.

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 APPLICATION PROGRAMS.

PROGRAMMED INPUT/OUTPUT A method of transferring data from a device to the host computer's memory that requires the CPU to perform the transfer. PIO is slower than DMA.

PROTOCOL A set of conventions governing the format of messages to be exchanged within a communications system.

P-TO-A TRANSITION CABLE An adapter used to connect 8-bit SCSI-1 devices using A-cables to a 16- or 32-bit SCSI-3 device using P-cables.

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Q-CABLE A 68-wire cable used in conjunction with a P-cable for 32-bit SCSI-3 buses.

QUARTER-INCH CARTRIDGE (QIC) A tape format used for backing up data. QIC tape is 1/4 inch.

QUEUING Grouping a series of commands in order to send them as a single command, thereby reducing data transfer overhead.

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. *See* DAISY CHAIN.

RAID *See* REDUNDANT ARRAY OF INEXPENSIVE DRIVES.

RAM *See* RANDOM ACCESS MEMORY.

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 APPLICATION PROGRAMS which access the disk run faster.

RANDOM ACCESS MEMORY Memory where any locatiom 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.

READ-INTENSIVE A process that requires a lot of reading of data from a device such as a hard disk.

READ-ONLY Something that can only be read from, not written to.

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.

RECALIBRATE Return to Track Zero. A common disk drive function in

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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 WRITECURRENT 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.

REDUNDANT ARRAY OF INEXPENSIVE DRIVES A collection of storage devices configured to provide higher data transfer rates and/or data recovery capability. Also called RAID.

REGULAR SCSI 8-bit SCSI.

RESOLUTION With regards to magnetic recording, the band width (or frequency response) of the recording heads.

RF Radio Frequency.

RIBBON CABLE A group of wires arranged in rows that comprise a single flat cable resembling a ribbon.

RLL *See* RUN LENGTH LIMITED CODE.

ROM *See* READ ONLY MEMORY.

ROTATIONAL SPEED The speed at which the media spins. On 5 1/4" or 3 1/2" Winchester drives it is usually 3600 rpm.

ROUND-ROBIN A method of guaranteeing that a number of devices will have an opportunity to be serviced. The round-robin method simply requires that every device is serviced in turn. After the last device is serviced, the process begins again with the first one.

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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".

SASI Shugart Associates System Interface. The predecessor to SCSI.

SC *See* SELCTOR CHANNEL.

SCAM *See* SCSI CONFIGUREDAUTO-MAGICALLY.

SCO UNIX A version, or flavor, of UNIX developed by Santa Cruz Operations.

SCSI Small Computer Systems Interface. An intelligent bus for transmitting data and commands between a variety of devices. The current "high end" CPU-to-drive interface. See SCSI-II, SCSI III, FAST SCSI, WIDE SCSI, FAST WIDE SCSI, FAST-20 and FAST-40 for various types of SCSIs available.

SCSI-II The second generation of SCSI; includes many improvements to SCSI-I, including FAST SCSI, WIDE SCSI, and mandatory parity checking.

SCSI-III Commonly used to refered to "Wide SCSI", although this is not the correct definition. SCSI-III is the third generation of SCSI; introduces FAST-20 and FAST-40 as improvements to the parallel bus. The standard also includes a number of specifications for high-speed serial bus architecture such as SSA, FIBRE CHANNEL, and IEEE 1394.

SCSI BIOS A chip on the host adapter that contains programs for communicating with the adapter and the bus.

SCSI CONFIGURED AUTO-MAGICALLY A pending standard that will give SCSI devices the ability to automatically select their SCSI IDs.

SCSI ID A number used on SCSI devices to uniquely identify them among other devices on the bus. Also referred to as a device ID.

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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 contguous 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.

SELECTOR CHANNEL An intelligent bus used on the IBM 360 mainframe.

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).

SERIAL Sending bits individually, one after the other. *See also* PARALLEL.

SERIAL STORAGE ARCHITECTURE A high-speed serial communication bus developed by IBM for sending commands, data and status signals between devices.

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" postition.

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 diskette.

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SHIELDED Containing a metal cover to keep out unwanted interference from the environment. A shielded connector has a metal cover. A shielded cable has a foil wrapping or braided metal sleeve under the plastic covering.

SHROUDED HEADER CONNECTOR A device connector with a plastic guard around its perimeter. The shroud ensures that all the pins on a cable are plugged into the device. Shrouded connectors also have a notch on one side so that the cable can only be inserted in one direction.

SILICON Semiconductor substrate material generally used to manufacture microprocessors and other integrated circuit chips.

SINGLE-ENDED A SCSI bus configuration in which each signal is carried by a signal wire. Single-ended buses are more susceptible to noice than differential buses.

SINGLE-TASKING The ability to perform only one process at a time. DOS is a single-tasking operating system.

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 for continuous read/write operation without losing disk revolutions.

SLAVE DRIVE The secondary drive installed in a IDE system. For example, drive D:.

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.

SNAIL-MAIL Regular old, lick the stamp, seal the envelope, and then sit and wait for several days mail. *See* E-MAIL.

SOFT ERROR A bit error during playback which can be corrected by repeated attempts to read.

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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 function not otherwise available using the standard software program.

SOLID-STATE Electronics not utilizing vacuum tubes.

SOUND CARD An add-on card used to play and/or record audio.

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.

SSA *See* SERIAL STORAGE ARCHITECTURE.

ST-506/ST-412 INTERFACE An early industry standard interface between a hard disk and hard disk controller. In the ST-506/St-412 interface, the "intelligence" is on the controller rather than on the drive. *See* INTERFACE STANDARD, ESDI, and SCSI.

STAND-ALONE Able to operate without support.

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.

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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 Storage module drive interface. An interface, used in larger disk drives, i.e., 8" & 14" drives.

SUSTAINED SPEED The rate at which data can be transferred continuously. *See* BURST SPEED.

SYNC Shortened form of synchronized. Events that happen at the same time.

SYNCHRONOUS DATA Data sent, usually in serial mode, with a clock pulse.

SYNCHRONOUS TRANSFER A method of sending data that allows many bytes of data to be sent before acknowledgment is received from the target. Only data can be sent in synchronous mode. Commands, messages and status must be transmitted in asynchronous mode.

SYNCHRONOUS TRANSFER NEGOTIATION The process of determining if a target is able to send/receive data using synchronous transfers.

TAPE DRIVE A sequential access memory device whose magnetic media is tape in a cassette, reel or continuous loop.

TARGET A device that responds to commands from a device (initiator).

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TERMINAL A screen and keyboard combination device used to interact with a computer. Terminals are usually used to access a mainframe computer.

TERMINATE AND STAY RESIDENT A program that resides dormant in the computer's memory until triggered by another program or by a device. Also called TSR.

TERMINATION A technique used to reduce echoing, ringing, and noise on a transmission line.

TERMINATOR 1) An electrical circuit attached to each end of a SCSI bus to minimize signal reflections and extraneous noise. SCSI defines passive, active and forced-perfect termination schemes. 2) A movie starring Arnold.

TERMPWR Terminator power.

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.

THIRD-PARTY DMA *See* DMA.

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 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.

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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 an 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.

TRANSLATION In IDE applications, the conversion from physical head, sector, and track numbers to their logical equivilents.

TRUNCATION In IDE applications, cylinder truncation can limit drive capacity. This occurs in older machines which do not have a BIOS supporting more than 1024 cylinders.

TSR *See* TERMINATE AND STAY RESIDENT.

TUNNEL ERASE An erase scheme where both sides of the recorded data are erased when writing data to elimate track to track interference. This is primarily used on floppy disk drives.

TWISTED PAIR Two wires twisted together to reduce susceptibility to RF noise.

TWISTED-PAIR FLAT CABLE A group of twisted pairs of wires arranged in rows that comprise a single flate cable. Twisted-pair flat cables are less susceptible to noise than are ribbon cables.

ULTRASCSI *See* FAST-20.

UMB Upper Memory Block. *See* UPPER MEMORY.

UNFORMATTED (CAPACITY) Drive byte capacity before formatting. Maximum capacity of a disk drive before formatting = (bits per track) x # of heads x # of cylinders. *See* MEGABYTE.

UNIX A multitasking operating system used on a variety of computer types, including PCs.

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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 by using a different disk drive within the product family.

UPPER MEMORY Memroy in the PC that is between 640K and 1 MB. This memory area is used for BIOS addresses and can be used to store TSRs and other drivers. Upper memory is divided into 64K subsections called upper memory blocks (UMBs).

USENET A collection of message areas accessed via Internet.

VERIFICATION This feature lets the computer go back and read what it just wrote to disk to ensure the data was written correctly.

VIDEO ELECTRONICS STANDARDS ASSOCIATION (VESA) A standards body that promotes video hardware and software specifications. VESA is also the organization governing the VL-BUS.

VL-BUS (VLB) VESA Local Bus. A 32-bit local bus promoted by VESA for communicating directly to the CPU rather than through the ISA or EISA bus.

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 nonvolatile and can be used for permanent (but changeable at will) storage fo 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.

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WIDE SCSI A 16-bit implementation of the SCSI-II standard, commonly referred to as SCSI-III. 68 pin connectors are commonly used with WIDE SCSI. MAximum transfer rates are 20-40Mbytes/sec.

WINCHESTER DRIVE A disk drive with a Winchester style (floats on air) heads and non-removable (fixed) disks sealed in a contaiment-free housing.

WINDOWS A multitasking operating system for the PC developed by Microsoft Corporation.

WINDOWS NT A high-end, cross-platform, multitasking operating system also developed by Microsoft Corporation.

WORD Number of bits processed in parallel (in a single operation) by a CPU. Standard word lengths are 8, 16, 32 and 64 bits (1, 2, 4 or 8 bytes).

WORM *See* WRITE ONCE, READ MANY.

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 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 a disk.

WRITE-INTENSIVE A process that requires a lot of writing of data to a device such as a hard disk.

WRITE ONCE, READ MANY A storage medium that can be written to only once, but read many times. Also called WORM.

XOR A binary operation that compares two bits and yields a 1 only if the bits being compared are different.

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XSMD Extended storage module drive interface. A popular electrical interface for 8" drives used in minicomputer and mainframe applications.

X3.131-1986 The document describing the specifications of the SCSI-1 standard.

X3.131-1994 The document describing the specifications of the SCSI-2 standard.

X3T10 The ANSI committee responsible for organizing, realizing, and promoting SCSI standards.

ZONED RECORDING (ZBR) 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. Also referred to as Zone Bit Recording.

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Eighth Edition
July, 1996

Martin Bodo
Author

Dedication

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

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Martin Bodo is the founder and president of Corporate Systems Center. An avid computer enthusiast since his early teens, he holds a degree in Physics from the University of Santa Clara.

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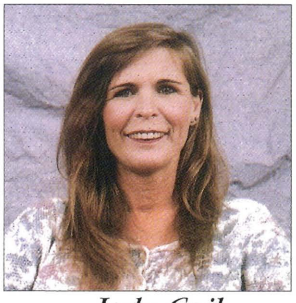

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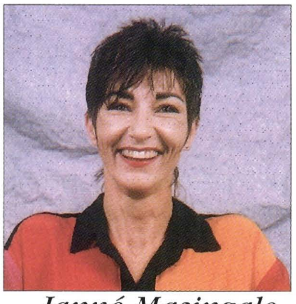

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