Introduction

- Disk memory includes floppy, fixed, and optical disk storage.

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Mass Storage Devices

Chapter Objectives

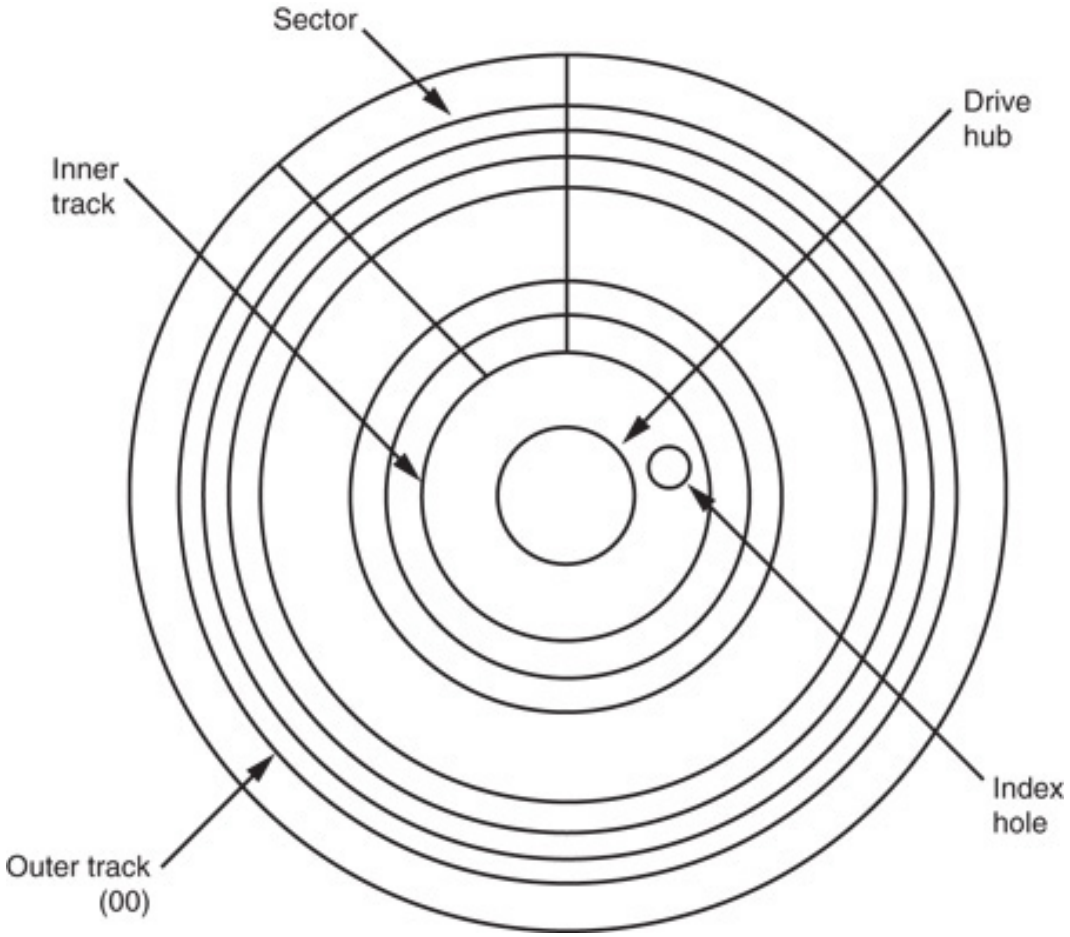
- Describe the disk standards found in personal computer systems.

Floppy Disk Memory

- The floppy, or flexible disk was once the most common and basic form of disk memory.
  - the floppy is beginning to vanish and may disappear shortly in favor of the USB pen drive
- Floppy disk magnetic recording media have been made available in three sizes:
  - 8″ standard
  - $5^1/_4$″ mini-floppy
  - $3^1/_2$″ micro-floppy.

- All disks have several things in common.
- They are all organized so that data are stored in tracks and sectors.
  - a track is a concentric ring of data stored on the surface of a disk
  - a sector is a common subdivision of a track designed to hold a reasonable amount of data
- In many systems, a sector holds either 512 or 1024 bytes of data.
  - size of a sector can vary from 128 bytes to the length of one entire track

Figure 13–18 The format of a $5^1/_4$″ mini-floppy disk.

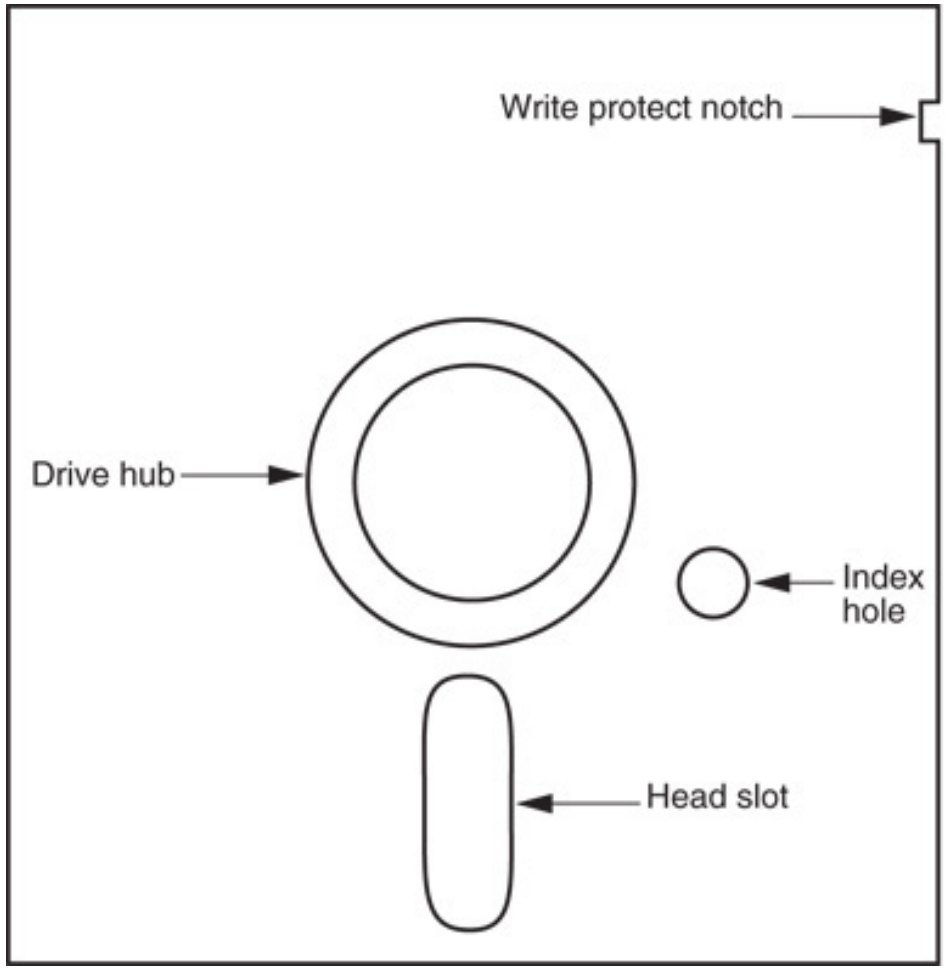


- the index hole is so the system can find the start of a track and first sector (00)
- tracks are numbered from track 00, the outermost track, toward the center
- sectors are often numbered from sector 00 on the outermost track

The 5 1/4″ Mini-floppy Disk

- The 5 1/4″ floppy is very difficult to find and is used only with older microcomputer systems.
- The floppy disk is rotated at 300 RPM inside its semi-rigid plastic jacket.
  - the head mechanism in a floppy drive makes physical contact with the surface of the disk, which causes wear and damage to the disk
- Most mini-floppy disks are double-sided.
  - data are written on the top & bottom surfaces

Figure 13–19 The $5^1/_4''$ mini-floppy disk.



- a set of tracks called a **cylinder** consists of one top and one bottom track
- Cylinder 00 consists of the outermost top and bottom tracks

- the magnetic recording technique used to store data on the surface of the disk is called non-return to zero (NRZ) recording
- with NRZ recording, magnetic flux placed on the surface of the disk never returns to zero
- arrows show the polarity of the magnetic field stored on the surface of the disk

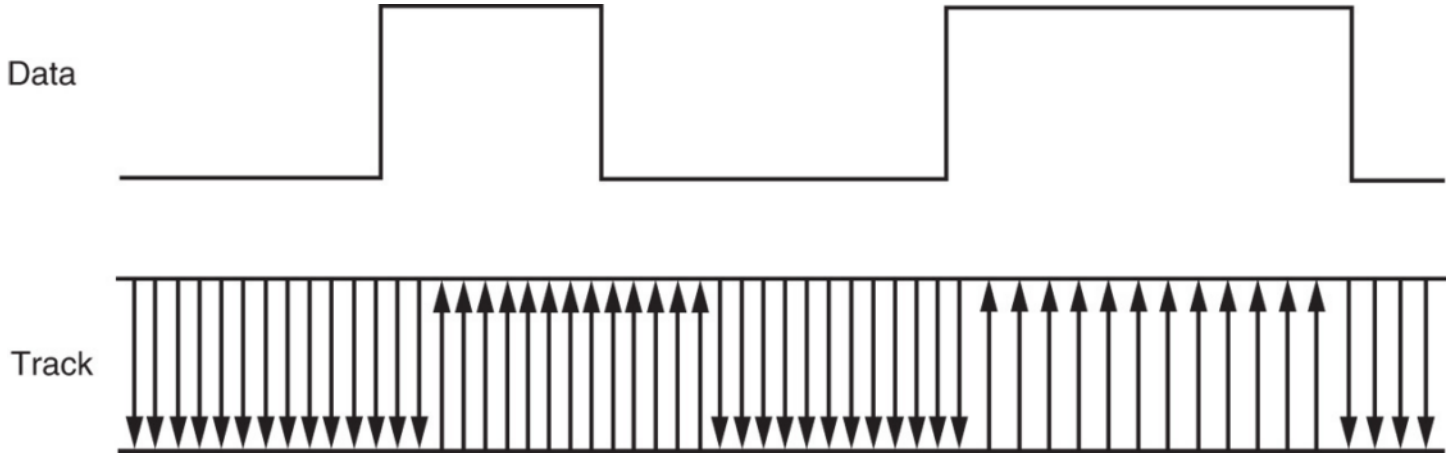


Figure 13–20 The non-return to zero (NRZ) recording technique.

- data are stored in the form of MFM (modified frequency modulation) on modern floppy disks
- each bit time is 2.0 μs wide on a double-density disk
- data are recorded at the rate of 500,000 bits per second

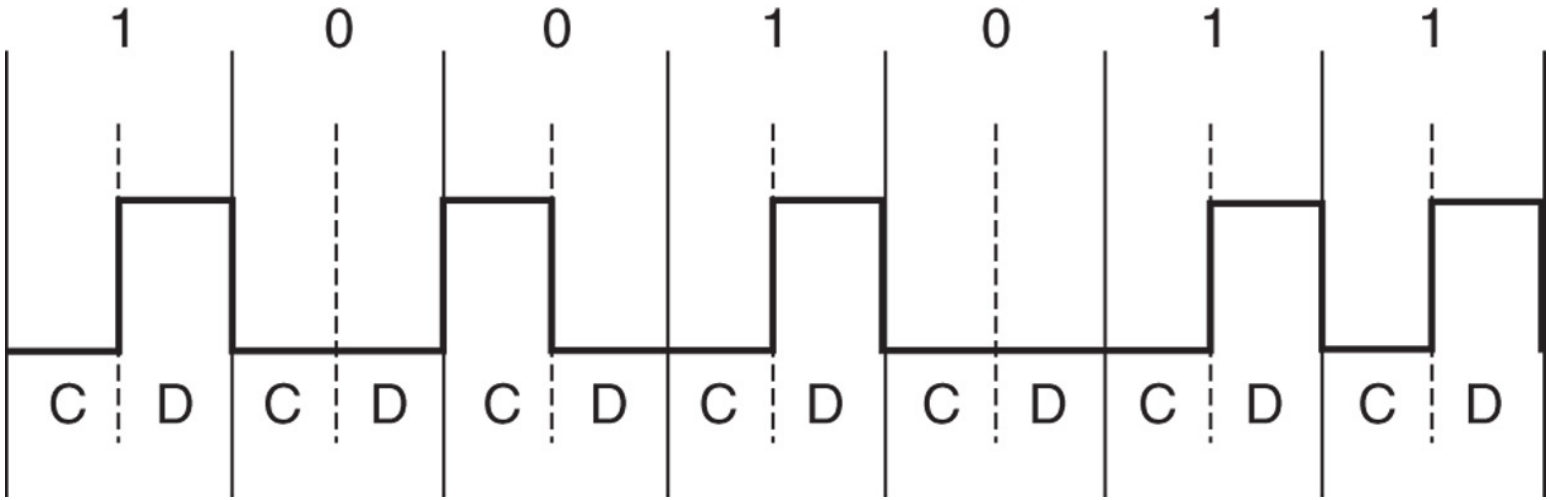
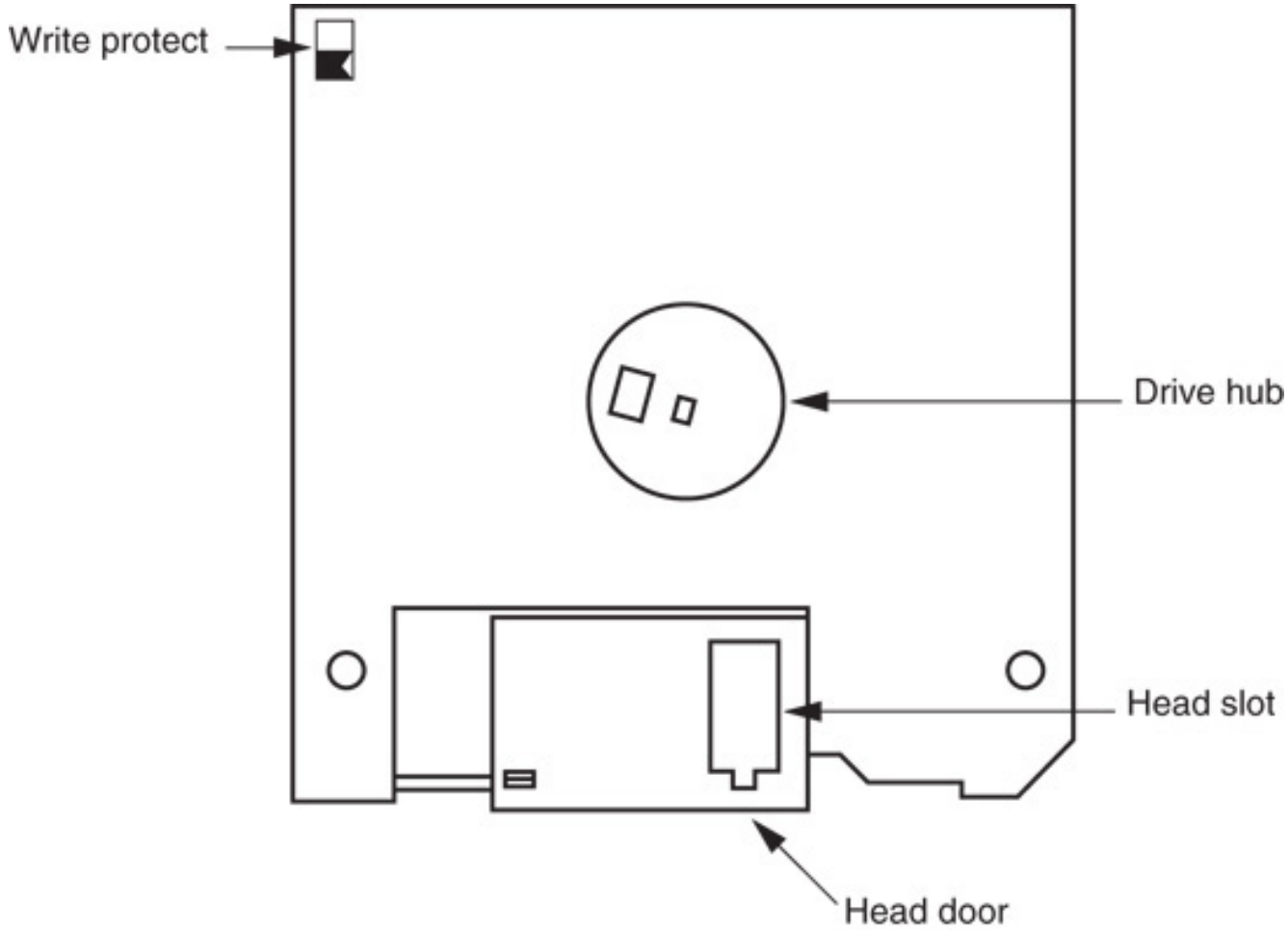


Figure 13–21 Modified frequency modulation (MFM) used with disk memory.

The 3 $^1/_2$" Micro-Floppy Disk

- A much improved version of the mini-floppy disk described earlier.
- The micro-floppy is packaged in a rigid plastic jacket that will not bend easily.
  - a much greater degree of protection to the disk
- The head door remains closed until the disk is inserted into the drive.
  - once in the drive, the mechanism slides open the door, exposing the surface of the disk to the read/write heads

Figure 13–22 The $3^1/_2$″ micro-floppy disk.



- On the mini-floppy, a piece of tape was placed over a notch on the side of the jacket to prevent writing.
  - this plastic tape easily became dislodged inside disk drives, causing problems
- The micro-floppy has an integrated plastic slide replacing the tape write-protection.
- To write-protect (prevent writing) the micro-floppy disk, the plastic slide is moved to open the hole through the disk jacket.
  - allows light to strike a sensor that inhibits writing

Pen Drives

- Pen drives, or flash drives use flash memory to store data.
  - a driver treats the pen drive as a floppy with tracks and sectors, though it really does not
- The FAT system is used for the file structure.
  - memory in this type of drive is serial memory
- When connected to the USB bus, the OS recognizes it and allows data to be transferred between it and the computer.

Hard Disk Memory

- Hard disk memory has a much larger capacity than the floppy disk memory.
  - often called a fixed disk because it is not removable like the floppy disk
- A hard disk is also often called a rigid disk.
  - the term *Winchester drive* is also used, but less commonly today
- Common, low-cost (less than $1 per gigabyte) sizes are presently 20G bytes to 500G bytes.
  - sizes approaching 1 T (tera) bytes are available

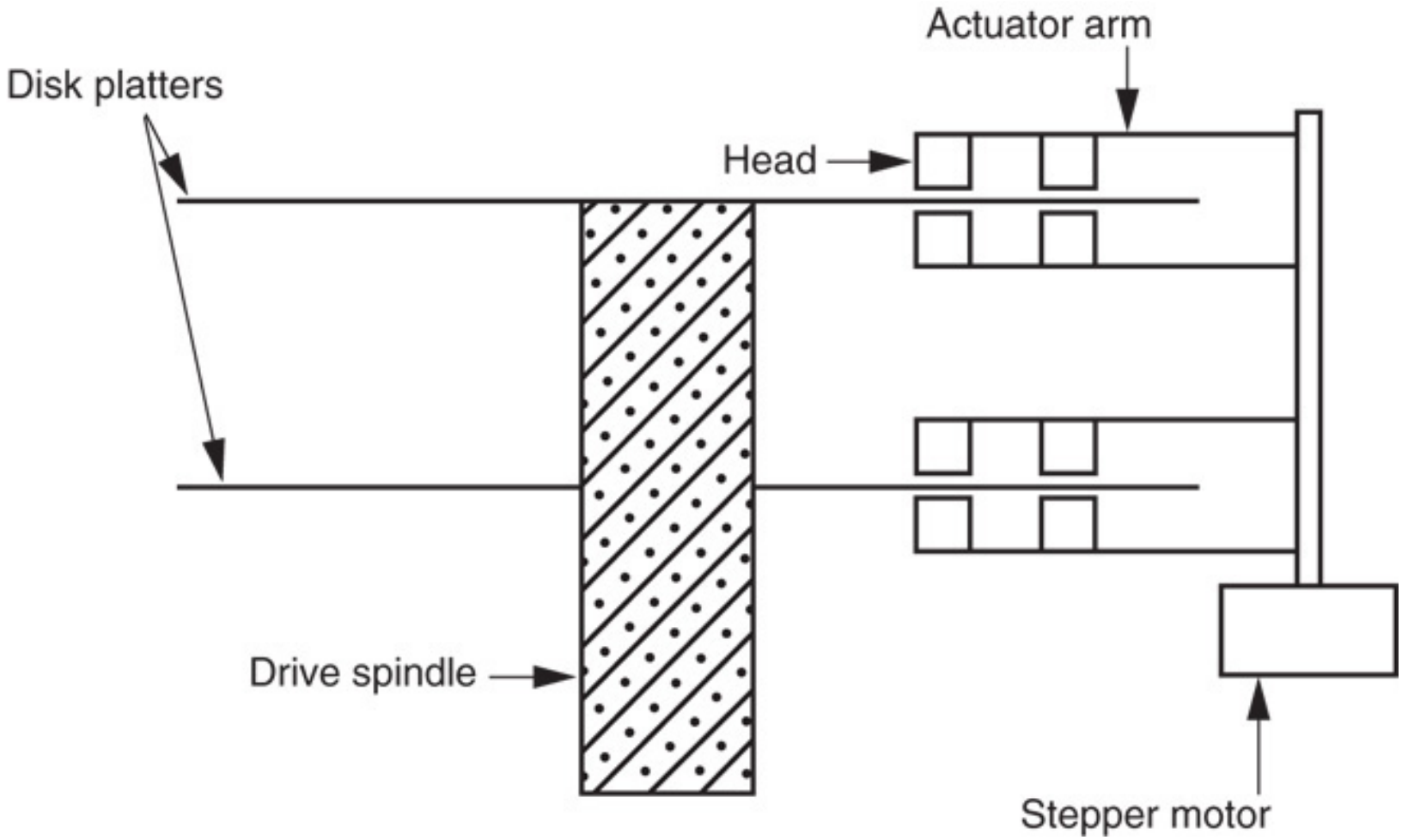
- The hard disk memory uses a flying head to store and read data.
- A flying head, which is very small and light, does not touch the surface of the disk.
  - it flies above the surface on a film of air that is carried with the surface of the disk as it spins
- The hard disk typically spins at 3000 to 15,000 RPM, many times faster than a floppy.
  - higher rotational speed allows the head to fly just over the top of the surface of the disk
- There is no wear on the hard disk's surface.

- Problems can arise because of flying heads.
  - if power is interrupted or the drive is jarred, the head can crash onto the disk surface, which can damage the disk surface or the head
- Some drive manufacturers have included a system to automatically park the head when power is interrupted.
  - when the heads are parked, they are moved to a safe landing zone (unused track) when power is disconnected

- Another difference between a floppy and a hard drive is the number of heads and disk surfaces.
  - a floppy has two heads, one for the upper surface and one for the lower surface
  - the hard drive has up to eight disk surfaces (four platters), with up to two heads per surface
- Each time a new cylinder is obtained by moving the head assembly, 16 new tracks are available under the heads.
- See Figure 13–23.

- Heads are moved from track to track by using either a stepper motor or a voice coil.
  - the stepper motor is slow and noisy; moving the head assembly requires one step per cylinder
  - the voice coil mechanism is quiet and quick; the heads can be moved many cylinders with one sweeping motion
- Stepper-motor-type head positioning mechanisms can become misaligned
  - while the voice coil mechanism corrects for any misalignment

Figure 13–23 A hard disk drive that uses four heads per platter.

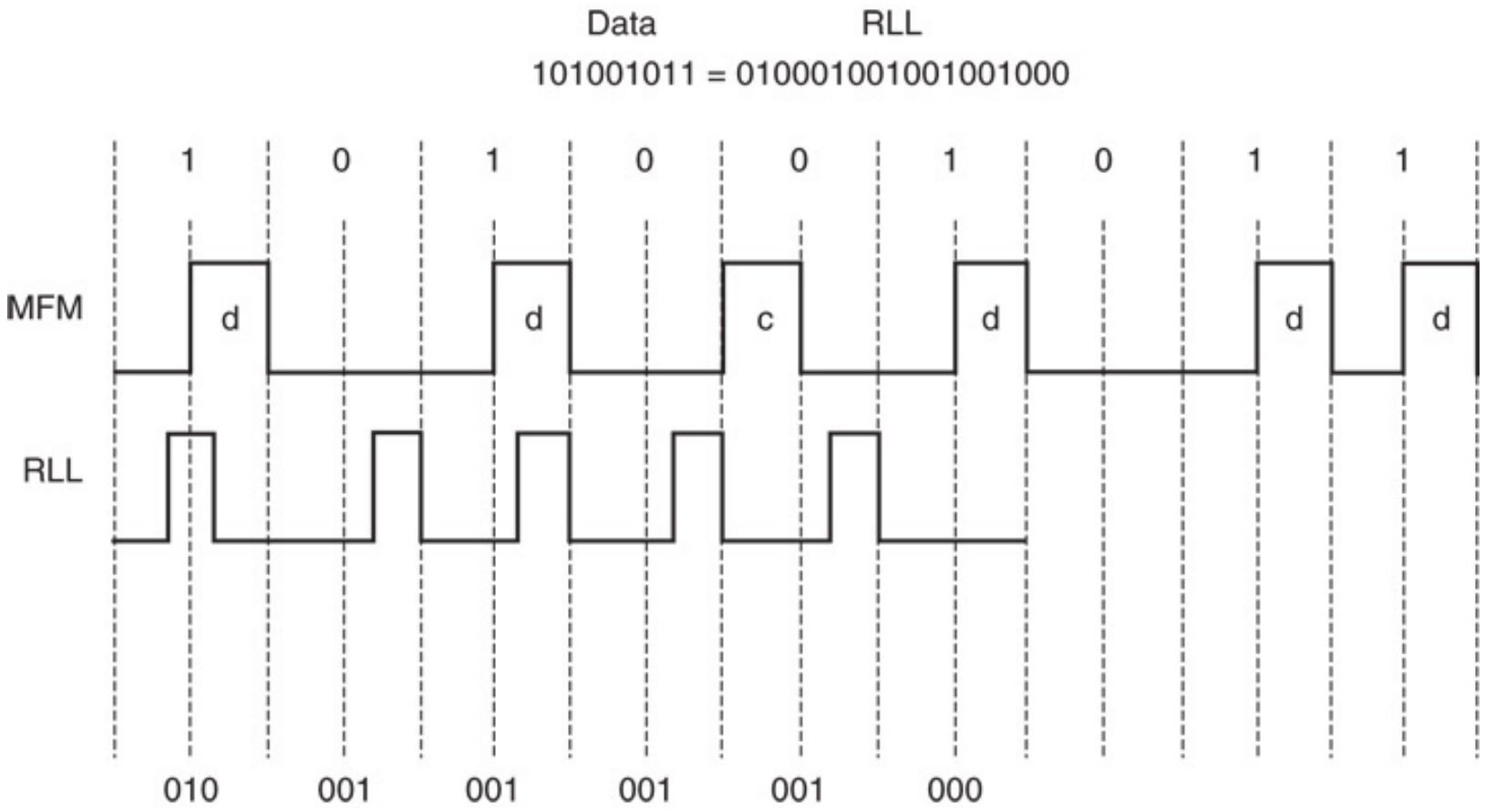


- Hard drives often store information in sectors that are 512 bytes long.
- Data are addressed in clusters of eight or more sectors, which contain 4096 bytes (or more) on most hard disk drives.
- All hard drives use today RLL encoding.

RLL Storage

- The term run-length limited (RLL) means the run of zeros (zeros in a row) is limited.
  - a common RLL encoding scheme is RLL 2,7, which means the run of zeros is always between two and seven
- An RLL drive often contains 27 tracks instead of the 18 found on the MFM drive.
- Fig 13–24 is a comparison of MFM & RLL.
  - besides holding more information, the RLL drive can be written and read at a higher rate

Figure 13–24 A comparison of MFM with RLL using data101001011.



- There are a number of disk drive interfaces in use today.
  - the oldest is the ST-506 interface, which uses either MFM or RLL data
- Newer standards are in use today.
  - which include ESDI, SCSI, and IDE
- The IDE system is becoming the standard hard disk memory interface.
- The enhanced small disk interface (ESDI) system is capable of transferring data at rates approaching 10M bytes per second.

- ST-506 interface approaches 860K bytes/sec.
- The small computer system interface (SCSI) allows up to seven different disk or other interfaces to be connected to the computer through same interface controller.
  - SCSI is found in some PC-type computers and also in the Apple Macintosh system
- An improved version, SCSI-II, has started to appear in some systems.
  - in the future, this interface may be replaced with IDE in most applications

- One of the most common systems is the **integrated drive electronics** (IDE) system.
  - incorporates the disk controller in the drive and attaches to the host system through a small interface cable
- IDE drives are found in newer IBM PS-2 systems and many clones.
  - even Apple computer systems are starting to be found with IDE drives
- The IDE interface is also capable of driving other I/O devices besides the hard disk.

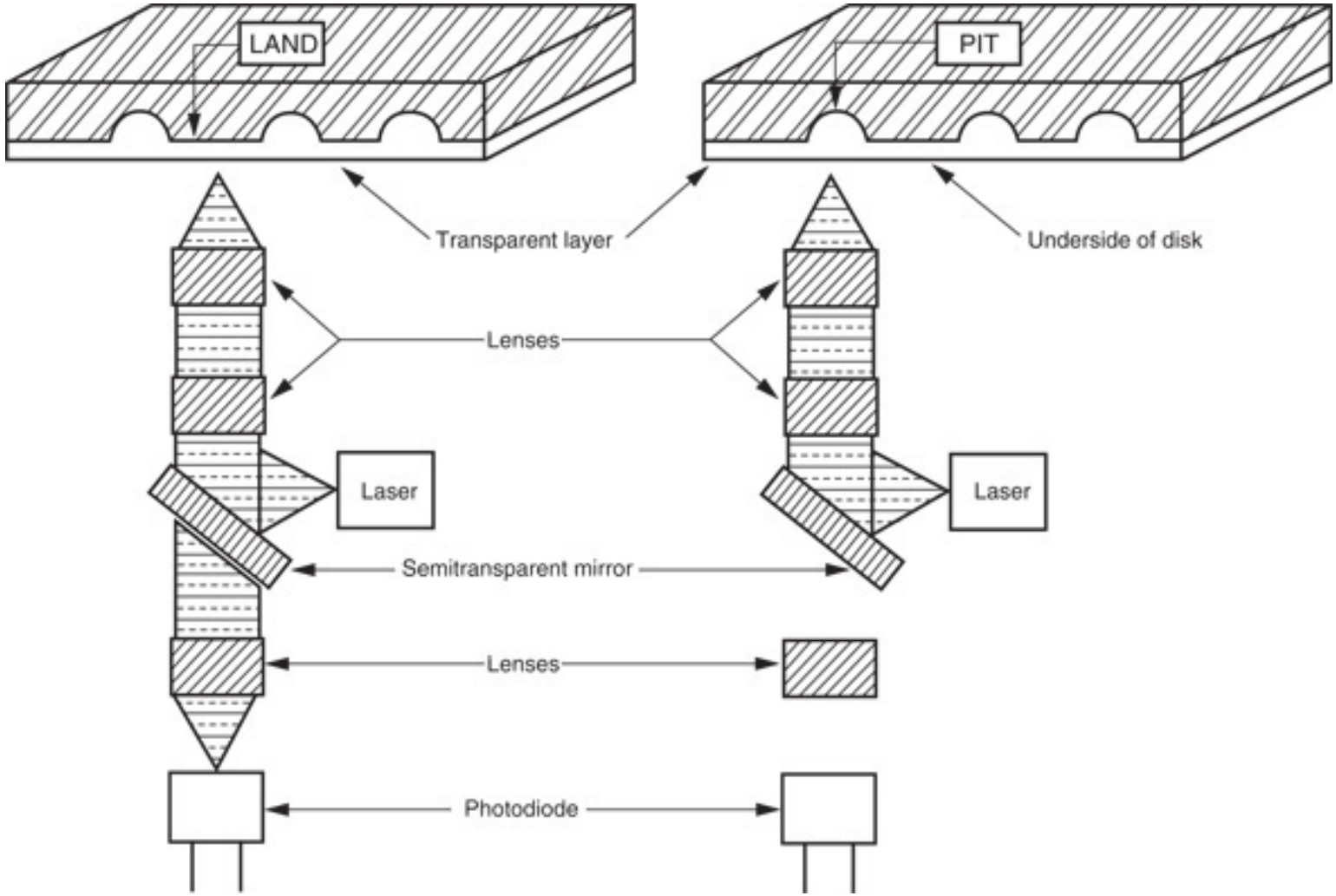
- IDE usually contains at least a 256K- to 8M-byte cache memory for disk data.
  - the cache speeds disk transfers
- Access times for an IDE drive are often less than 8 ms.
  - access time for a floppy-disk is about 200 ms
- IDE is also called ATA, an acronym for **AT attachment** where “AT” means the Advanced Technology computer.

- The latest is the serial ATA interface or SATA.
  - this interface transfers serial data at 150 MBps (or 300 MBps for SATA2), faster than IDE
- Not yet released is SATA3, which transfers data at a rate of 600 MBps.
- The transfer rate is higher because the logic 1 level is no longer 5.0 V. It is now 0.5 V.
  - which allows higher data transfer rates because it takes less time for the signal to rise to 0.5 V than to 5.0 V

Optical Disk Memory

- Optical disk memory is commonly available in two forms:
  - CD-ROM (compact disk/read only memory)
  - WORM (write once/read mostly)
- CD-ROM is the lowest cost, but suffers from lack of speed.
  - access times are typically 300 ms or longer
- As systems develop and become more visually active, use of the CD-ROM drive will become even more common.

Figure 13–25 The optical CD-ROM memory system.



- The WORM drive sees far more commercial application than the CD-ROM.
  - application is very specialized due to its nature
- WORM is normally used to form an audit trail of transactions spooled onto the WORM and retrieved only during an audit.
  - one might call the WORM an archiving device
- The advantage of the optical disk is durability.
- About the only way to destroy data on an optical disk is to break it or deeply scar it.

- The new versatile read/write CD-ROM, called a DVD, became available in the mid 1990's.
- New to this technology are the Blu-ray DVD from Sony Corporation and the HD-DVD from Toshiba Corporation.
  - Blu-ray DVD capacity is 50 GB; HD-DVD, 30 GB
- The big change from older DVDs is a switch from a red laser to a blue laser.
  - a blue laser has a higher frequency, which means it can read more information per second from the DVD, hence a high storage density