

# Understanding how magnetic storage devices work computer science essay

[Technology](#), [Computer](#)



A magnetic storage device includes a magnetic disk having a protective film and a lubricant layer formed on the protective film, a head stack assembly including a head operable to read information from and write information to the magnetic disk, and a suspension configured to support the head, a vibration detection sensor operable to output a detection signal to detect vibration of the head stack assembly, and an extraction unit operable to extract a specific frequency range from the detection signal outputted by the vibration detection sensor, the specific frequency range including a natural frequency of the head stack assembly but not including a natural frequency of an air film on the head.

## INTRODUCTION

Magnetic storage and magnetic recording are terms from engineering referring to the storage of data on a magnetized medium. Magnetic storage uses different patterns of magnetization in a magnetisable material to store data and is a form of non-volatile memory. The information is accessed using one or more read/write heads. As of 2009, magnetic storage media, primarily hard disks, are widely used to store computer data as well as audio and video signals. In the field of computing, the term magnetic storage is preferred and in the field of audio and video production, the term magnetic recording is more commonly used. The distinction is less technical and more a matter of preference. Other examples of magnetic storage media include floppy disks, magnetic recording tape, and magnetic stripes on credit cards.

How Is Data Stored on Magnetic Storage Devices?

## Analog Tape

Magnetic recorders have been around in one form or another since the end of the 19th century and were used to make audio recordings long before any of their other uses. The first form to come into widespread use was the analog tape. In an analog tape, a strip of plastic coated with a thin magnet coating is wound between two reels. To make a recording, the motor in the tape recorder unwinds the tape past an electromagnet, called the write head, at a steady rate.

### The Write Head

A current in the shape of the analog signal pulses through the write head. The current continuously goes from positive to negative as the sound wave being recorded goes up or down. This current creates a moving magnetic field in the write head, which induces a magnetic field in the nearby read head. The magnetic field stays on the tape, creating a recording of the sound.

### Digital Recording

Digital tapes do the same thing as analog tapes except that, instead of storing a continuous signal, they store digital information. The current in the write head does not go from negative to positive in a continuous wave, but instead jumps quickly between two different values to represent the binary digits 1 and 0. Digital tapes are used as backup, but they are a bit too slow

to use for normal day-to-day work, since the machine has to wind and unwind the tape to find every piece of information.

## Hard Drives

Hard drives are much quicker than tapes and are currently the most important magnetic storage devices. They read and write in the same way tapes do, but they have a different physical structure. A hard drive has several different disk-shaped “ platters” that are covered with grooves like records. Each has a write head that hovers above it as it spins very quickly. A control motor can move the head to any spot on the disk, where it retrieves the desired information from the disk as it spins.

## ACCESS METHOD

Magnetic storage media can be classified as either sequential access memory or random access memory although in some cases the distinction is not perfectly clear. In the case of magnetic wire, the read/write head only covers a very small part of the recording surface at any given time.

Accessing different parts of the wire involves winding the wire forward or backward until the point of interest is found. The time to access this point depends on how far away it is from the starting point. The case of ferrite-core memory is the opposite. Every core location is immediately accessible at any given time.

Hard disks and modern linear serpentine tape drives do not precisely fit into either category. Both have many parallel tracks across the width of the

media and the read/write heads take time to switch between tracks and to scan within tracks. Different spots on the storage media take different amounts of time to access. For a hard disk this time is typically less than 10 ms, but tapes might take as much as 100 s.

## Disk Storage

Disk storage or disc storage is a general category of storage mechanisms, in which data are digitally recorded by various electronic, magnetic, optical, or mechanical methods on a surface layer deposited of one or more planar, round and rotating platters. A disk drive is a device implementing such a storage mechanism with fixed or removable media; with removable media the device is usually distinguished from the media as in compact disc drive and the compact disc. Notable types are the hard disk drive (which is today almost always use fixed media), the floppy disk drive and its floppy disk, and various optical disc drives and associated media.

## Data Storage Device

A data storage device is a device for recording (storing) information (data). Recording can be done using virtually any form of energy, spanning from manual muscle power in handwriting, to acoustic vibrations in phonographic recording, to electromagnetic energy modulating magnetic tape and optical discs.

A storage device may hold information, process information, or both. A device that only holds information is a recording medium. Devices that

process information (data storage equipment) may either access a separate portable(removable) recording medium or a permanent component to store and retrieve information.

Electronic data storage is storage which requires electrical power to store and retrieve that data. Most storage devices that do not require vision and a brain to read data fall into this category. Electromagnetic data may be stored in either an analog or digital format on a variety of media. This type of data is considered to be electronically encoded data, whether or not it is electronically stored in a semiconductor device, for it is certain that a semiconductor device was used to record it on its medium. Most electronically processed data storage media (including some forms of computer data storage) are considered permanent (non-volatile) storage, that is, the data will remain stored when power is removed from the device. In contrast, most electronically stored information within most types of semiconductor (computer chips) microcircuits are volatile memory, for it vanishes if power is removed.

With the exception of barcodes and OCR data, electronic data storage is easier to revise and may be more cost effective than alternative methods due to smaller physical space requirements and the ease of replacing (rewriting) data on the same medium. However, the durability of methods such as printed data is still superior to that of most electronic storage media. The durability limitations may be overcome with the ease of duplicating (backing-up) electronic data.

Many different consumer electronic devices can store data.

A reel-to-reel tape recorder (Sony TC-630) the magnetic tape is data storage medium. The recorder is data storage equipment using a portable medium to store the data.

### Magnetic Storage Devices

The diskette drives, tape drives and hard disk drives are examples of magnetic storage devices. These devices are used to write and read data to and from the diskettes, tapes and hard disks. The surfaces of diskette, tape and hard disk are coated with magnetic material such as iron oxide or ferrous oxide, which can be magnetized (i. e. which reacts to a magnetic field).

The surfaces of disks and magnetic tapes are coated with millions of tiny iron particles so that data can be stored on them. Each of these particles can act as a magnet. The write/read heads of disk drives or tape drives contain electromagnets that generate magnetic fields in the iron on the storage medium as the head passes over the disk or tape. The presence of a magnetic field represents a ' 1' bit and its absence represents a ' 0' bit.

The data reading process from magnetic disk or tape is reversed. In reading process, no current is flowing through the electromagnetic and read/write heads have no magnetic field. Because the storage medium has a magnetic field but the head does not. The storage medium charges the magnet in the head, which causes a small current to flow through the head in one direction

or the other depending on the polarity of the field. The disk or tape drive senses the direction of the flow as the disk or tape passes by the head. In this way data is sent from the read/write head into memory in the form of electric pulses.

The information stored in a disk can be read many times without affecting the stored data. So the reading operation is non-destructive. But the writing of new data erases data previously stored at that location of the disk or tape.

## Types Of Magnetic Storage Devices

### Tape Drive

A tape drive is a data storage device that reads and writes data on a magnetic tape. It is typically used for off-line, archival data storage. Tape media generally has a favorable unit cost and long archival stability.

A tape drive provides sequential access storage, unlike a disk drive, which provides random access storage. A disk drive can move its read/write head(s) to any random part of the disk in a very short amount of time, but a tape drive must spend a considerable amount of time winding tape between reels to read any one particular piece of data. As a result, tape drives have very slow average seek times. Despite the slow seek time; tape drives can stream data to and from tape very quickly. For example, modern LTO drives can reach continuous data transfer rates of up to 80 MB/s, which is as fast as most 10, 000 RPM hard disks.

### Magnetic tape drive



## Magnetic Tape Sound Recording

Magnetic tape has been used for sound recording for more than 75 years. Tape revolutionized both the radio broadcast and music recording industries. It did this by giving artists and producers the power to record and re-record audio with minimal loss in quality as well as edit and rearrange recordings with ease. The alternative recording technologies of the era, transcription discs and wire recorders, could not provide anywhere near this level of quality and functionality. Since some early refinements improved the fidelity of the reproduced sound, magnetic tape has been the highest quality analog sound recording medium available. Despite this, as of 2007, magnetic tape is largely being replaced by digital systems for most sound recording purposes.

Prior to the development of magnetic tape, magnetic wire recorders had successfully demonstrated the concept of magnetic recording, but they never offered audio quality comparable to the recording and broadcast standards of the time. Some individuals and organizations developed innovative uses for magnetic wire recorders while others investigated variations of the technology. One particularly important variation was the application of an oxide powder to a long strip of paper. This German invention was the start of a long string of innovations that lead to modern magnetic tape.

## Hard Disk Drive

A hard disk drive (often shortened as hard disk, hard drive, or HDD) is a non-volatile storage device that stores digitally encoded data on rapidly rotating

rigid (i. e. hard) platters with magnetic surfaces. Strictly speaking, “ drive” refers to the motorized mechanical aspect that is distinct from its medium, such as a tape drive and its tape, or a floppy disk drive and its floppy disk. Early HDDs had removable media; however, an HDD today is typically a sealed unit (except for a filtered vent hole to equalize air pressure) with fixed media.

## A Hard Disk Drive

### Technology

HDDs record data by magnetizing ferromagnetic material directionally, to represent either a 0 or a 1 binary digit. They read the data back by detecting the magnetization of the material. A typical HDD design consists of a spindle that holds one or more flat circular disks called platters, onto which the data are recorded. The platters are made from a non-magnetic material, usually aluminium alloy or glass, and are coated with a thin layer of magnetic material, typically 10-20 nm in thickness – for reference, standard copy paper is 0.07-0.18 millimetres (70,000-180,000 nm) thick – with an outer layer of carbon for protection. Older disks used iron (III) oxide as the magnetic material, but current disks use a cobalt-based alloy.

A cross section of the magnetic surface in action. In this case the binary data are encoded using frequency modulation.

The platters are spun at very high speeds. Information is written to a platter as it rotates past devices called read-and-write heads that operate very close

(tens of nanometres in new drives) over the magnetic surface. The read-and-write head is used to detect and modify the magnetization of the material immediately under it. There is one head for each magnetic platter surface on the spindle, mounted on a common arm. An actuator arm (or access arm) moves the heads on an arc (roughly radially) across the platters as they spin, allowing each head to access almost the entire surface of the platter as it spins. The arm is moved using a voice coil actuator or in some older designs a stepper motor.

The magnetic surface of each platter is conceptually divided into many small sub-micrometre-sized magnetic regions, each of which is used to encode a single binary unit of information. Initially the regions were oriented horizontally, but beginning about 2005, the orientation was changed to perpendicular. Due to the polycrystalline nature of the magnetic material each of these magnetic regions is composed of a few hundred magnetic grains. Magnetic grains are typically 10 nm in size and each form a single magnetic domain. Each magnetic region in total forms a magnetic dipole which generates a highly localized magnetic field nearby. A write head magnetizes a region by generating a strong local magnetic field. Early HDDs used an electromagnet both to magnetize the region and to then read its magnetic field by using electromagnetic induction. Later versions of inductive heads included metal in Gap (MIG) heads and thin film heads. As data density increased, read heads using magneto resistance (MR) came into use; the electrical resistance of the head changed according to the strength of the magnetism from the platter. Later development made use of

spintronics: in these heads, the magneto resistive effect was much greater than in earlier types, and was dubbed “giant” magneto resistance (GMR). In today’s heads, the read and write elements are separate, but in close proximity, on the head portion of an actuator arm. The read element is typically magneto-resistive while the write element is typically thin-film inductive.

HD heads are kept from contacting the platter surface by the air that is extremely close to the platter; that air moves at, or close to, the platter speed. The record and playback head are mounted on a block called a slider, and the surface next to the platter is shaped to keep it just barely out of contact. It’s a type of air bearing.

### Floppy Disk

A floppy disk is a data storage medium that is composed of a disk of thin, flexible (“floppy”) magnetic storage medium encased in a square or rectangular plastic shell.

Floppy disks are read and written by a floppy disk drive or FDD, the initials of which should not be confused with “fixed disk drive”, which is another term for a (non-removable) type of hard disk drive. Invented by the American information technology company IBM, floppy disks in 8-inch (203 mm), 5+1a?,, 4 in (133 mm), and 3+1a?,, 2 in (89 mm) formats enjoyed nearly three decades as a popular and ubiquitous form of data storage and exchange, from the mid-1970s to the late 1990s. While floppy disk drives still have some limited uses, especially with legacy industrial computer

equipment, they have now been superseded by USB flash drives, external hard disk drives, CDs, DVDs, and memory cards.

## APPLICATIONS

As of 2008, common uses of magnetic storage media are for computer data mass storage on hard disks and the recording of analog audio and video works on analog tape. Since much of audio and video production is moving to digital systems, the usage of hard disks is expected to increase at the expense of analog tape. Digital tape and tape libraries are popular for the high capacity data storage of archives and backups. Floppy disks see some marginal usage, particularly in dealing with older computer systems and software. Magnetic storage is also widely used in some specific applications, such as bank cheques (MICR) and credit/debit cards (magnetic stripes).

## FUTURE PROSPECTIVE

A new type of magnetic storage, called Magneto resistive Random Access Memory or MRAM, is being produced that stores data in magnetic bits based on the Tunnel Magneto Resistance (TMR) effect. Its advantage is non-volatility, low power usage, and good shock robustness. The 1st generation that was developed was produced by Everspin Technologies, and utilized field induced writing. The 2nd generation is being developed through two approaches: Thermal Assisted Switching (TAS) which is currently being developed by Crocus Technology, and Spin Torque Transfer (STT) on which Crocus, Hynix, IBM, and several other companies are working. However, with storage density and capacity orders of magnitude smaller than an HDD,

MRAM is useful in applications where moderate amounts of storage with a need for very frequent updates are required, which flash memory cannot support due to its limited write endurance.

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