

## CD and DVD History

CD-DA (Compact Disk-digital audio), the original compact disc for music, was defined by Philips and Sony, in 1982. The CD-DA allows a music playing time of 74 minutes 30 seconds.

CD-ROM (Compact Disk, read-only-memory) is an adaptation of the [CD](#) that is designed to store computer data in the form of text, video, and graphics, as well as stereo sound. . Format of the CD-ROM is the same as for audio CDs: a standard CD is 120 mm (4.75 inches) in diameter and 1.2 mm (0.05 inches) thick and is composed of a polycarbonate plastic substrate (underlayer - this is the main body of the disk), one or more thin reflective metal (usually aluminum) layers, and a lacquer coating.

## High Sierra Format (HSF)

The specifications were so general that there was some fear in the industry that multiple incompatible and proprietary formats would be created. In order to prevent such an occurrence, representatives from industry leaders met at the High Sierra Hotel in Lake Tahoe to collaborate on a common standard. Nicknamed the *High Sierra Format*, this version was later modified to become ISO 9660. Today, CD-ROMs are standardized and will work in any standard CD-ROM drive. CD-ROM drives can also read audio compact disks for music, although CD players cannot read CD-ROM disks.

## CD-ROM Data Storage

Although the disc media and the drives of the CD and CD-ROM are, in principle, the same, there is a difference in the way data storage is organized. Two new sectors were defined, Mode 1 for storing computer data and Mode 2 for compressed audio or video/graphic data.

## CD-ROM Mode 1

CD-ROM Mode 1 is the mode used for CD-ROMs that carry data and applications only. In order to access the thousands of data files that may be present on this type of CD, precise addressing is necessary. Data is laid out in nearly the same way as it is on audio disks: For mode 1 CD-ROM data storage, the sectors are further broken down, and 2,048 used for the expected data, while the other 304 bytes are devoted to extra error detection and correction code, because CD-ROMs are not as fault tolerant as audio CDs. There are 75 sectors per second on the disk, which yields a disc capacity of 681,984,000 bytes (650MB) and a single speed transfer rate of 150 KBps, with higher rates for faster CD-ROM drives. Drive speed is expressed as multiples of the single speed transfer rate, as 2X, 4X, 6X, and so on.

## CD-ROM Mode 2

CD-ROM Mode 2 is used for compressed audio/video information and uses only two layers of error detection and correction.. Therefore, all 2,336 bytes of data behind the sync and header bytes are for user data. Mode 1 and Mode 2 are the same size, the amount of data that can be stored varies considerably because of the use of sync and header bytes, error correction and detection. The Mode 2 format offers a flexible method for storing graphics and video. It allows different kinds of data to be mixed together. Mode 2 can be read by normal CD-ROM drives, in conjunction with the appropriate drivers.

## Data Encoding and Reading

The CD-ROM, like other CD adaptations, has data encoded in a spiral track beginning at the center and ending at the outermost edge of the disk. The spiral track holds approximately 650 MB of data. That's about 5.5 billion bits. The distance between two rows of pits, measured from the center of one track to the center of the next track is referred to as track pitch. The track pitch can range from 1.5 to 1.7 microns, but in most cases is 1.6 microns.

## Constant Linear Velocity (CLV)

Constant Linear Velocity is the principle by which data is read from a CD-ROM. This principal states that the read head must interact with the data track at a constant rate, whether it is accessing data from the inner or outermost portions of the disk. This is affected by varying the rotation speed of the disk, from 500 rpm at the center, to 200 rpm at the outside. In a music CD, data is read sequentially, so rotation speed is not an issue. The CD-ROM, on the other hand, must read in random patterns, which necessitates constantly shifting rotation speeds. Pauses in the read function are audible, and some of the faster drives can be quite noisy because of it.

## CD-R

CD-R (for *Compact Disk, recordable*) is a type of *write once*, CD format that allows one-time recording on a disk. The CD-R (as well as the [CD-RW](#)) format was introduced by Philips and Sony in 1988. Prior to this, CDs had been read-only audio (CD-Digital Audio ), to be played in CD players, and multimedia (CD-ROM), to be played in computers' CD-ROM drives, any user with a CD recorder drive could create their own CDs from their desktop computers.

CD-Rs are composed of a polycarbonate plastic substrate, a thin reflective metal coating, and a protective outer coating. However, in a CD-R, a layer of organic polymer dye between the polycarbonate and metal layers serves as the recording medium. The composition of the dye is permanently transformed by exposure to a specific frequency of light. Some CD-Rs have an additional protective layer to make them less vulnerable to damage from scratches, since the data - unlike that on a regular CD - is closer to the label side of the disk. A pregrooved spiral track helps to guide the laser for recording data, which is encoded from the inside to the outside of the disc in a single continuous spiral. The laser creates marks in the dye layer that mimic the reflective properties of the *pits* and *lands* (lower and higher areas) of the traditional CD. The distinct differences in the way the areas reflect light register as binary data that is then unencoded for playback.

CD-R disks usually hold the standard 74 minutes (650MB) of data, although some can hold up to 80 minutes (700MB). With [packet writing](#) software and a compatible CD-R or CD-RW drive, it is possible to save data to a CD-R in the same way as one can save it to a floppy disk, although - since each part of the disc can only be written once - it is not possible to delete files and then reuse the space. The rewriteable CDs, CD-RWs, use an alloy layer (instead of the dye layer) which can be transformed to and from a crystalline state repeatedly.

## CD-RW

CD-RW (for *Compact Disk, rewriteable*) is a CD format that allows repeated recording on a disk. The CD-RW format was introduced by Hewlett-Packard, Mitsubishi, Philips, Ricoh, and Sony, in a 1997. CD-RW drives can write both CD-R and CD-RW disks and can read any type of CD.

CD-RW disks usually hold 74 minutes (650MB) of data, although some can hold up to 80 minutes (700MB) and, according to some reports, can be rewritten as many as 1000 times. With packet writing software and a compatible CD-RW drive, it is possible to save data to a CD-RW in the same way as one can save it to a floppy disk. For a CD to record correctly, it is crucial for a steady data stream to be created. Typically, the drives have a 2MB cache, used as a [buffer](#). If the buffer runs out of data during the writing process, the CD produced will be unusable.

## DVD (Digital Versatile Disk)

DVD is a relatively new optical disc technology that uses denser recording techniques in addition to layering and two-sided manufacturing to achieve very large disc capacities. DVDs can hold video, audio and computer data. DVD drives are also able to read CD-ROMs. The original purpose of DVD was to hold video data in particular - DVD once was said to stand for *Digital Video Disk*. However, as the number of DVD applications grew, the variety of data that can be stored on DVD was reflected in its present name, Digital Versatile disc (although some claim that it should be referred to only by the three letters, DVD).

Also a 4.7 inch diameter (120 mm) by .05 inch (1.2mm) thick disk, the DVD stores data on a spiral track like the CD. The wave length of the laser beam used to read the DVD disc is shorter than that used for standard CDs. The DVD disc is created with shallower and smaller indentions, thereby enabling greater storage capacity.

In addition, there are more tracks per disc on DVDs, because they are placed closer together than on CDs. The track pitch has been reduced to 0.74 microns. This is less than half that of CDs, which is 1.6 microns. Data pits are considerably smaller, which allows a greater number per track than on CDs. The average DVD disc holds 4 times the number of data pits that can be held by a CD. The average capacity of a single-sided, single-layered disc is 4.7 gigabytes. DVD has also increased the efficiency of the data structure on the disk. In the 1970s, when CDs were first developed, considerable error correction was necessary to ensure that the disc would play correctly. More bits were being used for error detection and correction, which limited the disk's capacity to carry user data. DVD's more efficient error correction code (ECC) allows increased capacity for user data.

The larger number of data pits on a DVD is accomplished by shortening the wavelength of the laser used to create the pits. The wavelength was reduced from 780nm (nanometers), infrared light, for the CD, to 635nm to 650nm, red light, for the DVD. *Synchronization* ensures that both audio and video portions of the DVD are presented to the user simultaneously (at the same time), an important aspect of digital movie playback architecture.

## Double-Layered DVD Disks

DVD disks can also be constructed with two layers. On a double-layered disk, each data layer is half as thick as that used in the CD-ROM. Data can, therefore, be written in two layers. The outer layer is semi transparent to allow reading of the underlying silver layer. The reading laser operates at two different intensities, the stronger one reads the inner, silver layer. This increases the storage capacity to 8.5 Gb of data and eliminates the necessity of removing and flipping the disk.

An additional feature that improves efficiency is the dual-directional readability of the second data layer. Unlike standard-density CD-ROMs, which can only be read from the innermost part of the spiral track to the outermost part, the second layer of the double-layered DVD can be written to and read from either direction. This results in faster transitions by the reading laser. It can actually take less time for the reading laser to refocus to retrieve data from a different layer on a DVD than it does for the laser to relocate and retrieve data from a different part of the same layer on a CD-ROM.

An extension of the double-layered disc is the double-sided DVD disk. To enable the refocusing of the read laser, manufacturers have constructed DVD disks with a thinner plastic substrate than that used on a CD-ROM disk. This reduces the distance that the laser must travel to reach the data pits. The resulting disks were only 0.6mm thick, too thin to remain flat and withstand handling. Two disks were then bonded back-to-back resulting in a thickness of 1.2mm, a manageable thickness. This virtually doubled the disc capacity.

### **DVD Versions and Storage Capacity - Unlike standard CDs, DVD disks have varying storage capacities, expressed as a numeral**

DVD VERSION	Description & Storage Capacity
<b>DVD-5</b>	Single-sided, single-layered disc with 4.7Gb capacity
DVD-9	<b>Single-sided, double-layered with 8.5Gb capacity</b>
DVD-10	<b>Double-sided, single-layered disc with 9.4Gb capacity</b>
DVD-18	<b>Double-sided, double-layered disc with 17Gb capacity</b>

## DVD Regional Codes

In an effort to control the home release of movies in different countries, motion picture studios have devised a method to prevent playback of certain disks in certain geographical regions. Since theatre releases are not simultaneous, and because studios sell distribution rights to foreign distributors and would like to guarantee exclusive markets, pressure was brought to bear on the writers of the DVD standard. The standard now includes codes that can be used in playback devices to ensure that only disks purchased in the same geographical areas as the players will function properly.

Regional codes are entirely optional for disc manufacturers, however. disks without codes will play on any player regardless of its origin. One byte of information holding the regional code can be checked by the player. There is no encryption involved, but regional codes are a permanent part of the disc with no unlocking mechanism included. Although manufacturers originally planned to code only new releases, most DVD disks today are geographically coded.

## The DVD Forum

1. The DVD Forum is an international organization made up of companies using or manufacturing DVD - related products. The Forum, which was originally called the DVD Consortium, was created in 1995 when ten companies (Hitachi, Matsushita, Mitsubishi, Philips, Pioneer, Sony, Thomson Multimedia, Time Warner, Toshiba Corporation, and Victor) joined for the common purpose of promoting DVD worldwide, establishing single formats of each DVD application for the marketplace, and addressing the issues threatening DVD acceptance, such as standardization and device compatibility issues. From ten founding members, the DVD Forum membership has grown to include some 230 companies worldwide.

Digital Versatile disc - Read Only Memory (DVD-ROM) is a DVD format with technology similar to the familiar DVD video disk, but with a more computer-friendly file structure. The DVD-ROM format was designed to store the same type of computer data typical of a CD-ROM, and is intended for use in DVD-ROM drives in a personal computer. DVD-ROMs have seven times the storage capacity of CD-ROMs.

DVD-ROM is sometimes described as a "bigger bit bucket," meaning that it is a larger storage space, and one that can be filled with whatever the user chooses, such as video, music, or computer-specific data. A DVD-ROM drive is similar to the [CD-ROM](#) drive, but with enhanced optical engineering that enables it to read the greater data load. DVDs, although the same size as CDs, have varying storage capacities of up to 17GB (this is a format called DVD-18), compared with the standard CD's approximate (and unvarying) capacity of 750MB. DVDs increase the numbers of pits and lands (lower and higher areas on the disc that are read by the laser and recorded as binary data) by decreasing both the size of the pits and the track pitch (space between tracks). In order to read the data from the smaller pits, the laser wavelength used by DVD-ROM drives was also reduced significantly.

DVD-ROM drives have a base speed of 1.32 megabytes/second; specific drive speeds are expressed as multiples of base, in the same way that CD-ROM drives are. DVD-ROM drives are [backward compatible](#), and can read CD-ROMs, usually at speeds comparable to a 24X or 32X CD-ROM drive. The DVD-ROM drive - which is being manufactured by most makers of CD-ROM drives - is expected to replace the CD-ROM in the near future.

## DVD-RAM

Digital Versatile disc - Random Access Memory (DVD-RAM) is an adaptation of DVD-ROM that uses magneto-optical technology to record data, both on the grooves and the lands (flat areas) of the disk. DVD-RAM , were released by the DVD Forum in 1998. Like most DVD formats, DVD-RAM can contain any type of information, such as video, text, audio, and computer data; however, at 2.6 gigabytes, the storage capacity is much lower than the other types of DVD. Single-sided DVD-RAM disks can be read by DVD-ROM drives, but double-sided DVD-RAM disks are not compatible with most DVD-ROM drives. Hitachi's DVD-RAM drive was introduced in 1998. The Hitachi drive could record and play single and double-sided DVD-RAM disks and could play CD-ROM, CD-R, CD-RW, and audio CDs .

## DVD-Audio

DVD-Audio (DVD-A) is a DVD format developed by Panasonic. The DVD Forum released the final DVD-A specification in March of 1999. The new DVD format is said to provide at least twice the sound quality of audio CD on disks that can contain up to seven times as much information. Various types of DVD-A-compatible DVD players are being manufactured, in addition to the DVD-A players specifically developed for the format.

Almost all of the space on a DVD video disc is devoted to containing video data. As a consequence, the space allotted to audio data, such as a Dolby Digital 5.1 soundtrack, is severely limited. A lossy compression technique - so-called because some of the data is lost - is used to enable audio information to be stored in the available space, both on standard CDs and DVD-Video disks. In addition to using lossless compression methods, DVD-A also provides more complexity of sound by increasing the sampling rate and the frequency range beyond what is possible for the space limitations of CDs and DVD-Video. DVD-Audio is 24-bit, with a sampling rate of 96kHz; in comparison, DVD-Video soundtrack is 16-bit, with a sampling rate of 48kHz, and standard audio CD is 16-bit, with a sampling rate of 44.1kHz.

## **DVD-R**

**Digital Versatile disc - Recordable (DVD-R) is a type of *write once, read many* (WORM) DVD format that allows the user to record a single time on a DVD disk. DVD-R specifications, were released by the DVD Forum in 1997. Similarly to CD-R, DVD-R can contain any type of information, such as video, text, audio, and computer data, for example. DVD-R disks can be played on any type of DVD playback device that can handle the type of information stored, such as a DVD-ROM drive, or a DVD video player. DVD-R disks are read at the same speeds as commercially made DVDs.**

DVD-R recording, like CD-R recording, is enabled by the use of a layer of organic dye that is permanently changed by exposure to a finely focused laser beam. The dye layer is coated onto the DVD's base layer, a polycarbonate plastic substrate (the base layer of all CDs and DVDs), which is injection molded, and has a pre-grooved spiral track on its surface to guide the laser. To increase the storage capacity of DVDs, both the wavelength and aperture size of the laser are decreased so that smaller pits (the areas read by the laser to obtain binary data) can be created - reading the disc also requires the same changes. Once the data has been written, the dye layer is coated with a thin, reflective metal coat that will enable the laser to read data from the differences in the way pits and lands reflect light. DVD-Rs can be written in a single session (called write-at-once recording) or incrementally, in a process similar to the packet writing technology used for CD-Rs.

## **DVD-RW**

Digital Versatile disc - Rewritable (DVD-RW) is a DVD format that allows the user to record and erase multiple times on a single DVD disk. DVD-RW specifications were released as Book F in 1999 by the DVD Forum.

A slightly different rewritable DVD format, DVD+RW is backed by a group of companies known as the DVD+RW Consortium, made up of Philips, Sony, Hewlett-Packard, Mitsubishi Chemical, Yamaha, and Ricoh.

Similarly to CD-RW and DVD-R, DVD-RW can contain any type of information, such as video, text, audio, and computer data, for example. DVD-RW disks can be played on any type of DVD playback device that can handle the type of information stored, such as a DVD-ROM drive, or a

DVD video player. Like DVD-R, DVD-RW disks can hold up to 9.4 gigabytes of data, compared to the 650 megabyte capacity of the CD.

DVD-RW recording is similar to CD-RW recording, just as the one-time recording format, DVD-R, has a similar process to that of CD-R. The basic structure of all CDs and DVDs - a polycarbonate substrate, a thin, reflective metal layer, and a protective outer layer - is the same. In the case of the one-time recording formats, an organic dye layer (which is permanently changed by exposure to a finely focused laser) serves as the recording medium. In a DVD-RW, the dye layer is replaced with an alloy that can change back and forth from a crystalline form when exposed to a particular light, through a technology called phase change. The patterns created are less distinct than those of other CD formats, requiring a more sensitive device for playback.

Similarly to DVD-R, the DVD-RW's polycarbonate substrate is preformed with a spiral groove to guide the laser. The alloy phase-change recording layer is sandwiched between two dielectric layers that draw excess heat from the recording layer. After heating to one particular temperature, the alloy will become crystalline when it is cooled; after heating to a higher temperature it will become amorphous (won't hold its shape) when it is cooled. By controlling the temperature of the laser, crystalline areas and non-crystalline areas are formed. The crystalline areas will reflect the laser, while the other areas will absorb it. The differences will register as binary data that can be unencoded for playback. To erase or write over recorded data, the higher temperature laser is used, which results in the non-crystalline form, which can then be reformed by the lower temperature laser.

### **TYPES OF CD'S AND DIGITAL VERSATILE DISK ( DVD'S)**

CD-DA	COMPACT DISK-DIGITAL AUDIO
CD-ROM	(READ-ONLY-MEMORY)
CD-ROM TYPES	CD-ROM STORAGE OF COMPUTER DATA CD-ROM STORAGE FOR COMPRESSED AUDIO OR VIDEO/GRAPHIC DATA
CD-R TYPE AND WRITE ONCE - CD'S FOR AUDIO/VIDEO	CD'S FOR COMPUTER DATA
CD-RW	REWRITEABLE
CD-ROM XA	EXTENDED ARCHITECTURE
CD-i	USED IN EDUCATIONA SYSTEM
BRIDGE DISK	THREE BRIDGE DISC FORMATS
ENCHANCED CD	USED BY RECORDING ARTISTS
CD-MO (MAGNETO-OPTICAL)	USE MAGNETIC FIELD TO STORE DATA

MULTISESSION CD	DATA CAN BE ADDED AT DIFFERENT TIMES
SUPER AUDIO CD (SACD)	HIGH RESOLUTION AUDIO CD FORMAT
DOUBLE DENSITY CD (DDCD)	INCREASE STORAGE CAPACITY OF CD
DOUBLE -LAYERED DVD DISKS	DATA CAN BE CONSTRUCTED ON TWO LAYERS
DVD-ROM	READ ONLY MEMORY
DVD-RAM	DIGITAL VERSATILE DISK HOLDS ALL TYPES OF DATA
DVD-AUDIO	AUDIO DATA
DVD-R	WRITE ONCE AND READ
DVD-RW	RECORD AND ERASE MULTIPLE TIMES