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Overview of Compact Disc Standards, Including CD-ROM, CD Write Once, and Photo CD

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"CD-ROM Standards" was to be the title of this discussion and would have made this hour an easy one. At the end of a detailed explanation regarding just CD-ROM the reasons why certain discs will not play in certain CD players would still remain unclear.

We must take on the whole family of CDs and see how they relate to each other and then we will have discovered why they are not interchangeable.

Of course, no one in this room has had trouble playing a disc. After all, if they fit in the player, they should work. Right?

When Philips and Sony began in 1982 with the digital audio musical disc and players they detailed the standards and were given proprietary licenses in a red covered book.

The Red Book standard covers the CD-DA audio disc which is the first of several standards and the one the rest are patterned after.

The Yellow Book followed in 1983 when the same people announced a modification that would allow for the storage of information along with or instead of music. CD-ROM read only memory had emerged.

The Orange Book and Green Book have since emerged as standards that go beyond the Yellow Book standards.

Slide 1 A quick review of the many different types of CDs will help us get started. Then, we will relate these different types of discs to the various standards.

The CD-DA or audio disc is the first and it is the one that plays the music. This is digital audio for the consumer. No more LP albums needed.

The CD-ROM is the data storage disc with read only memory and is the one disc related in every way to the ISO standards. Compliance with these standards insures that the disc will play on players made to meet the standard.

CD-ROM HFS is made to play on MAC platforms and is not standardized.

CD-ROM/XA is based on the CD-ROM standards but has gone beyond the original technology and is not an ISO standard.

CD-I is Philips Motion Video.

CD-I Ready is an audio disc with features for CD-I player

CD-WO is a write-once disc used for writing multiple sessions until a disc is full.

Photo CD is compressed images using the XA technology to permit Kodak to write photos to a CD disc

CDTV is a disc that only plays on a Commodore system.

(The only ISO standard CD is a CD-ROM, other standards are not ISO)

Slide 2 There are 3 types of track layouts for CD disc, the Red Book and the Yellow Book are both ISO standard 10149.

The Orange Book standard is not yet an ISO standard but is very much in use because of Photo CD and multimedia CDs using this track layout.

The Red Book has a Lead-in and TOC followed by music tracks and finishing with a Lead-out.

The Yellow Book can be a Mode 1 for recording data in 9660 format, or Mode 2 for recording sound, images, and video. The Lead-in and TOC followed by the Lead-out are present here only one time.

Orange Book includes the Write Once, Multisession and can write Red, Yellow, and Green Book data. Notice the Lead-in followed by data and a Lead-out can be repeated many times.

Slide 3 The Red Book Audio Track Layout is the basis for the technology and remains a good place to learn about CDs.

Data written to a track is in increments called sectors. Each sector is a small container of bytes of data.

Sectors are read by the player at the rate of 75 per second. The disc can hold 74 minutes of sectors or 333,000 sectors.

To read the disc in proper timing, the speed of the spinning disc must change from 500 rpms at the center to 200 rpms at the outer edge.

Mixed Mode tracks are found to contain a Lead-in and TOC followed by several data types or just one structure of data written to the 9660 standard and a Lead-out. Mixed Mode complies with the Yellow Book standard.

Slide 4 Slide 5 The Orange Book Track Layout is used for the more exciting products in the CD family. All recordables, multisession, Photo-CD, music, and mixed mode data can be written to this kind of disc.

After looking at the three basic tracks found on a CD it is time to look at how the data is broken down to small containers called sectors of data.

Once again, we begin with the first CD: the Red Book audio structure. Each disc can contain up to 99 tracks. Each track will contain data in increments called sectors of 2352 bytes of data. A CD disc can contain up to 330,000 sectors of data.

Slide 6 CD audio sectors contain only music and do not contain Error Correction and Detection schemes.

Slide 7 The sectors used for the Red Book are modified to contain data and EDC and ECC. Each change in sector construction reflects a different usage of the 2352 bytes available in each sector.

The Yellow Book standard also requires 12 bytes of sync and 4 bytes for header information.

Sync is a location address code and header is a sector name, both are required to randomly seek the sectors of data. The computer needs this data to determine which sector it is reading.

Each 2048 bytes of data written to a sector is verified when read out to assure accuracy of the data in Mode 1. Since Mode 2 contains audio, or images EDC and ECC is not used.

Slide 8 Just as the Yellow Book sector started with the original Red Book design, the Orange Book sectors are based on the Yellow Book Mode 2 structure.

CD-ROM/XA Mode 2 contains compressed audio and computer data interleaved on the same track. This permits the playback of both types of data almost simultaneously which is the defining characteristic of this type of disc.

The Orange Book standard describes a CD-ROM Mode 2, XA (extended architecture) format. The CD-ROM/XA may be written in either Form 1, or Form 2 sector structure.

Orange book sectors begin with Sync and Header bytes but have added Subheader data to the structure. This byte of information is used to specify a file number that identifies all sectors belonging to the same file and defines which type of sector it is, Form 1 or Form 2.

Form 1 sectors are primarily used to store computer data due to the EDC and ECC allocations at the end of the sector.

Form 2 sectors usually contain compressed audio, data, video, or picture data. There is no EDC and ECC coding in Form 2 which allows more room for data storage.

The Orange Book standard requires the use of the Yellow Book Mode 2 sector design as a basis for its unique sector design. Data written to these sectors can be Form 1 or Form 2 as stated above.

The Orange Book also describes the write-once recordable CD types.

Part I refers to CD-MO (magneto optical) technology which means part of the disc can be pre- mastered and part left open for recording electronically. Reading is accomplished by changes in polarization which affect the laser beam. Also, Part I can be 100 percent rewriteable. Regular CD players cannot read this disc.

Slide 9 Part II refers to a CD-WO (write once) disc. After the last recording is made, a TOC is written to the disc and a regular CD player can read the first entry recorded. If more than one recording is written to the disc, or compressed audio or video is present, a special board or a purely XA player must be used on this Hybrid disc.

Photo-CD uses this standard for its product. Specifically, Photo-CD is a Mode 2 Form 1, Orange Book Part II Hybrid disc. Photo-CD uses the CD-Bridge disc format to allow CD-I and CD- ROM/XA players to read this data structure.

Slide 10 CD-DA is an audio music disc, the original CD disc written to the Red Book Standard; it plays on a CD audio drive.

CD-ROM is a read only memory disc which follows the ISO 10149 Yellow Book Standard for physical standards, and the ISO 9660 logical standards for file structure. The standards guarantee readability if the standard drive is used for playing. Can be read on multiple platforms.

CD-ROM HFS is a Macintosh product and requires Mac hardware and is not standardized.

CDTV is a proprietary format used by Commodore requiring their hardware for playability.

CD-ROM/XA goes beyond the ISO 10149, ISO 9660 standards and is used to record interleaved data for concurrent playback. Also used by Kodak Photo-CD and other write once products.

CD-I refers to Philips interactive motion video and can be viewed using Philips players and a TV screen.

CD-MO is a magneto optical technology that allows for a rewriteable area on a CD-ROM/XA. If the disc has a premastered area this area can be read on any player.

CD-WO a disc containing one or many recording sessions. Standard CD players can only read the first session but with additional software can be made to read all sessions. Regular WO discs can be read on standard player; Hybrid WO must use an XA player or have the software mentioned above.

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CD-ROM is the only completely standard product.

ISO 10149 describes the size of the disc, refers to the Yellow Book for track structure and sector structure and guarantees readability.

ISO 9660 is the logical file structure standard and further guarantees readability by assuring read/write compatibility between data on disc and software designed to read the standard. .Directories are assembled beginning with a Primary Volume Descriptor found in logical sector 16. This file points to a path table file which contains directions to all subdirectories contained in the next 7 levels of directories.

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The information for this lecture was taken from the above mentioned organizations and Multimedia, Making It Work by Tay Vaughn; CD-ROM, Facilitating Electronic Publishing by Linda W. Helgerson. The SIGCAT Foundation in Reston, VA also contributed to this study.