Disc Manufacturing, Inc.
A QUIXOTE COMPANY

More than CD ...

Enhanced CD Formats

Misty Roohi

WHO IS DMI?

Disc Manufacturing, Inc. (DMI) manufactures all compact disc formats (i.e., CD-Audio, CD-ROM, CD-ROM XA, CDI, PHOTO CD, 3DO, KARAOKE, etc.) at two plant sites in the U.S.; Huntsville, AL, and Anaheim, CA. To help you, DMI has one of the largest Technical Support staff and sales force dedicated solely to CD-ROM in the industry.

The company has had a long term commitment to optical disc technology and has performed developmental work and manufactured (laser) optical discs of various types since 1981. In 1983, DMI manufactured the first compact disc in the United States. DMI has developed extensive mastering expertise during this time and is frequently called upon by other companies to provide special mastering services for products in development.

In August 1991, DMI purchased the U.S. CD-ROM business from the Philips and Du Pont Optical Company (PDO). PDO employees in sales, marketing and technical services were retained.

DMI is a wholly-owned subsidiary of Quixote Corporation, a publicly owned corporation whose stock is traded on the NASDAQ exchange as QUIX. Quixote is a diversified technology company composed of Energy Absorption Systems, Inc. (manufactures highway crash cushions), Stenograph Corporation (manufactures shorthand machines and computer systems for court reporting) and Disc Manufacturing, Inc.

We would be pleased to help you with your CD project or answer any questions you may have. Please give us a call at 1-800-433-DISC for pricing or further information.

We have five additional technical papers available entitled

Integrating Mixed-Mode CD-ROM
An Overview to MultiMedia CD-ROM Production
Compact Disc Terminology - 2nd Edition
A Glossary of CD and CD-ROM Terms
Introduction to ISO 9660

These are available upon request
800-433-DISC
http://www.discmfg.com

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Introduction

Since it's introduction in the early 1980's, the compact disc has become the chosen format for millions of music listeners. Due to it's digital recording, the fidelity produced is of the highest quality and the disc itself is near indestructible. The same technology makes the CD an attractive medium for transporting other types of digital information. Not only are compact discs extremely reliable but large quantities can be reproduced quickly and inexpensively.

Because of the phenomenal growth of CDs and technology as a whole, new CD formats are being defined and adopted very quickly. The basic CD standards and principles are defined in the Red Book (audio), Yellow Book (CD ROM), Orange Book (CD-R), and Green Book (CD-I). All other technologies, whether an official standard or not, are derived from the principles defined in these original industry books.

Most new formats are being introduced as a "multi-media" solution. Multimedia is simply a blend of media types: audio, text, graphics, and/or video that is being delivered all on one medium. Multimedia is important because it allows us for the first time a chance to mix what was previously viewed as separate and distinct media. Information can be combined from various sources: books, films, periodicals, LPs, cassettes, computer software, etc. Record companies can now produce CDs that not only contain audio recordings, but can also include animation, graphics, text, and video that further complements the artistic expression and adds additional value for the consumer. The consumer may choose to use all in combination or only a chosen part. It is from this direction that the proposed or newly standardized formats discussed in this paper originate. There are many variables and considerations in introducing a new CD format, i.e., hardware (players), software, market demand, etc.. This paper attempts to discuss various new and current formats that are the latest in CD technology, with the advantages, disadvantages and the requirements of each.

The Old Fashioned "Mixed Mode" CD

A Mixed Mode CD (see Diagram A, Appendix A) is basically a CD that contains more than one mode or format. Typically, the Mixed Mode format contains ROM data in track 1, and is followed by up to 98 audio tracks. A ROM drive is required to play the ROM track and appropriate software drivers are required to play audio on the ROM drive. Audio players are capable of playing the audio tracks and depending on the hardware may or may not mute the ROM track when it is attempting to play.

Advantages

The audio tracks are playable on an audio player. The ROM track is fully compatible with ROM drives. The audio portion may be played on ROM drives as well with the appropriate software (see also Disadvantages).

Disadvantages
When the ROM track (track 1) is played on a non-muting audio player, full volume static is heard which can be damaging to audio equipment. To prevent this, you must immediately skip to track 2 which starts the audio tracks.

Hidden Track (aka I-Track, ROM Ready, Audiovision™)
This is a relatively new, "home grown" format that was developed to compensate for the non-muting audio players that play a ROM track as full static. Because most developers, especially those from the music industry, see non-muting as a serious liability for their product, new solutions are being developed to compensate that may or may not be represented in the industry standards. The Hidden Track formatted disc (see Diagram B, Appendix A) is designed to play in a ROM or audio player. The ROM data is contained in Track 1, index 0 and the audio tracks begin at Track 1, index 1. Most audio players initialize at Track 1, index 1, so the ROM track is "hidden" to the consumer. ROM drives, with the appropriate software drivers, can read the ROM track from index 0 of track 1.

Advantages
Audio players will play the audio tracks. Most non-muting audio players will not play the ROM data as full static. The ROM track can be played on most Mac and MPC (PC) systems with the appropriate software drivers.

Disadvantages
Most Macs do not need additional software to read this format but a lot of MPC (PC) systems may need software driver upgrades. This format is not defined in the industry standards but preliminary "Voluntary Specifications" have been made by the RIAA (Recording Industry Association of America). Another disadvantage is that on some audio systems, the consumer may rewind or back up into the ROM data, thus introducing the opportunity to play the full static if their player does not have muting capability.

Enhanced Audio Product (aka Selectware)
This is another home grown format designed to eliminate the liability presented by non-muting audio players. In this non-standard format, an audio warning is inserted into the ROM data track warning users to "advance to track 2 to avoid playing full static" (see Diagram C, Appendix A). This format has previously only been designed for the MPC (PC) developer following the ISO 9660 CD ROM file structure.

Advantages
There is an audible warning alerting consumers to advance to track 2 or they will experience hearing full volume static in a very short period of time. With the appropriate drivers, most PCs can read the ROM track. Tracks 2 - 99 can contain audio tracks that are playable on audio players.

Disadvantages
The only tested structure for this format has been ISO 9660; currently this would not be an option for Macintosh developers. There may be some configurations or software drivers not capable of reading this format. There is a fraction of a second of full volume static before the audio warning is heard. If the consumer chooses not to advance to the next track, then they will hear full volume static. This format is not defined in the industry standards.

CD+ (aka Stamped Multisession, CD Extra)
CD+ is the newly defined format that solves the "track 1" problem for music industry products. Record companies can release music CDs that also contain interactive data for the consumers who own personal computers. This added value offers artists the opportunity to express themselves beyond the content of today's audio CDs. CD+ is the Sony/Philips industry proposed standard that is defined in the Blue Book and supported by Microsoft. Because all audio is contained in session 1 and ROM data in session 2, the ROM data is not available to be played on audio players (see Diagram D, Appendix A). Audio players only see what is in session 1, thus solving the problem of playing static on some audio players. Multisession hardware and software would be capable of playing the ROM data. Currently, software drivers are being developed by Microsoft and others, and once available, CD+ could become a dominant format for creating enhanced CDs.

Advantages
Audio players will not be capable of playing the ROM data so the problem with the full static playing is not an issue. Multisession capable hardware and software will be able to play the ROM track when it is fully available. Audio players will play the audio tracks.

Disadvantages
Software drivers are not currently fully available. Some older hardware may not be multisession capable and will not see beyond the first session.

CD-I Ready
Compact Disc Interactive (CD-I) is a proprietary format developed by Philips for consumer use on CD-I players. The CD-I format (see Diagram E, Appendix A) is defined in the industry standard Green Book. CD-I players connect to your television set in a manner closely resembling the connection of a VCR (Video Cassette Recorder). CD-I applications vary but include developed titles for education, training, video, games, and other areas of interest where you need to present video, graphics, text and audio to a consumer audience having access to a TV and CD-I player. You must obtain appropriate authoring software if you wish to build a CD-I disc.

CD-I Ready is a combination of a couple of other formats already mentioned in this paper. The CD-I Ready disc is composed of a CD-I track residing in Track 1, index 0 followed by up to 98 audio tracks beginning in Track 1, index 1. The purpose of this disc is to add additional value by being able to market the disc as a CD-I as well as an audio disc. Because the CD-I data track is in index 0 of track 1, most non-muting audio players will not attempt to play the data track.

Advantages
You can market the disc to more than one audience. The audio tracks will play in any audio player. The CD-I data track will not play on most non-muting audio players.

Disadvantages
This disc will only play on CD-I players and audio players. Some consumer audio players can rewind or back up into the CD-I data contained in index 0 of track 1 and possibly play the full static.

CD+G (CD + Graphics)
This is a standard audio disc that contains a limited amount of graphics in defined subcode channels. This disc works in all audio players but the graphics portion is only available in a special CD+G or Karaoke player.

Advantages
A CD+G CD can be sold as a basic audio CD with the added features of having displayable graphics that can be viewed with the appropriate equipment.

Disadvantages
CD+G graphics can only be viewed with a CD+G compatible player. A CD+G disc must be created with special authoring software. Only a very small amount of data can be stored as graphics in the appropriate subcode channels.

Conclusion
As you may now conclude, the basic Compact Disc format developed by Philips and Sony allows for tremendous variation, thus creating opportunity to use this durable and versatile medium for innumerable uses. Whatever your Compact Disc application, there are format choices currently available and more are being developed. As the industry adopts new formats and new standards are created, some formats will become dominant on the market while others have only limited value.

As the largest independent Compact Disc manufacturer in North America, Disc Manufacturing, Inc. leads the industry in cutting edge optical technology. As new formats are developed, DMI provides technical expertise in all aspects of the Compact Disc manufacturing processes to our customers. Disc Manufacturing, Inc.'s Vision Statement reads "Customer Satisfaction is Priority One" and one of the ways we manifest this is by our committment to provide unsurpassed technical service. DMI's two manufacturing plants, Anaheim, CA and Hunstville, AL have a combined capacity of over 200 million CDs per year.

Additional reference material can be found in DMI's Compact Disc Terminology paper. Copies of this paper and others are available on Compuserve as well as DMI's Web Site (addresses listed below). Please feel free to contact us with any question that you may have. We look forward to working with you on your next CD project!

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Appendix A: Compact Disc Layouts

Diagram A. - Mixed Mode Layout

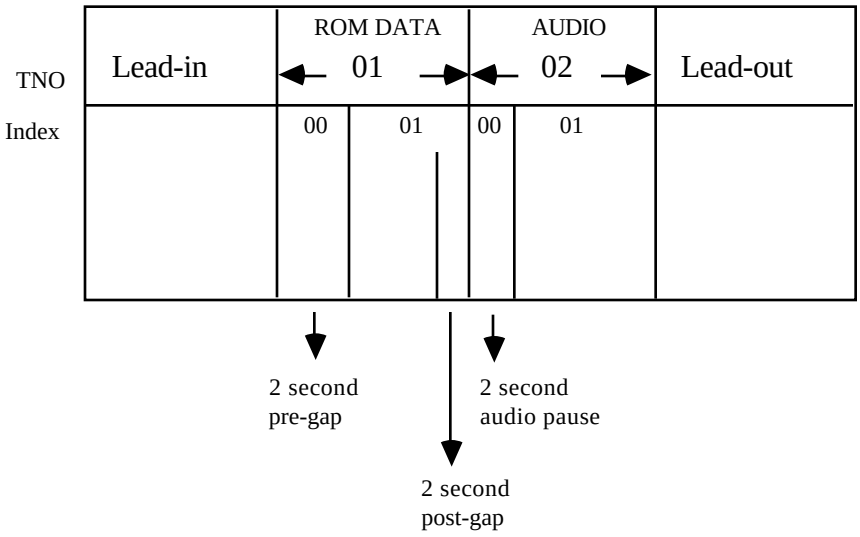


Diagram B. Hidden Track Layout

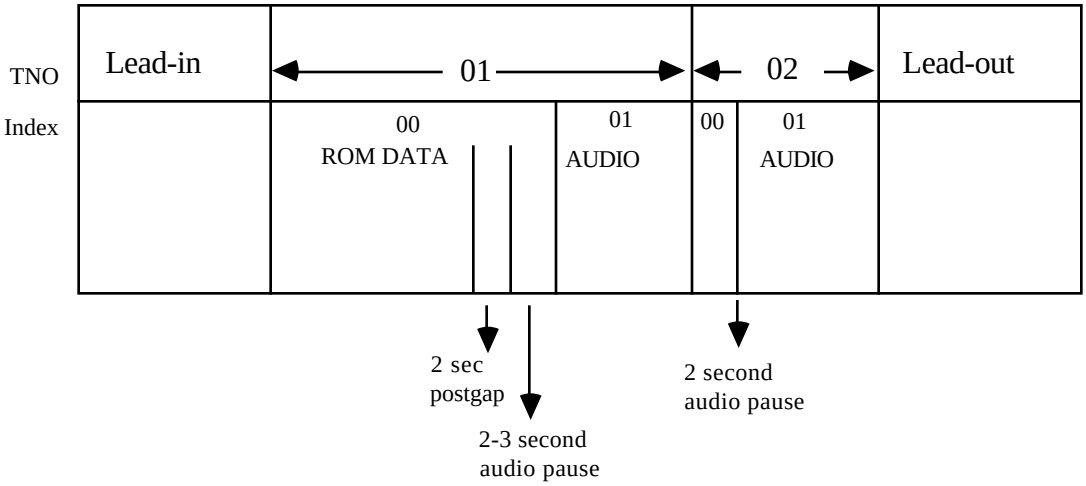


Diagram C. Enhanced Audio Product Layout

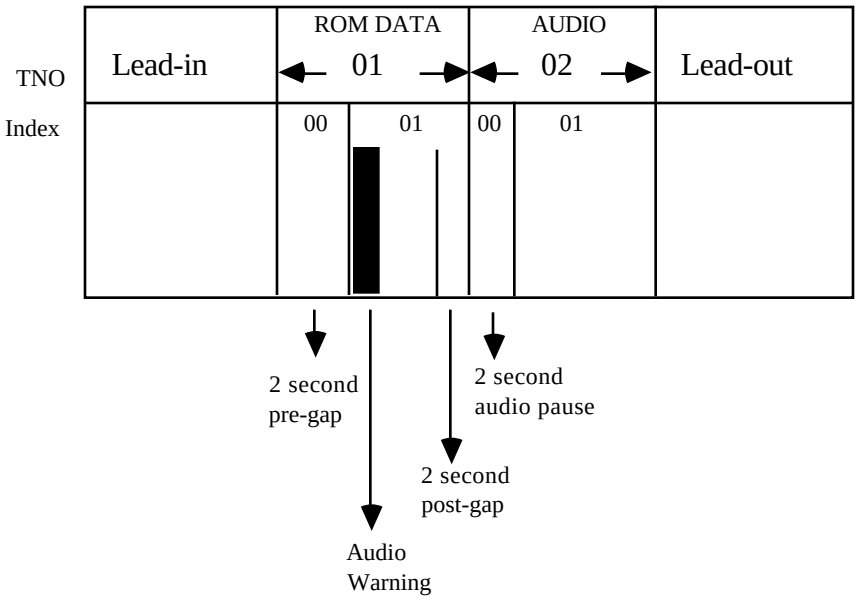


Diagram D. Multisession & "CD+" Layout
** Only two (2) sessions are shown in this example **

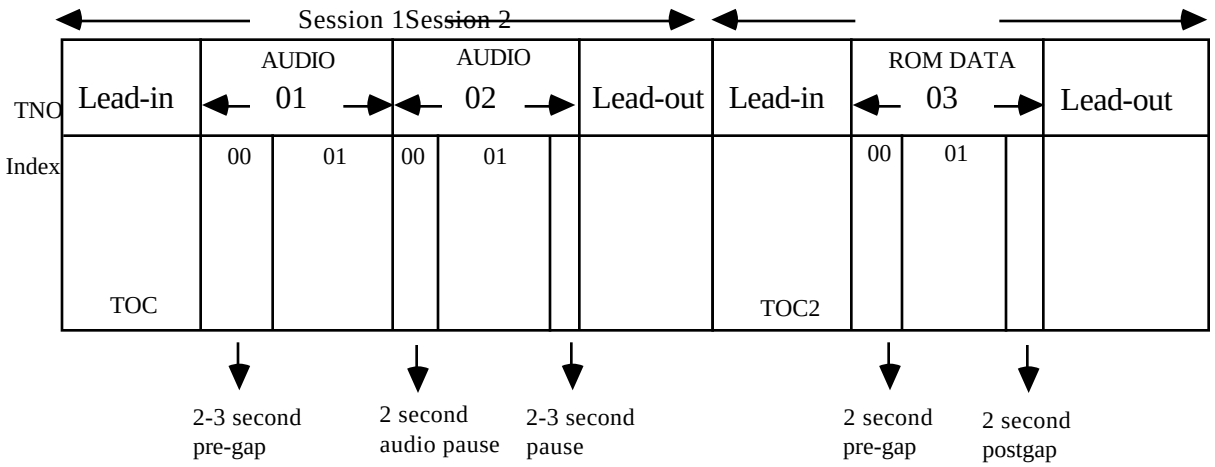
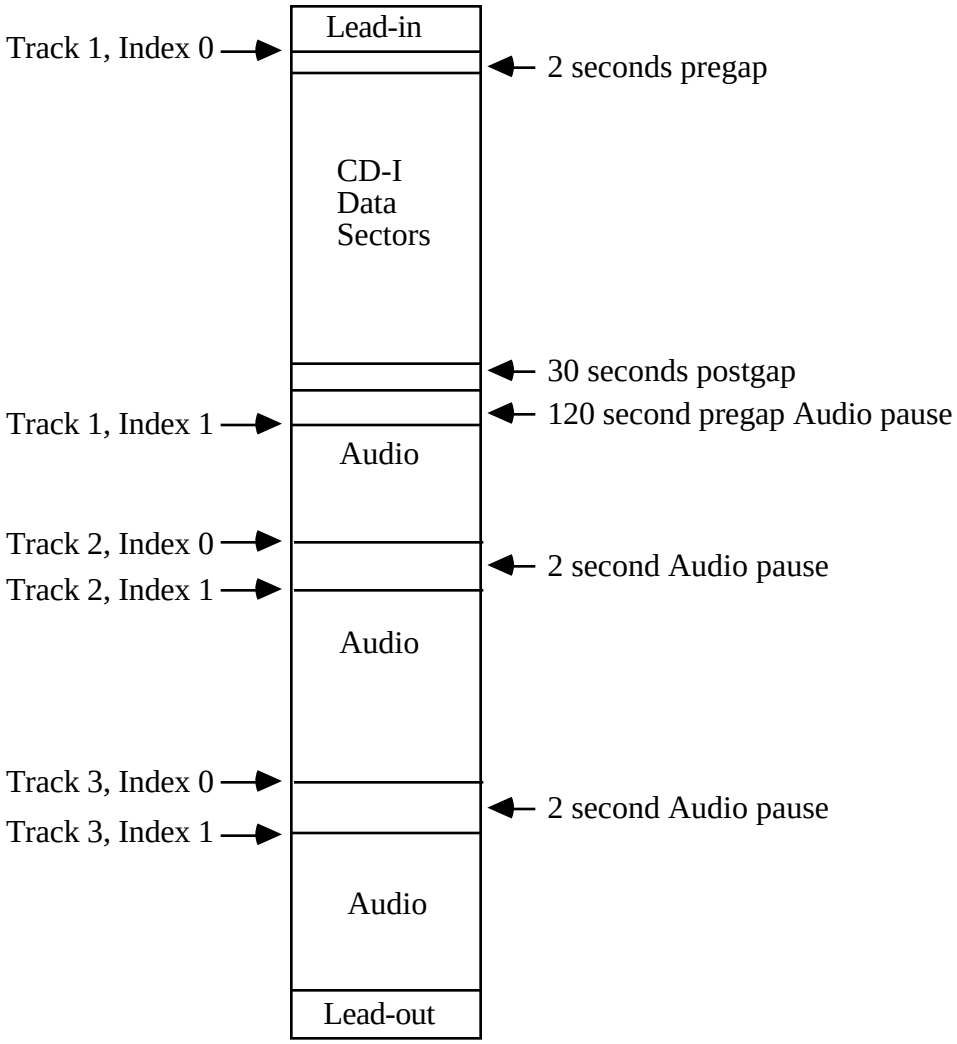


Diagram E. CD-I Ready Disc Layout



Appendix B.

Enhanced CD Formats

Enhanced Format	Audio	CD ROM	Mac/MPC	Comments	DMI
Mixed Mode	Audio starts at Track 2, non-muting audio players will play track 1 as static	ROM data is in track 1	Most Macs and MPCs can read ROM data	There is potential for playing full volume static if non-muting audio player attempts to play track 1 (ROM track).	DMI can manufacture
Hidden Track (a.k.a. I-Track, ROM Ready, Audiovision™)	Works in all audio players, audio starts at Track 1, index 1	ROM data is in Track 1, index 0	Most Macs play, MPCs may need software upgrade	Non-muting audio players will not play ROM track, possible need for additional software drivers for MPCs may limit the format	DMI can manufacture
Enhanced Audio Product (a.k.a. Select-ware)	Audio tracks begin with Track 2	ROM data is in track 1 and contains audio warning	Currently unavailable for Mac, some MPCs may require additional software	Less than 1 second of static is heard on non-muting audio players, then an audible warning is made requesting that the user advance to the next track. Possibility of full volume static. Format is not available for the Mac.	DMI can manufacture
CD+ (a.k.a. Stamped Multisession)	Works on all audio players	ROM data is in 2nd session	Macs and MPCs require multisession capability	Multisession hardware and software must be available, software currently being developed. When complete, this could become the dominant format. No possibility of playing static on non-muting audio player.	DMI can manufacture
CD-I Ready	Works on all audio players	CD-I data is in Track 1, index 0	Macs/MPCs can play audio only (with appropriate software)	Proprietary format - requires CD-I player to play CD-I data. CD-I format typically used for consumer markets geared towards training, entertainment, kiosks, etc. CD-I player connects to a television much like a VCR. CD-I requires special authoring software.	DMI can manufacture
CD+G	Works on all audio players	ROM data is in subcode.	Macs/MPCs can play audio only (with appropriate software)	CD+G requires special players and are used for applications such as Karaoke. Limited graphics data can be stored in the subcode channels. Requires special authoring software.	DMI can manufacture