Super Video Compact Disc
A Technical Explanation

MPEG2 on
COMPACT DISC

There is a market need for a standardized full digital Compact Disc based video reproduction system.

The Super Video-CD standard upgrades the current Video-CD format. It utilizes better Video and Audio Quality. It also standard includes extensions for surround sound multi-channel audio, provisions for PC playback, and is prepared for further future improvements. It is also based on variable bit rate (VBR) MPEG2 coding for more efficient use of the disc capacity.

The objective of this standards is further to ensure the best price/performance combination possible with the latest state of the art technology available, and to offer more flexibility for publishers to use the best video/ audio quality given its limited bandwidth and disc capacity.

Super Video-CD is also known as IEC 62107, however this standard is but not identical.

COMPACT disc
SUPER VIDEO

History
CD is one of the major new technological steps of this century. Beginning as a pure , high-quality sound reproduction system, it rapidly developed into a whole family of systems, with applications extending across to multimedia data storage and distribution. The CD-ROM XA format makes it possible to combine normal computer data files with real-time multimedia files offering an additional 14% capacity. The format is platform independent to allow additional CD-DA tracks (CD-Extra) and to be played on a multimedia-computer. All new formats since 1990 have been based on the XA format.

Standardisation
The purpose for a formal CD disc standard is to achieve full worldwide compatibility between Players and Discs, so that all discs can play on all players. The standard is a disc format specification, specifying the physical, optical, disc organization, data retrieval, content formats, metadata, and API's on the disc. It is an implicit player or authoring systems specification. How to implement a player is up to each manufacturer, but a customer is expecting that the player (or drive) can support at least all the mandatory disc functions and features.

For the format to become successful and accepted, it must fulfil the given market and user requirements next to the availability of attractive publishing content.

For the introduction of a new standard is needed:

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- A complete detailed specification. All essential parameters have to be well defined.
- Agreement on the specification with all involved partners and stakeholders.
- Demonstration players and discs to promote the standard.
- Authoring tools to produce demo, test, and commercial discs.

For checking the compliance and compatibility of players and discs is needed:

- A set (suite) of test discs with test each function described in the standard at least once and if achievable also the most important combinations of content and applications within the scope of the standard. These discs are used for player development and manufacturing, as well as for testing players that give problems in the market.
- A prototype test player, to play demo and test discs, and for player production development.
- A disc verifier tool to check if authoring systems and produced discs are compliant with the standard.

White Book standard

The first MPEG-1 application introduced in the world was Karaoke-CD in Japan, later followed by Digital Video on CD-i and Video-CD in USA and Europe. Today the largest Video-CD market is in China.
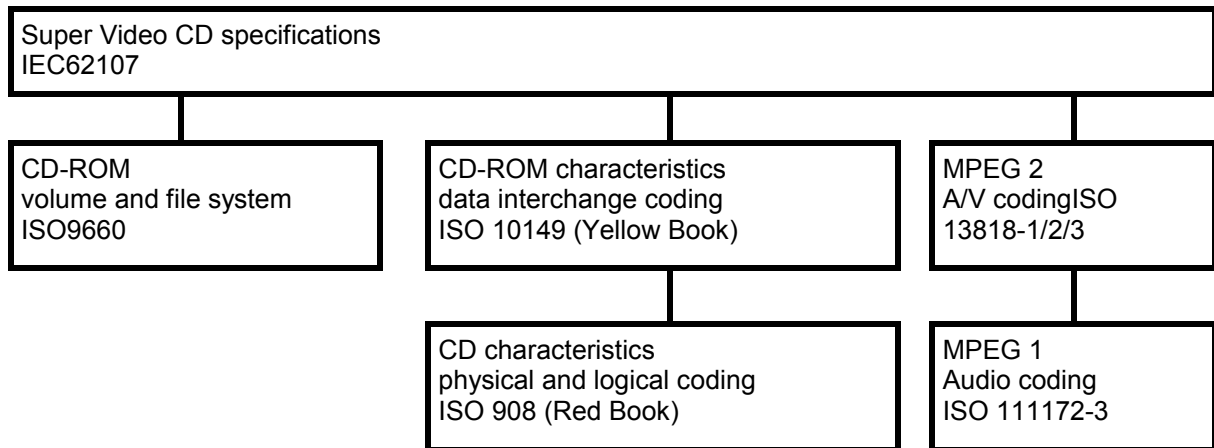
The Video-CD system adds a new dimension to the film and music video business. It offers up to 74 minutes of motion video combined with CD quality stereo sound packed onto a one 12 cm optical disc. For music video this allows for the same amount of music material as on a conventional CD-Digital Audio disc, but now also with digital video. A full length feature film up to 140 min can be offered in a standard 2 disc package. Surround sound, direct chapter access, single step and other sophisticated functions are available.

The basic features of Video-CD are; CD-DA quality audio (stereo / 2 mono), Full quality video (MPEG-1), PAL / NTSC compatible format, Playing time of 74 minutes per disc, Fast Track (and Index) access, Album support (multi disc), Multi platform standard.

The system uses the ISO MPEG-1 standard audio/video coding technology to realize the full screen full motion pictures with associated high quality audio. The MPEG-1 standard for compression and decompression of digital video data is an enabling technology that makes it possible to include full-motion video in consumer, computer and communications products for the first time. The data delivery rate for a TV studio signal, as specified by the international standard CCIR 601, is 165 Mbit/sec. For a normal CD the delivery rate is 1.4 Mbit/sec. The ingenious achievement of MPEG lies in compressing such

Disc formats		Partners	Features	User benefits
CD Digital Audio (CD-DA)	1983	Philips, Sony	2 x 16 bit PCM coded audio, 99 tracks, 72 minutes playing time	ease of use, sound quality, robust, small format, durable
CD ROM	1985	Philips, DEC	reliable 660 MB storage	ease of use, compact, fast read, multimedia files, games
CD-ROM XA based formats				
CD Interactive (CD-i)	1990	Philips, Sony, Microware	Interactive User control	Interactive TV programs, games
Photo CD	1992	Philips, Kodak	CD Recordable	archiving, TV view, zoom, desktop authoring on PC
Video CD 1.1	1993	Philips, JVC	Movies, Karaoke	smaller disc, lower cost, digital, multi-platform
Video CD 2.0	1995	Philips, Sony, Matsushita, JVC	pictures, menus, playlists	HiRes pictures, interactive playback control
Video CD-ROM	1996	Philips, Sony, Matsushita, JVC	PC / MAC program files	plays on MPC with SW MPEG decoder, no extra costs
Video CD-Internet	1997	Philips, Sony, Matsushita, JVC, Hitachi	Hybrid publishing on CD and WWW	fast access to multimedia (a/v) files
Super Video CD	1998	Philips, Sony, Matsushita, JVC	MPEG-2 video, VBR, overlay graphics	better video resolution, subtitling, multilingual

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Super Video CD specifications IEC62107		

CD-ROM volume and file system ISO9660	CD-ROM characteristics data interchange coding ISO 10149 (Yellow Book)	MPEG 2 A/V codingISO 13818-1/2/3
	CD characteristics physical and logical coding ISO 908 (Red Book)	MPEG 1 Audio coding ISO 111172-3

data rates to within CD delivery capacity.
The Video CD standard admit to use one or more tracks (sequences) and well as for entries within a track (sequences). In this context a track is an A/V sequence with one or more entry points and one exit point. This feature allows the publisher of Music video and Karaoke discs that songs can be selected individual as well as be played in a long sequences (e.g. Life concert or movie) where the user can start at a selected place and continue till the end.

Super Video CD
The target for this new Super Video CD, standard is to ensure the best price /

performance combination possible with the latest state of the art technology available, and to offer more flexibility for publishers to use the best video / audio quality given the limited disc capacity. The standard has been specified to allow for cost optimised Super Video CD players. This specification is an upgrade of the Video CD 2.0 standard utilizing better Video and Audio quality by MPEG-2 coding, as well as new Overlay Graphics functions for multi-lingual Karaoke lyrics or Movie sub-titling. It also includes extensions for surround sound multi-channel audio, more interactivity, Internet connectivity, PC playback, and is prepared for further future improvements.
It's also based on using variable bit rate (VBR)

Item	Super Video CD	Video CD 2.0
Sector rate	variable up to 150 Hz (2X speed)	fixed to 75 Hz
CDDA tracks	not used	optional
Data retrieval File locations	Fixed locations	fixed locations
CDI sub-directory	not used	mandatory
Video bit rate (mbps) resolution NTSC (HxV) resolution PAL (HxV)	MPEG-2 variable up to 2.6 480 x 480 480 x 576	MPEG-1 1.15 352 x 240 352 x 288
Still Picture resolution NTSC (HxV) resolution PAL (HxV)	MPEG-2 480 x 480, 704 x 480 480 x 576, 704 x 576	MPEG-1 352 x 240, 704 x 480 352 x 288, 704 x 576
Audio bit rate audio channels surround sound	MPEG-1, layer II from 32 to 384 kbps up to 2 stereo or 4 mono MPEG-2 (5+1) extension	MPEG-1, layer II fixed to 224 kbps 1 stereo or 2 mono stereo with Dolby pro-logic
Overlay Graphics and text sub-channels coding	overlay video plane <= 4 4 color CLUT (2 bit / pixel)	not used N/A N/A
SVCD compared with Video-CD 2.0		

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#N-1	<------	TRACK # N	------>	#N+1
	Pause	MPEG-2 Program Stream		
TOC value >				
Example of a MPEG Track:				

MPEG-2 coding for more efficient use of the disc capacity. The playing time per disc can vary from 35 minutes to more than 70 minutes depending on the average bit rate used.

The Super Video CD format is based on the CD-ROM XA disc format. Super Video CD discs can be played on, Super Video CD players, and other compliant hardware and software platforms. It may include application programs for a variety of platforms.

Improvements

Improvements of the Super Video CD standard specification compared to VIDEO CD 2.0 standard specification

Variable bitrate (VBR)

The variable bit rate (VBR) may vary up to double (2X) speed. For a 2 disc movie title of 110 minutes, the gain of the average bit rate of the MPEG video stream is typically 45%, which is used for the resolution improvement.

MPEG-2 Video

Much better picture quality is achieved by using MPEG-2 instead of MPEG-1 coding, and by interlaced double vertical resolution of 480 lines for NTSC and 576 lines for PAL.

Two Audio streams

One extra MPEG audio stream has been added for a second language. The Audio streams are selectable by the user, and VBR coding is used for a more efficient compression.

Surround Sound Multi-channel Audio

As backward compatible extension in included Movie surround sound MPEG-2 Multi-Channel (5+1 channels) coding.

Overlay Graphics

New Overlay Graphics for Movie sub-titling and Karaoke lyrics, with up to four selectable (language / lyrics) sub-channels, and Karaoke highlight colour change support.

SVCD disc structure

The Disc format is compliant with CD-ROM XA, and can be a pre-mastered disc or a CD-Recordable disc. All tracks of the Program Area are encoded as CD-ROM XA data tracks. The first track on the disc is a special DATA track with data retrieval information and interactive playback MPEG sequences. The MPEG-2 streams on disc are recorded in MPEG tracks, and are intended to be played sequentially starting from Track #2 . A Karaoke / Music application has normally one track per song. This means that song number 1 is recorded in Track #2, and song number 2 in Track #3, and so on. A Movie could have different coded parts of INTRO, COPYRIGHT, FILM, CREDITS, each stored in a separate track. The film itself can be stored in one track with the possibility to be subdivided into chapters within the one track.

DATA track format

The DATA track contains Special Information Areas, and a Segment Play Item Area intended for menus or interactive use, and other optional program data files. Data files use Mode2, Form1 (2048 byte) DATA sectors, and MPEG files use Mode2, Form2 (2324 byte) MPEG sectors.

Karaoke Basic Information Area

A Super Video CD disc can contain the Karaoke Basic Information Area as an option. The data in the Karaoke Basic Information Area provides basic information to produce a quick reference table of the Karaoke music programs on the disc.

Information Area

The Super Video CD Information Area contains the files "INFO.VCD" and "ENTRIES.VCD", "TRACKS.SVD" and "SEARCH.DAT". As an option it may contain the files "LOT.VCD" and "PSD.VCD".

Segment Play Item Area

Lead-In Area	
Track #1	SVCD DATA track
Track #2	SVCD MPEG tracks
...	
Track #nn	
Lead-Out Area	
No MPEG-1 or CD-DA tracks are allowed.	

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pre-gap	150 sectors
Unused Area	16 Empty sectors
Primary Volume Descriptor	ISO 9660
SVCD Information Area	Disc Information "INFO.VCD" Entry table "ENTRIES.VCD" List ID Offset table "LOT.VCD" Play Sequence Descriptor "PSD.VCD" Access point sector addresses "SEARCH.DAT" Track Information "TRACKS.SVD"
Segment Play Item Area	Play Items (Still Picture, Motion Picture, Audio) in segments of 150 sectors (option)
Other Files	EXT directory Playing time related access "SCANDATA.DAT" Clopsed Caption data "CAPTnn.DAT" PC playback application
Example of layout of the DATA Track #1.	

A Segment Play Item consists of a MPEG-2 Program Stream (PS) stored in MPEG sectors. It may contain video, audio and still pictures conform to MPEG 2 Program Stream coding. The Segment Play Item Area address is indicated in "INFO.VCD". Segment Play Items may occupy one or more segments. Segment Play Items are not accessed directly by the normal track playing mechanism, but indirectly by interpretation of the Play Sequence Descriptor file.

MPEG track format
All Tracks except the first Track should be MPEG tracks. Each MPEG track must contain only one MPEG-2 Program Stream, stored in MPEG sectors, using Mode2 Form2 with 2324 user bytes.

File system structure
A Super Video CD disc contains two different Data Retrieval Structures; The first is the File System structure conform to CD-ROM XA, and ISO 9660, and a second Data Retrieval Structure is based on absolute sector addresses to the specific SVCD files

Directory structure
The required directories for a Super Video CD disc are: Root directory 0, "SVCD", "MPEG-2", and "EXT" directories. If Karaoke Basic Information is available on a disc, then these files must be located in the directory "KARAOKE". The SVCD Information files must be located in the directory "SVCD". If the Segment Play Items are available on the disc then these files must be located in the directory "SEGMENT". All files that represent the MPEG Audio/Video Tracks must be located in the directory "MPEG2". The "SCANDATA.DAT" file must be located in the "EXT" directory. Other files or directories may exist outside the required Ssuper Video CD directory hierarchy. The figure below gives an example of the file structure for a Super Video CD disc. Additional files can exist within the directories shown.

SVCD directory
This directory contains the files from the Super Video CD Information Area. The required mandatory files in the SVCD directory are "INFO.

Field	Value
Layer	layer II only
Protection bit	CRC check always on
Bit Rate mode = single_channel mode = dual_channel mode = stereo mode = joint_stereo	(may vary from frame to frame) between 32 and 192 kbps between 64 and 384 kbps between 64 and 384 kbps between 64 and 384 kbps
Sampling frequency Emphasis	44.1 kHz no emphasis
MPEG-1 Audio (ISO 11172-3) constraints	

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	Stereo program	Special Karaoke music program (dual channel mode)
CH-0	Left	Mono without vocal
CH-1	Right	Mono with vocal
	Audio channel encoding	

VCD" , "ENTRIES.VCD", SEARCH.DAT and TRACKS.SVD. Optional files in the SVCD directory are "PSD.VCD" and "LOT.VCD".

INFO.VCD file

This file of one sector contains the Super Video CD system identification and a provision to identify the discs belonging to one Album. An Album is a serie of discs which contains related Audio/Video programs. It also contains information associated with the Play Sequence Descriptor (PSD).

ENTRIES.VCD file

This file of one Sector contains the list of start positions of Entries in the MPEG-2 Audio/Video Tracks on the disc. The Entry address values are used by the PSD playlist to access Play segments in the MPEG tracks. It's also used at linear playback for NEXT / PREVIOUS chapter.

SEARCH.DAT file

Due to VBR coding and the nature of the buffering used in MPEG-2 video coding the relation between playing time and sector address is not fixed. This file contains a list of Access Point sector addresses of the nearest Intra pictures on a regular time interval for the MPEG tracks. This is useful for features such as time search.

TRARKS.SVD file

This file contains content related information as the Playing time, Video system type, and number of audio streams for each MPEG track on the disc.

PSD.VCD file

This file contains the data for the Play Sequence Descriptor (PSD). The size of the PSD may be variable, up to a maximum of 256 sectors or 512 KB.

LOT.VCD file

This 32 sectors file contains the List ID Offset Table (LOT). The LOT associates List ID numbers with the corresponding List Offset values.

MPEG2 directory

This directory contains the files that represent the MPEG-2 encoded Audio/Video Tracks. Each MPEG-2 Track is represented by a file with the name "AVSEQnn.MPG", where "nn" is the Sequence Number. The Sequence Numbers (nn) starts with number = 01, and are incremented sequentially for each recorded MPEG track. The file with the name "AVSEQ01.MPG" corresponds to Sequence Number 1 and is the only file in Track number 2.

```
ROOT
|-- SVCD
|       |-- INFO.VCD
|       |-- ENTRIES.VCD
|       |-- SEARCH.DAT
|       |-- TRACKS.SVD
|       |-- PSD.VCD
|       |-- LOT.VCD
|
|-- MPEG-2
|       |-- AVSEQ01.MPG (track #2)
|       |-- AVSEQ02.MPG (track #3)
|       |-- AVSEQnn.MPG (track #nn+1)
|
|-- SEGMENT
|       |-- ITEM0001.MPG (segment item #1)
|       |-- ITEM0002.MPG (segment item #2)
|       |-- ITEMnnnn.MPG (segment item #nnnn)
|
|-- EXT
        |-- SCANDATA.DAT
        |-- CAPTnn.DAT
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SEGMENT directory
This directory is optional and contains the files that represent the Segment Play Items. Each Segment Play Item is represented by a file with the name "ITEMnnnn.MPG", where "nnnn" is the Segment Play Item Number.

EXT directory
This directory contains:

SCANDATA.DAT file
Used for playing time related access. This file contains a list of Access Point sector addresses. For playing time access into a MPEG stream the sector address can be found in the list by looking up the sector address for the corresponding time. There is a sector address list for each MPEG track and for each motion picture Segment Play item.

CAPTnn.DAT file.
For each track containing user data with Closed Caption information a file shall be present Other (CD-ROM) files may be included in this directory, usually intended for computer based systems.

MPEG-2
The MPEG-2 Program Stream (PS) contains multiplexed Video, Audio, and Overlay Graphics data, compressed in Elementary streams in PES packets.
Variable Bit Rate (VBR) coding is a method to significantly increase the efficiency of MPEG-2 encoding, by adjusting the bit rate allocated based on the audio or video complexity. More bits are used to encode scenes which are difficult to compress; and less bits are used when the video or audio content is easier to compress. Synchronization among the Elementary streams is accomplished with Presentation Time Stamps (PTS) in the Program Stream in reference to a common System Clock Reference (SCR). These time-stamps describe the delivery time instances of when a pack is taken from the track buffer and payload is extracted and placed into the decoder. CR values are not a linear set of values as in Video CD 2.0, but are dictated by the VBR packet scheduling.

Presentation times for video or audio frames without an associated PTS will be interpolated based on the previous PTS and display duration of the video or audio frame. For the case of still pictures, a PTS shall be coded for every still picture frame. For the case of graphics overlay, a PTS shall be coded for every graphics page.

MPEG-2 VIDEO format
There are basically two types of Video encoded discs, namely either encoded from PAL or NTSC source video data, however encoding may change from track to track. The encoded video stream is stored in MPEG sectors. For the coding of video, the constraints defined by MPEG for the Main Profile at Main Level (MP@ML) shall apply.
The pack and packet structure for Still Pictures are the same as those specified for Motion Pictures. Each still picture shall be encoded as an MPEG-2 Intra Frame; see ISO 13818-2.

MPEG AUDIO format
The PS stream may contain two audio streams. The audio stream is selectable by the user. In the audio stream the left audio channel is encoded as MPEG Audio Channel zero (CH-0) and the right audio channel as MPEG Audio channel one (CH-1). For Karaoke use the dual channel mode only is used for special music

Field	Value
Layer	layer II only
Bit Rate mode = single_channel mode = dual_channel mode = stereo mode = joint_stereo	(may vary from frame to frame) between 32 and 192 kbps between 64 and 384kbps between 64 and 384kbps between 64 and 384kbps
Sampling	44.1 kHz
MPEG1 (ISO 11172-3) audio formats	

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	NTSC	PAL
horizontal_pixels x vertical_lines	480 x 480	480 x576
Formats for still images		

programs, with in one channel the music without the vocal part and in the other channel the music with the vocal part; MPEG Audio channel one will in this case contain the music with the vocal part. For general use the dual channel mode can be used for two separate languages without compromising video/audio quality. The MPEG Audio channel CH-0 will in this case contain the default language. The table below shows the application of the MPEG Audio channels. It is only allowed to change the audio Mode within one Sequence between stereo and joint stereo. MPEG audio can adapt the bit rate used by the encoder every audio frame (26.1 ms) to the complexity of the sound to be encoded. The use of VBR is optional on the disc, but the decoder in the player must support this.

Simple pieces of music demand a low bit rate, while complex sound require a higher one. When VBR is used, the average bit rate correspond to the average sound complexity, but at constant bit rate (CBR) the bit rate is set for the most complex piece of sound. A typical gain is 30 to 40 %.

Surround Sound can either be realized by coding a Dolby Surround matrix encoded two-channel audio source with MPEG-1 Audio, or optionally by coding a 5.1 channel audio source with MPEG-2 multi-channel (5+1) Backwards Compatible audio. This mode is defined in the MPEG-2 Audio standard (ISO/IEC 13818-3), and is fully compatible with MPEG-1. A MPEG-1 decoder will decode the basic stereo (left and right) audio from the multi-channel MPEG-2 audio signal. So it's an option to add a MPEG-2 multi-channel decoder.

Private Data Streams
Besides video and audio, a Program Stream may contain other elementary data streams. Because these are not defined in ISO/IEC 13818, the syntax and semantics for these additional data streams are defined specially for the Overlay Graphic data stream.

Overlay Graphics and Text (OGT)

The Overlay Graphics layer is designed for two main applications, namely Movie subtitling and Karaoke lyrics. It is a full screen resolution overlay with 4 colours, and transparency. Multi-colour support is provided, to allow for highlighting of song lyrics or other picture highlighting. The main advantage of OGT is that the graphics and text are not put into the video picture before encoding, but mixed in the decoder, which allows for selectable language and improved picture quality. The encoder model is based on two separate video planes; One for motion video, and one for OGT. The OGT page is displayed on top of the Video picture.

Play Sequence Descriptor (PSD)
This is a set of control structures that enables the playback of pre-programmed sequences with user selection and interaction. The PSD contains a set of basic control structures i.e. the Play List, Selection List, and the End List.

The Play List defines a list of Play Items that are played in sequence. A Play Item may be one of the following items

- The whole or part of an MPEG Audio / Video Track.
- One, or more, MPEG encoded Still Pictures; with or without MPEG Audio.
- MPEG Audio with no pictures.
- Motion Picture; with or without MPEG Audio

The Selection List defines the action of the player in response to various user inputs, and may be used to implement menu systems for user selection of sequences. The Selection List may be extended to include hotspot information or commandlists. The player must response to user actions (NEXT, PREVIOUS, DEFAULT SELECTION, NUMERIC, RETURN).

The Play List defines a list of Play Items that are to be played sequentially.

The Selection List is used in the PSD.VCD file, and is a List for implementing selection menus and enabling branching under user control. Segment Play Items are encoded as MPEG Sectors and are restricted to the Segment Play

VIDEO TYPE	FRAME RATE	RESOLUTION
NTSC	29.97Hz	480 x 480
PAL	25Hz	480 x 576
SVCD encoding formats.		

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Item Area. Segment Play Items allow a Still Picture mode.

Play List extensions have been defined for more interactivity by a Command List Interpreter and use of variables for storing scores and other application variables.

USER data

User data is used to encode scan information and closed caption information. The Scan Information Data is mandatory. On a Super Video CD disc it is only allowed to encode user data in the picture layer of the MPEG Video stream.

Scan Information Data

It is mandatory to encode Scan Information in User data groups, and they must be included as user data in the picture layer of all Intra pictures. Scan Information data contains forward and backward pointers to Sectors that contain the start of an Intra picture. Scan Information data is used for both Motion Pictures and Still Pictures.

PC PLAYBACK

The Super Video CD is based on the CD-ROM-XA format. This format allows the possibility to add PC playback applications on the same disc enabling the disc to be played on a PC.

The "EXT" directory is mentioned to contain such application and setup files. The main root could contain even an autorun enabling files.

This document is based on the Super Video CD standard version 1.0 by Royal Philips Electronics (Eindhoven, the Netherlands) and has been prepared in cooperation with Matsushita Electric Industrial Co., Ltd (Osaka, Japan), Sony Corporation (Tokyo, Japan), and Victor Company of Japan, Ltd. (Yokohama, Japan).

The development of this format also resulted in the standard IEC 62107 (Super Video Compact Disc). The present version of the document IEC 62107 is a full subset of this Super Video CD standard version 1.0. The additional elements comprised by the latter are Overlay Graphics, extended PSD.

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