SONY

AVCHD INTRODUCTION HANDBOOK

For NXCAM

NXCAM

AVCHD

Contents

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AVCHD

Introduction

The AVCHD format is currently the de facto recording and playback standard in consumer-level HD video cameras. Reasons for its widespread adoption include intuitive thumbnail viewing of content; easy file transfer to PCs for editing and storage; and the use of a highly efficient video compression scheme – MPEG-4 AVC/H.264 – that enables numerous hours of video to be stored at good quality levels on inexpensive memory and hardware media.

These compelling advantages make AVCHD attractive not only to users of consumer-level camcorders but also to users of professional camcorders who require high-quality images and efficient editing and storage

Sony has been waiting for professional nonlinear editing systems to gain sufficient technical capabilities to fully utilize the advantages of the AVCHD format. At last, the moment has arrived and Sony has launched the professional NXCAM series, which records in the ACVHD format.

This handbook provides a general introduction to the AVCHD format as it relates to the NXCAM series. We hope it enhances your general understanding of both the format and the models that employ it.

The AVCHD and Blu-ray Disc™ Connection

The Blu-ray Disc™ format was originally created as a standard for easily viewing HD movies at home. It has since become the de facto standard for HD movies and its popularity continues to rise.

The AVCHD format is fully has a very similar folder framework as Blu-ray Discs™. This is because AVCHD was mainly created to enable recording of HD movie files on home video cameras using the technology of Blu-ray Discs™. The format is compatible with memory cards, hard disk drives, and optical disc media.

The following illustrates the folder frameworks on AVCHD-compatible memory cards used by NXCAM and Blu-ray Discs™.

Folder framework comparison
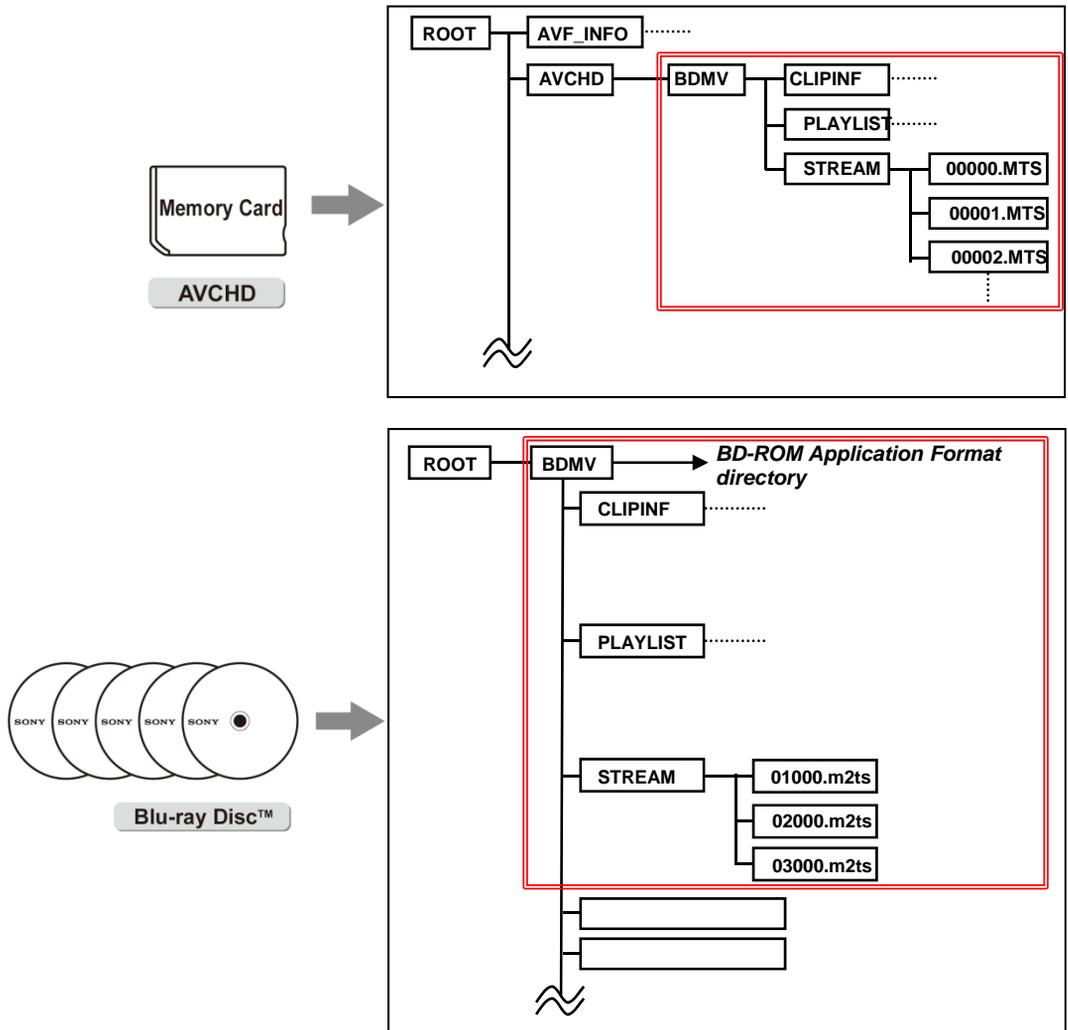
The two folder frameworks have clear similarities. Various players and software packages compatible with Blu-ray Disc™ are also compatible with AVCHD.

Note: In general, "AVCHD compatible" can mean one of the following:
・Able to play, edit and output image files compressed with the AVCHD standard.
・Able to play, edit and output image files compressed with the AVCHD standard, as well as recognized and generate folder names and a folder framework that meet AVCHD standards.

Main Advantages of AVCHD

Basic AVCHD specifications have been set by Sony Corporation and Panasonic Corporation.

The primary purpose of AVCHD was to develop HD video camera recorders that can shoot and play back HD video footage using media such as flash memory, hard disk drives and optical discs.

Feature 1

Compatibility with Blu-ray Disc™

DVDs recorded in the AVCHD format will play back not only on the camcorder itself, but also on a Blu-ray Disc™ drive or PLAYSTATION®3 that supports AVCHD with high definition quality. In addition, AVCHD files can be recorded to Blu-ray Disc™ without any degradation in image quality.

Feature 2

Recording HD images onto random-access media such as Flash Memory, hard disk drives and 8cm DVD discs.

Regarding recording media, AVCHD camcorders use random access media such as Flash Memory, hard disk drives, and 8cm DVD discs, which have proliferated in recent years. Non-linear media allows improved user-friendly operation with thumbnail image displays; it also eliminates concerns about accidental or unintentional overwriting of desired A/V material. The use of the MPEG-4 AVC/H.264 video compression scheme permits the efficient reduction in size of the data files, providing sufficient shooting time while maintaining the high picture quality of the HD recording.

Feature 3

MPEG-4 AVC/H.264 is used as the compression format

This is a more efficient video compression technique when compared to the conventional MPEG-2/MPEG-4 compression systems. The user obtains a Full HD1080 picture, while using the same bitrates and obtaining the same recording times as a Standard Definition camcorder.

AVCHD Specifications

AVCHD uses the MPEG-4 AVC/H.264 compression system, internationally standardized in 2003 as a successor to the highly successful MPEG-2/H.262 compression system. To ensure HD picture quality, a suitable high-resolution recording and playback system has been developed that boasts 720 effective scanning lines (progressive scanning) and 1,080 effective scanning lines (interlaced scanning). Moreover, the audio quality makes it possible to record and play back multiple channels with Dolby® Digital sound or uncompressed linear PCM.

AVCHD and HDV Tables

	AVCHD (HD) specifications		HDV 1080 specifications (reference)
Picture format	1080/60i	720/60p	1080/60i
	1080/50i	720/50p	1080/50i
	1080/24p	720/24p	1080/24p (option)
Number of pixels	1,920 × 1,080	1,280 × 720	1,440 × 1,080
	1,440 × 1,080		
Aspect ratio	16:9		16:9
Compression (video)	MPEG-4 AVC / H.264		MPEG-2
Sampling format	4:2:0		4:2:0
Quantisation	8 bit		8 bit
Audio format/Audio bitrate/Audio mode	Dolby® Digital/64-640kbps/1-5.1ch		MPEG-1 (Audio Layer II) /384kbps/Stereo 2ch
	Linear PCM (uncompressed)/1.5Mbps/1-7.1ch ?		
Multiplexing scheme	MPEG-2 Transport Stream		MPEG-2 Transport Stream
Bitrate after compression	Up to 24Mbps/18Mbps via DVD (variable data rate)		25Mbps (fixed data rate)

Aspect ratio	: Width and height ratio of the picture.
Sampling format	: This indicates the pixel density ratio allotted to the three video component signals: Y (luminance signal), R-Y (red signal minus luminance signal), and B-Y (blue signal minus luminance signal), when converting analogue video to digital data.
Quantisation	: This indicates the number of bits assigned for the digital representation of the analogue video components.
Bitrate	: This represents the amount of data used per second (1 Mbps = 1 megabit of data per second).

Notes:

・The HXR-MC1 supports 1080/60i or 1080/50i depending on region and its audio format/bitrate/mode supports Dolby® Digital (AC-3)/2ch only

• A standard subset of the AVCHD format called AVCHD Lite supports 720p recording and playback.

• SD (standard definition) recording is possible through the AVCHD format, but Sony does not support this capability. Instead, the HXR-NX5J employs MPEG-2, the same compression scheme used in DVD Video, when recording in the SD mode.

*As of December 2009.

AVCHD compression format

AVCHD employs the MPEG-4 AVC/H.264 compression scheme

MPEG-4 AVC/H.264 allows users to flexibly assign the bit rate, and image resolution and audio quality depending on the intended application. This compression technique is widely adopted for numerous applications besides AVCHD and is the format of choice for:

- Blu-ray Disc™ HD movies
- Digital TV broadcasts (e.g. One Seg broadcasting in Japan)
- Video websites such as Youtube™
- Video playback on PSP™ (PlayStation Portable)
- Video playback on portable devices such as Walkman™, iPhone™ and iPod™.

Notes:
Other names for MPEG-4 AVC/H.264 include MPEG-4 part 10, AVC (Advanced Video Coding) and H.264.
Not all digital broadcasting systems adopt MPEG-4 AVC/H.264.
The movie file extension (.flv, .mov .mp4, etc.) does not indicate whether the file was compressed with MPEG-4 AVC/H.264.

AVCHD Compression (Video)

**Basic concept of data compression in moving images**

There are two general methods for data reduction in moving pictures. One is called "intraframe compression," which is similar to used for the DV format. This method discards high-frequency information containing fine detail and image texture in the image data when the bit-rate exceeds the bit-rate budget. The other is called "interframe or long GoP compression," which is used for MPEG-2 Logo GOP and MPEG-4/AVCHD. This method first divides a frame into 16 x 16-pixel blocks and data reduces similar-looking blocks in neighboring frames when found Such "interframe compression" is highly effctive in achieving high levels of data reduction. Interframe or long GoP compression dramatically improves compression efficiency, producing much higher quality at the same bit rate as interframe compression.

Data compression of MPEG-4 AVC/H.264

AVC/H.264 is a moving pictures codec standardised by ITU-T and ISO, and has been adopted as a standard codec by DVDs such as Blu-ray Disc™ media. In the future, this AVC/H.264 standard will become more popular. For example, among optical-fibre-based on-demand TV networks, high-compression 1080i high definition broadcasting is almost ready for actual service because of the efficiencies brought about by the AVC/H.264 scheme. Also due to its wide bit-rate scalability, this compression system enables not only handling of HD video footage but also movie playback on PlayStation® Portable (PSP®) with Memory Stick and on mobile terminals. Additionally, AVC/H.264 shows reliable performance for stable SD-quality movie shooting with smaller data size.

High-quality image achieved through higher-precision "motion-prediction" blocks

Compared to conventional MPEG-2, AVC/H.264 offers improvements with respect to many compression processes. For example, a conventional MPEG-2 block unit used for motion prediction is 16 x 16 pixels, while an AVC/H.264 block unit can be a minimum of 4 x 4 pixels, allowing finer detail in compression operation for motion prediction than MPEG-2.
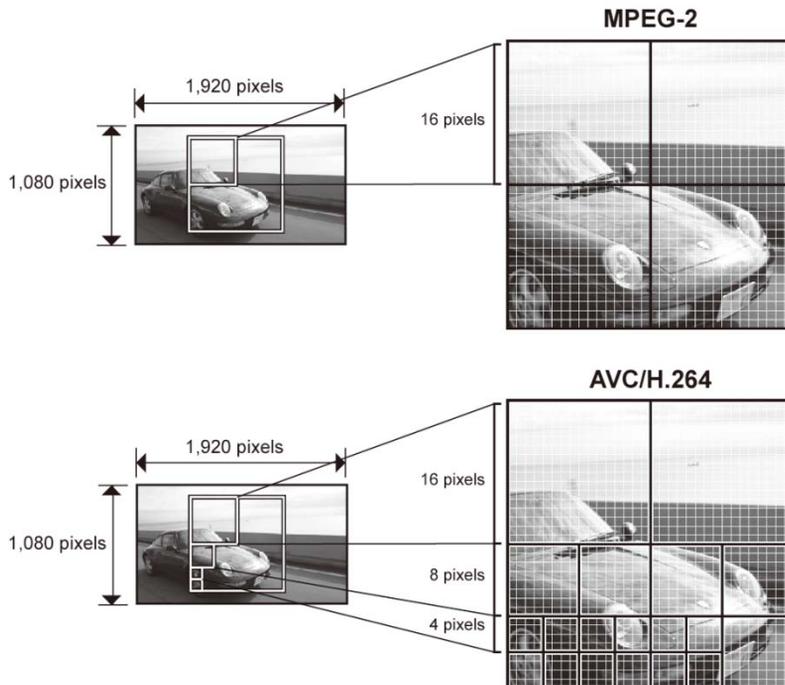
Compared to MPEG-2 compression, H.264 divides the image into smaller pixel blocks for higher picture quality

Interframe compression

MPEG-2/ MPEG-2 Logo GOP encoding works by referring to one frame before the current frame and one frame
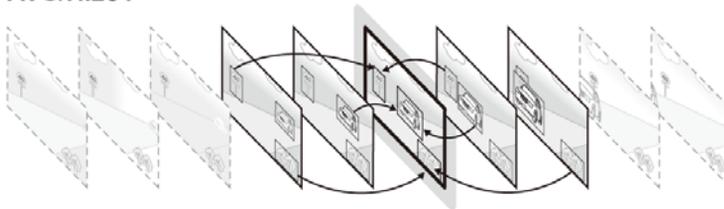after. AVC/H.264 encoding is far more powerful, in that it references four frames at a time.
Consequently, more blocks in these frames can be used for compression of the intended block in the
current frame, thus enhancing efficiency.

MPEG-2

Timeline
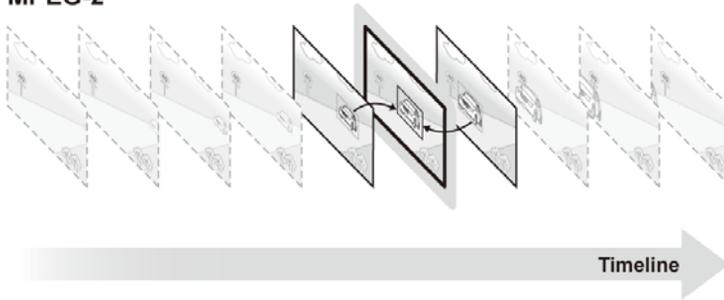
AVC/H.264

High-quality image compression achieved through the use of optimised DCT (Discrete Cosine Transform) block units

In image compression protocols such as JPEG and MPEG, a frequency transformation process called DCT (Discrete Cosine Transform) is applied to each block, dividing a frame into blocks of a specified size. More effective image compression is achieved by distributing more bits to visually significant parts of the image. Conversely, fewer bits are distributed to areas that have a low visual impact on the eye.

In AVC/H.264 Main Profile, the block unit is 4 x 4 pixels, enabling motion -compensated residual DCT to

be applied in finer detail. Moreover, AVC/H.264 High Profile can use both 4 x 4-pixel and 8 x 8-pixel

blocks in the same frame. Optimal frequency transformation is applied depending on patterns and

movements: 4 x 4-pixel blocks are used for detailed parts, whereas 8 x 8-pixel blocks are used for flat

areas in the same image.

Main Profile

4x4 pixels

4x4 pixels

High Profile

8x8 pixels
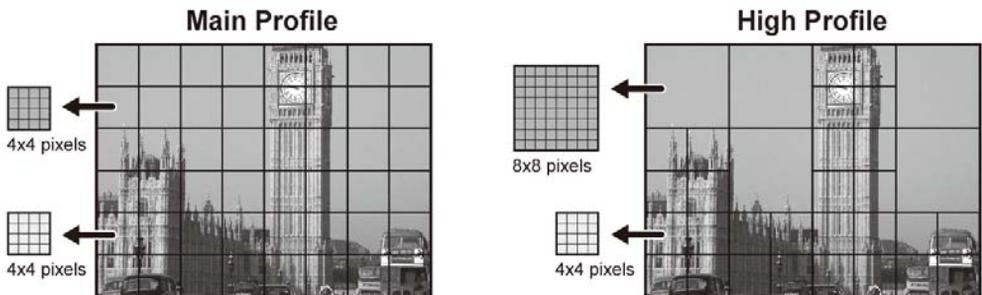
4x4 pixels

Main Profile:Fixed process is applied using 4 x 4-pixel blocks.
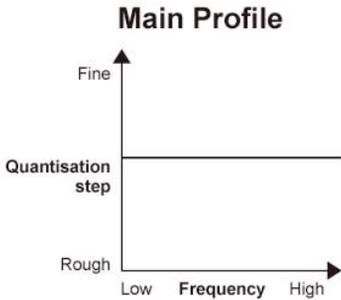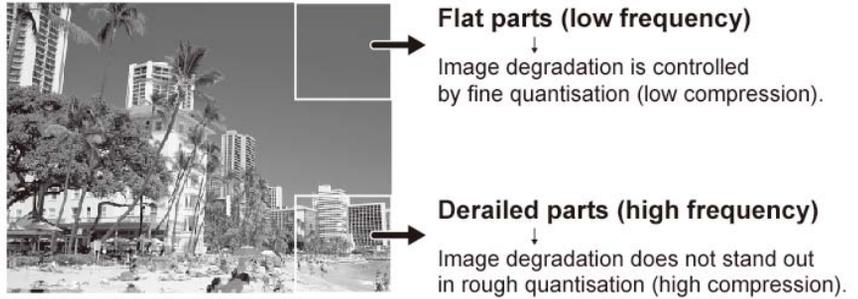High Profile:Rough process (8 x 8 pixels) is applied to flat areas, whereas a precise process (4 x 4 pixels) is applied to detailed parts.

High Profile improves image quality by processing relatively evenly patterned parts such as the sky, using high transformation performance 8 x 8-pixel blocks, allowing more information distribution (i.e. bits) to detailed parts in the same image.
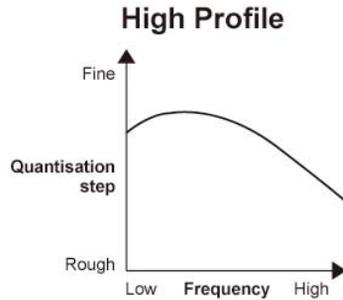
Optimal compression through quantisation matrix

Image distortion due to data compression is often more noticeable in flat patterns and can be visually disregarded in detailed patterns. This is one of the characteristics of the human visual system.

For some image patterns, uniform compression might cause serious image degradation. The quantization matrix enables the retention of high image quality by maintaining the original image properties, achieved by applying low compression to the flat areas of an image. Given the characteristics of the human visual system, these parts can be easily perceived.

Flat parts (low frequency)
↓
Image degradation is controlled
by fine quantisation (low compression).

Derailed parts (high frequency)
↓
Image degradation does not stand out
in rough quantisation (high compression).

Main Profile

Fine

Quantisation step

Rough

Low **Frequency** High

■ Compression rate is fixed.

High Profile

Fine

Quantisation step

Rough

Low **Frequency** High

■ Compression rate is variable.

HDV and AVCHD

Professional moviemakers have widely adopted the HDV format, which allows seamless interaction with the DVCAM and DV formats. The HDV format was jointly developed by Sony Corporation, Canon Inc., Victor Company of Japan, Limited, and Sharp Corporation to enable HD movie recording on DV tape. In 2004, Sony launched the HDR-FX1 and HVR-Z1J, the world's first HDV camcorders to record at HDV 1080i resolution. Since then, Sony's HDV camcorder lineup has greatly expanded. The latest models record footage as data files, and there have also been dramatic advances in the ability of nonlinear editing software to edit movie footage recorded in the HDV format. Today, the HDV format is widely used by consumers and professionals alike, such as for use on Blu-ray Disc™ media and broadcasting programs.

	HDV	AVCHD
Video compression method	• The popular MPEG-2 format is ideal for non-linear editing. • The bitrate for movie recording is fixed at 25Mbps and cannot be adjusted.	• AVCHD employs MPEG-4 AVC/H.264 to efficiently compress video to smaller file sizes. • The bitrate can be adjusted to strike a desired balance between quality and file size.
Media and data transfer	• HDV is recorded on conventional DV tape like DVCAM, allowing easy long-term storage. • Real-time data stream output is possible from an i.LINK terminal. • Data can be copied in MPEG-2 format (.m2t) on hard disks and Compact Flash for high-speed transfer to non-linear editing systems (via recorders such as HVR-DR60 and HVR- MRC1K).	• Popular non-linear media like MemoryStick Duo can be used. Such media are expected to keep lowering in cost. • Saving the original movie content requires a large-capacity HDD or Blu-ray Disc™. • Since no available equipment can handle the data stream via i.LINK terminal, the data must be transferred as files.
Compatibility with SD	• HDV camcorders can record at SD resolution on DVCAM and DV tape, and HDV-compatible equipment can convert HDV content to SD content for editing.	• NXCAM camcorder has a down-conversion function from HD to SD. • SD recording in the DV format is not possible. Note: The HXR-NX5 can record at SD resolution in the MPEG-2 format.
Editing environment	• The widely used MPEG-2 format allows smooth, non-linear editing of HDV content without conversion to an intermediate codec.	• AVCHD records to Flash Memory, etc., allowing the swift transfer of content to PCs. • Most major NLEs already support AVCHD but more powerful computer is required to edit AVCHD comfortably.

Why the NXCAM Series Employs the AVCHD Format

There are many reasons why Sony uses AVCHD in this professional lineup:

A more efficient file-based workflow
Easy image verification is possible via thumbnail display and/or random access on the camcorder. File-based storage enables quick transfer to PCs and efficient content management.

Efficient movie production

Increasing compatibility with pro nonlinear editing software
Many nonlinear editing software packages that allow HDV editing now handle AVCHD files. Moreover, improvements in CPU processing speed and GPU (Graphic Processing Unit) performance enable high-speed AVCHD processing on recent PC models.

The AVCHD editing environment is gaining ground.

The industry is starting to provide widespread support for AVC/H.264 codecs
AVCHD has been widely adopted on consumer-level devices and enjoys broad market support. Some Blu-ray Disc™ players are compatible with the AVCHD format and Windows 7 offers AVCHD file playback as a standard feature. There are many convenient ways to record and play AVCHD files and support continues to expand.

Cost-effective movie production on consumer equipment

**Compatible media is widely available**
Every day it becomes easier to obtain memory cards that are compatible with the AVCHD format. Such generic consumer memory cards can be used in an NXCAM camcorder.

The widely available and reusable media meets on-location needs and lowers costs.

Using Images Recorded in AVCHD Format

Recorded HD images can be played back on an AVCHD Blu-ray Disc™ drive or PLAYSTATION®3

Blu-ray Disc

Memory card → 8/12cm AVCHD (DVD or Blu-ray) disc created on PC → Blu-ray Disc player/recorder / PLAYSTATION®3
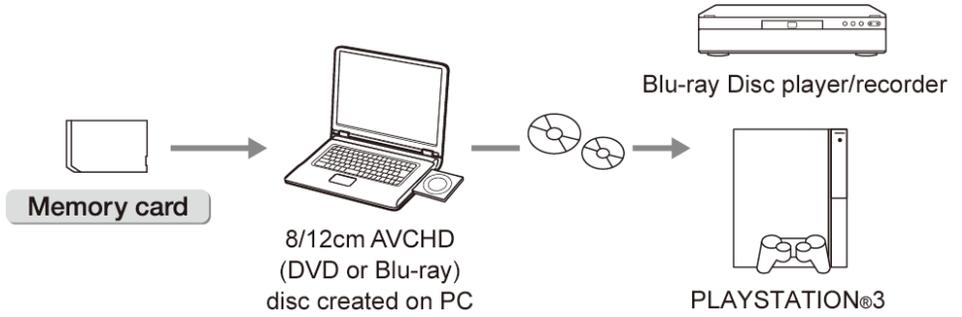
HD images recorded with AVCHD DVD equipment can be played back on an AVCHD Blu-ray Disc™ drive or PLAYSTATION®3 by recording the data to an optical discs

Memory card
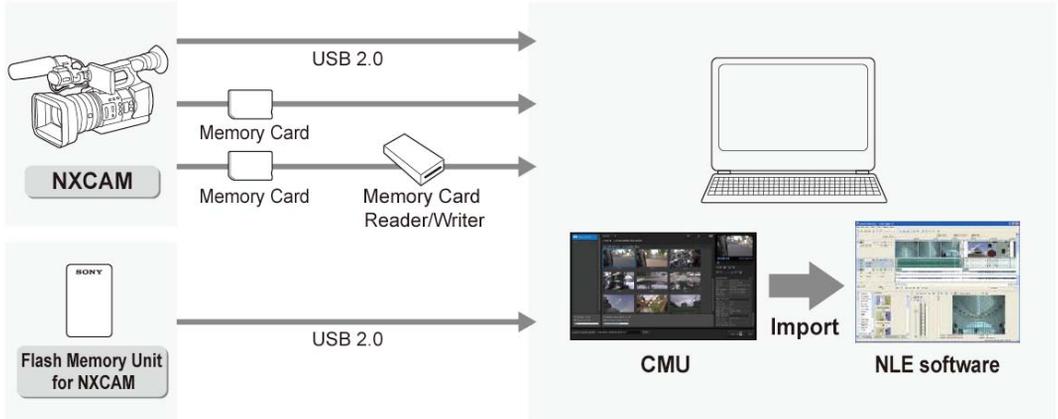

Memory card / Memory Card Reader/Writer → PLAYSTATION®3
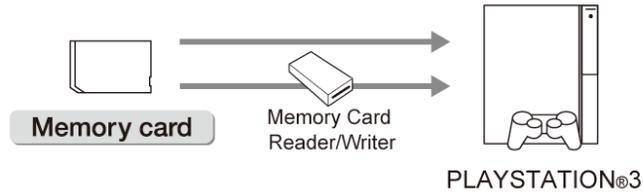
Notes
• An AVCHD-recorded DVD cannot be played back on conventional DVD equipment.
• Press the option button on PLAYSTATION ® 3 and select Display All to display content.

How to Import AVCHD Files From an NXCAM

For Windows® users
Use Contents Management Utility (CMU) Software to ingest

NXCAM

Memory Card

Memory Card

Memory Card
Reader/Writer

USB 2.0

Flash Memory Unit
for NXCAM

USB 2.0

CMU

Import

NLE software

For Final Cut Pro® Users
Use "Log & Transfer" and convert to ProRes422 to edit

NXCAM

Memory Card

Memory Card

Memory Card
Reader/Writer

USB 2.0

Flash Memory Unit
for NXCAM

USB 2.0

Log & Transfer
Edit on Final Cut Pro®
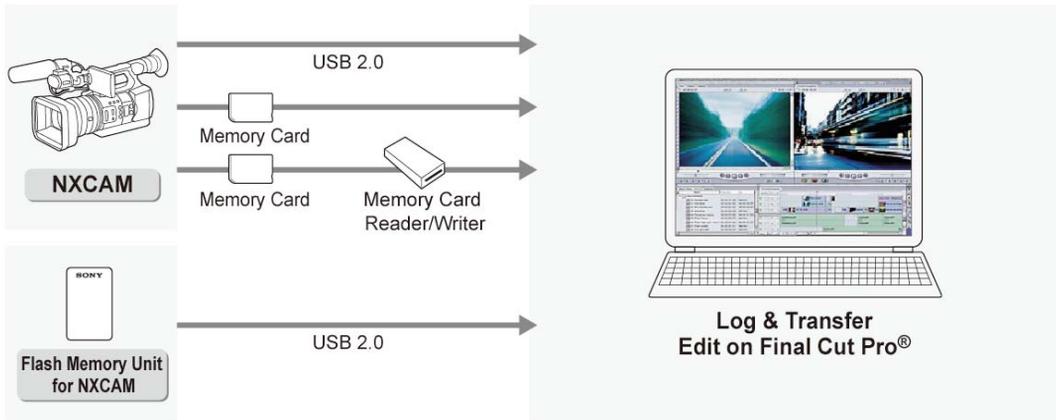
Utilize the HD-SDI or HDMI outputs

NXCAM

HDMI

HD-SDI

HD-SDI input*
HDMI input*
(Using a interface board)

OR

Video Switcher of
recorder with HD-SDI
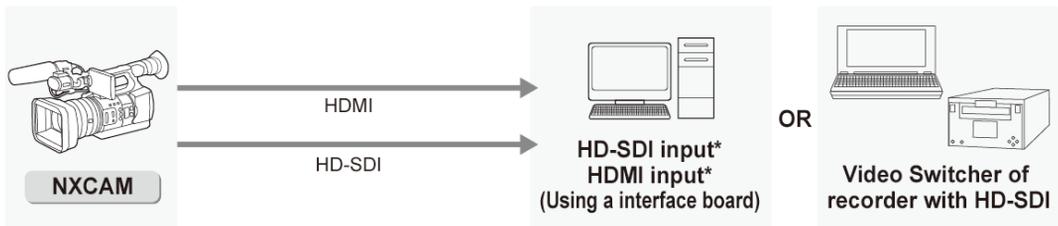
*Please contact the manufacturer for further detailed information

Logo and Trademark

Usage example

We ask for your cooperation in using the trademark "AVCHD" logo appropriately, and maintaining the consistency of the AVCHD visual identity (VI), according to AVCHD logo guidelines.

1-1 Definition of the AVCHD logo
The AVCHD logo indicates the standard (AVCHD standard) that allows for recording and playback of high definition images using an 8cm DVD disc, hard disk drive, or flash memory. This standard belongs to Sony Corporation and Panasonic Corporation.

1-2 Applicable users
The following may use the AVCHD logo:
• Sony Corporation
• Panasonic Corporation
• Parties that have obtained permission from the above corporations based on a licensing agreement

1-3 Applicable products
The AVCHD logo may be used for products based on the AVCHD standard with permission obtained based on a licensing agreement, product packaging (including packing materials), users' manuals, advertising and publicity (catalogues, posters and other print media, as well as TV commercials, the Internet, and other image media), sales promotion materials (displays, point-of-purchase advertising, etc.), and events.

1-4 Applicable regions
The AVCHD logo may be used worldwide, except for regions where it cannot be used legally as a trademark.

1-5 Attention to trademarks protection
In case of using the AVCHD logo on print media, Web sites, etc., it is required that is to be mentioned that the AVCHD logo is a trademark. We recommend adding the "TM" mark at the lower right of the AVCHD logo.
e.g.: "AVCHD" and the "AVCHD" logo are trademarks of Sony Corporation and Panasonic Corporation

Q&A

Q1. Why does the NXCAM employ the AVCHD format?

A1. We received many requests from professional customers for a non-linear camcorder that would seamlessly fit the non-linear workflow.
Our response was the NXCAM, which records in the AVCHD format using the efficient H.264/MPEG-4 AVC codec. A number of factors influenced our decision. For example, major professional NLE software began to support AVCHD editing. Large-capacity memory media became quite affordable. A 16GB " Memory Stick PRO Duo" stores approximately 6 hours of LP-mode video data. Popular hardware and software such as Playstation®3 and Windows®7 now support AVCHD as a standard feature. In short, the AVCHD playback and editing environment has evolved to the stage of professional usage. For these reasons and more, the AVCHD format was adopted on the NXCAM.

Reference: Comparison of recording time

	HDV 25Mbps	AVCHD 24Mbps(max) FX Mode	AVCHD 17Mbps(avg) FH Mode	AVCHD 9Mbps(avg) HQ Mode	AVCHD 5Mbps(avg) LP Mode
32GB Media	144 min	170 min	225 min	385 min	605 min

Q2. Will Sony abandon HDV for AVCHD in the future?

A2. No. HDV has already established a secure position as the de facto standard in the business. The capabilities of HDV has continued to improve and it is now able to handle not only tape recording, but also file-based management and simultaneous HD/SD recording. Also, although HDV is widely accepted in the market, the DVCAM format is still used by a wide range of customers. This illustrates how long it takes for customers to shift to a new camcorder format. At Sony, we imagine it will take a long time before our customers shift to the AVCHD format.

Q3. Does HDV or AVCHD offer better image quality?

A3. The answer isn't simple, since image quality is affected by various factors, including not only the format but also the lens and image sensor.

Q4. Does AVCHD with the AVC/H.264 codec or HDV with the MPEG2 codec offer better quality at the same bitrate?

A4. Image quality cannot be judged simply by the video codec. Even models using the same codec may employ different parameter values for the compression algorithms. The solidly established MPEG2 codec in current Sony camcorders was developed through advanced Sony know-how and offers sufficient image quality for professional use. In fact, the NXCAM employs AVC/H.264 codec technology originally developed for general Handycam® users. Besides, a special fine-tuned algorithm is used for NXCAM which offers professional image quality.

Q5. Is the recording format of the NXCAM the same as in Panasonic AVCHD camcorders? And can the NXCAM interact with Panasonic AVCHD camcorders for playback?

A5. The recording format is based on the same standard, however Sony cannot guarantee playback interaction since Panasonic uses different media.

Q6. Will you offer new HDV products in the future?

A6. We are not at the stage where we can discuss specific plans, but Sony will continue answering customer demands with an extensive lineup that includes HDV products.

Q7. Will you continuously launch AVCHD products?

A7. Sony seeks to offer camcorders appropriate for various uses and the AVCHD format offers great potential in this regard.

Q8. Is the industry shifting to AVCHD (AVC/H.264 video codec)?

A8. Sony does not believe that AVCHD will soon replace HDV in camcorders. Sony will continue to answer customer demands with an extensive lineup that includes HDV products.

Q9. Can the NXCAM shoot videos at SD resolution?

A9. Yes, using the MPEG2-SD format.

Q10. Is SD-resolution footage compressed in the AVCHD format?

A10. No. It is compressed in the MPEG2-SD format for maximum usability. This format is compatible with the popular DVD-VIDEO optical disc standard.

Q11. What is NXCAM?

A11. NXCAM is a product family name for professional camcorders, which can record on non-linear media and uses AVCHD as a recording format. NXCAM stands for N=Non-linear, X=Multiple-usage, Cross-category, and NX= NeXt Generation Camcorder.

Q12. What is the difference in the AVCHD format of NXCAM and HXR-MC1?

A12. Basically the format used is the same for both cameras. However NXCAM can select a higher bit-rate mode than the maximum 16Mbps FH mode in HXR-MC1, which is 24Mbps FX mode. Files recorded in FX mode with NXCAM cannot be played on HXR-MC1.

Q13. Why is not HXR-MC1 included in the NXCAM family?

A13. Since HXR-MC1 cannot record in AVCHD FX mode 24Mbps, files recorded in FX mode cannot be played on HXR-MC1. In order to ensure playback compatibility within the NXCAM family, we excluded HXR-MC1 from the NXCAM family.