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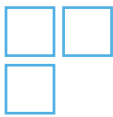
HANDYCAM



HDV TECHNOLOGY HANDBOOK

HDV

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worryfreedigital™ video

Moments worth recording on video take place at any time, which is precisely why Sony® Handycam® camcorders feature worryfreedigital video. It's never been easier to immortalize your memories in stunning sight, sound and motion. Intuitive controls, compact design, unparalleled resolution and amazing innovations seamlessly work together, allowing you to simply capture life as it happens.

worryfreedigital video makes moviemaking fun again. It's technology Like No Other for camcorders Like No Other™.

Toward worryfreedigital™ High Definition video

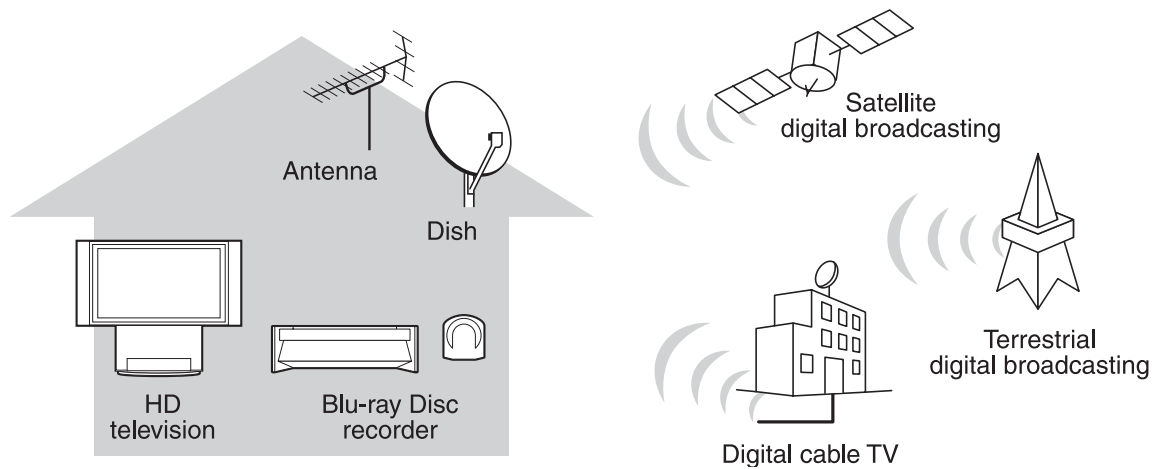
Now Sony is poised to extend the worryfreedigital concept to High Definition moviemaking. Imagine all the benefits of Sony Handycam® camcorders together with all the amazing resolution of High Definition. Such a combination is made possible by a new videocassette recording standard, called HDV™.

Arrival of the HDV Standard

High Definition Television (HDTV) means viewing that's far more real and compelling than any previous broadcast system. HDTV means greater detail that you can enjoy on a bigger television screen. HDTV means more beautiful, more vivid color. And HDTV means the superlative accuracy of digital pictures accompanied by digital surround sound. It's no wonder that countries all over the world are adopting HDTV standards.

As HDTV becomes accepted in country after country, it is also becoming available through more and more delivery pipelines:

- **Over-the-air (terrestrial) HDTV broadcasting** is bringing the benefits of High Definition to hundreds of millions of potential viewers.
- **HDTV satellite broadcasting** is helping to speed the acceptance of High Definition.
- **HDTV cable service** can provide a rich range of programming.
- **HDTV personal video recorders (PVRs)** let you capture HD programming on a hard disk drive for playback at a later time.
- **HD Blu-ray Disc® (BD) recorders** enable you to build your own, personal library of High Definition content.



The conversion to High Definition touches the entire A/V environment.

As the home entertainment system increasingly makes the move to High Definition, the next stage will be HD personal content creation, with the consumer HD camcorder. That's the idea behind the HDV™ standard.

On September 30, 2003, the HDV standard was finalized and agreed upon by four companies: Canon Inc., Sharp Corporation, Sony Corporation, and the Victor Company of Japan, Limited. The agreement has tremendous implications for consumers the world over.

Thanks to HDV, you can capture weddings, birthdays and family vacations with the exceptional clarity and impact of High Definition. Thanks to HDV, your memories are more vivid, more detailed and more like life itself. Thanks to HDV, your home videos are better suited to playback on big-screen television. And thanks to HDV, home video achieves an entirely new level of quality.



HDV camcorders represent the conversion of personal content to High Definition.

HDV Advantages

The HDV™ standard enables consumers to record superb, High Definition imagery onto DV tape. In this way, HDV camcorders leverage the broad availability of DV recording media—and the considerable development costs already devoted to DV recording mechanisms. This makes HDV a practical, affordable alternative for real-world home video.

1. Personal memories in High Definition

At last, the spectacular picture quality of High Definition is no longer limited to Hollywood and the broadcasting professionals. Thanks to HDV, you can capture the memories of your life with the gorgeous resolution, lifelike color and vivid contrast of digital High Definition at 1080i and 720p.

2. Digital picture quality

While analog video recording exposes the picture to noise and distortion, digital video recording maintains low noise, high accuracy and incredibly rich, vivid color. In addition, component digital recording with separate channels for Y (luminance), B-Y (blue color difference) and R-Y (red color difference) makes for a wider range of recorded colors.

3. 16:9 widescreen recording

HDV captures images in the same 16:9 widescreen format that is used for High Definition television. Because this widescreen image is a better match for the human field of vision, it results in a more lifelike, more immersive experience—closer to the feeling of "being there."

4. Digital sound quality

The HDV format sound tracks use MPEG-1 Audio Layer II digital encoding. In this way, home videos approach the sound quality Compact Disc, at far lower bitrates.

5. Affordable DV tapes

HDV uses exactly the same cassette tapes that are already popular for DV recording. Even the recording time is the same. In addition, the tape transport and head drum are identical to those used in current DV recording systems.

6. MPEG-2 compression

HDV uses the same MPEG-2 compression that is already used for digital broadcasts and DVDs. The MPEG-2 system is so widely used because it employs "interframe" compression in addition to the "intraframe" compression employed in DV recording.

Using both compression technologies enables HDV to achieve a superb High Definition picture at the same bitrates as Standard Definition DV. While MPEG decoding appears in a wide range of consumer products, including all DVD players, MPEG encoding had been too complex for consumer products until recently. Advances in large-scale integrated circuits (LSIs) and signal processing technology have now made High Definition MPEG encoding available for consumer products like HDV camcorders.

7. Powerful error correction

Compared to DV, HDV uses higher compression ratios. This makes HDV more susceptible to visual impairment when recorded data is missing during playback. For this reason, the HDV format incorporates greater error correction redundancy and more robust error correction methods. While the DV correction method operates only within recorded tracks, the HDV method operates among multiple tracks. The result is a dramatic improvement in error correction. Even when data is lost, the HDV picture can continue to look sensational.

8. Both 720p and 1080i recording

For added flexibility, the HDV standard embraces two types of High Definition recording. The 1080-line interlace scan (1080i) recording takes advantage of 1440 horizontal pixels per line (1440 x 1080). The 720-line progressive scan (720p) recording incorporates 1280 horizontal pixels per scanning line (1280 x 720).

HDV™ Specifications

	DV	HDV (720p)	HDV (1080i)
Media	DV tape		
Video Signal	576/50i (PAL) 480/60i (NTSC)	720/25p, 720/50p, 720/30p, 720/60p	1080/50i, 1080/60i
Number of Pixels	720 x 576 (PAL) 720 x 480 (NTSC)	1280 x 720	1440 x 1080
Aspect Ratio	4:3 (16:9)	16:9	
Video Compression	DV	MPEG-2 Main Profile at High-14 Level	
Luminance Sampling Frequency	13.5 MHz	74.25 MHz	55.6875 MHz
Video sampling Format	4:2:0 (PAL) 4:1:1 (NTSC)	4:2:0	
Video quantization	8 bit		
Video bitrate after compression	25 Mbps	19 Mbps	25 Mbps
Audio compression	n/a	MPEG-1 Audio Layer II	
Audio sampling frequency	48 kHz/44.1 kHz (2-ch. mode) 32 kHz (4-ch. mode)	48 kHz	
Audio quantization	16 bit (2-ch. mode) 12 bit non-linear (4-ch. mode)	16 bit	
Audio bitrate after compression	1.5 Mbps	384 Mbps	
Audio Mode	Stereo (2-ch.) Stereo x2 (4-ch.)	Stereo (2-ch.)	
Data format	n/a	MPEG-2 system	
Stream type	n/a	Transport Stream	Packetized elementary stream
Stream Interface	IEEE 1394 (DV)	IEEE 1394 (MPEG-2-TS)	

Aspect Ratio: Ratio of picture width to picture height.

Sampling Frequency: The number of digital samples per second.

Sampling Format: In digital video systems, the frequency ratios of the Y/B-Y/R-Y channels.

Quantization: The number of bits used to express a digital sample. 16-bit quantization yields 216 or 65,536 possible levels.

Bitrate: The number of bits per second. 1 Mbps equals 1 million bits per second.

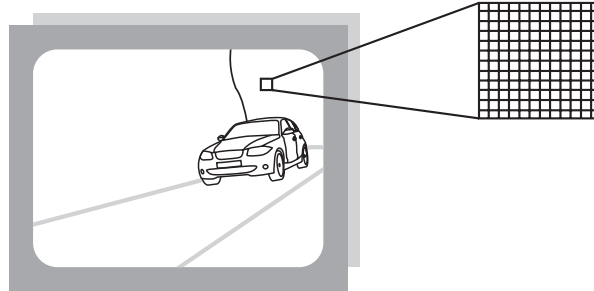
Data format: The standard used for audio and video data.

Stream type: The system for combining audio and video data in the MPEG-2 system.

Stream interface: The data transmission standard.

HDV Compression

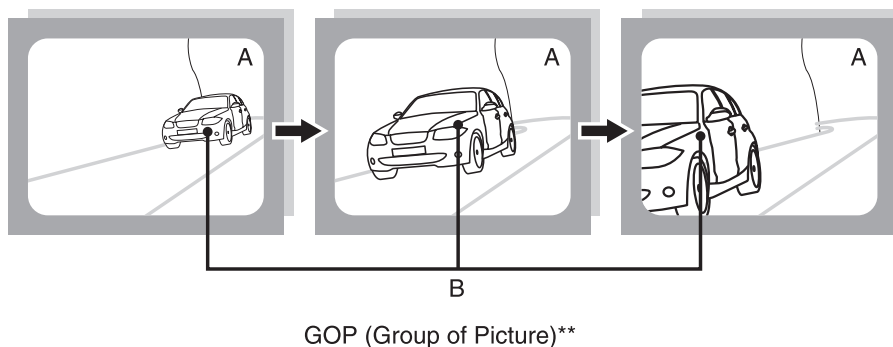
To appreciate the MPEG-2 compression system used for HDV™ technology, it helps to first consider the simpler, "intraframe" compression system used for DV. The system works because one pixel of blue sky is almost exactly the same as the next. By encoding only the differences between pixels—in fact, only the differences you can see—DV compression can cut the data rate by 80%. That's a 5:1 compression ratio, which reduces an initial bitrate of roughly 124 Mbps to a recorded bitrate of 25 Mbps after compression.



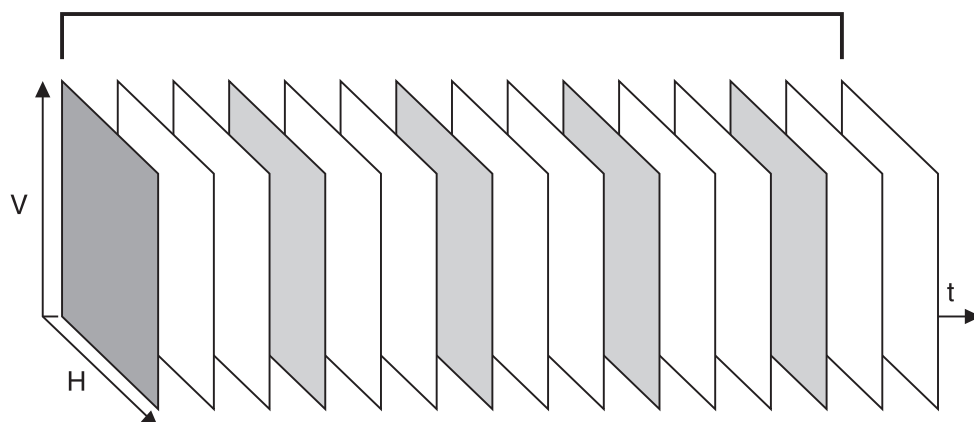
Intraframe compression works because each pixel of blue sky is almost exactly the same as the one next to it. The system needs to record only the differences.

Because it records a High Definition signal, HDV must handle far higher initial bitrates. For example, the 1080/60i HDV signal (1440 x 1080) has 4.5 times as much data as the 480/60i DV signal used in NTSC countries (720 x 480 pixels).

For this reason, HDV must use a more powerful compression engine: MPEG-2. MPEG-2 starts with intraframe compression, similar to the DV compression system. But MPEG-2 goes on to add "interframe" compression. This system works because, in the typical sequence of pictures, one frame of video is almost exactly the same as the next. By encoding only the differences between frames, MPEG-2 can achieve another major round of bitrate reduction!



The interframe compression of MPEG-2 works because of the similarities between most video frames. In this example, the background "A" stays same while only the car "B" moves. The system can reduce data by encoding only the differences between frames rather than the frames themselves.

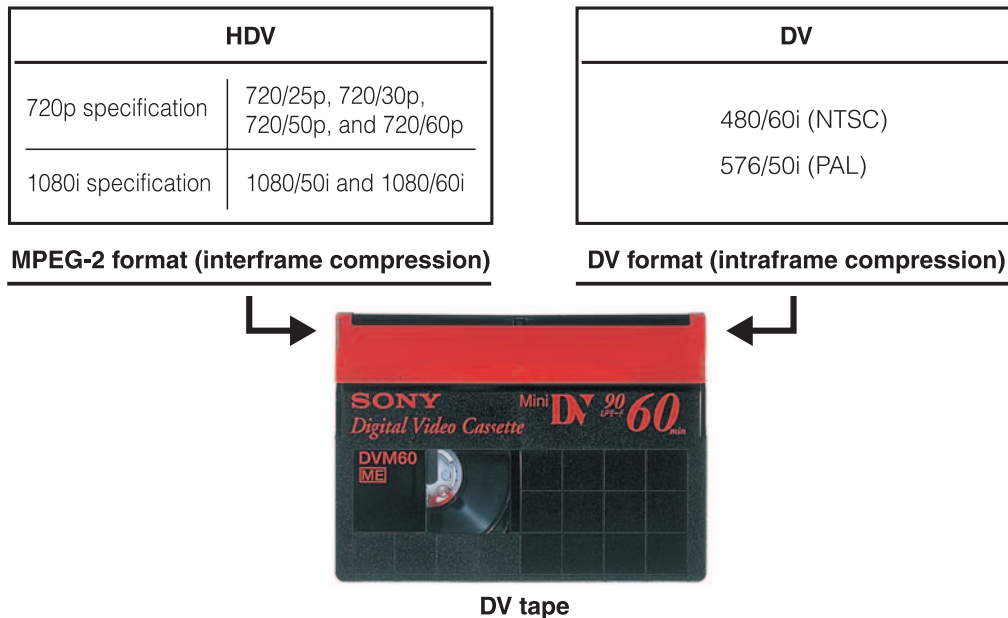


MPEG-2 organizes frames into a Group of Pictures or GOP. Each GOP begins with a fully-described frame (at left). Other frames in the GOP are described in terms of difference only.

By combining the power of both intraframe and interframe compression, the MPEG-2 system of HDV is far more efficient than DV compression. In this way, even though HDV encodes a signal with up to 4.5 times the data of DV, it can achieve comparable quality at the same bitrates as DV.

HDV Recording

HDV™ products record signals onto standard DV cassettes, which have been available since the launch of the DV format in 1997. In this way, HDV takes advantage of recording media that is widely available and easily affordable.



Not only does HDV use the same cassette as DV, it also uses the same tape speed and the same track pitch. In fact HDV products can use the same mechanisms developed for DV, including head drum and cassette compartment housing. HDV also uses the same ITI sectors, for track structure and width, and the same subcode sectors, for index flags and time code. In this way, HDV accommodates High Definition video and audio signals in the same running time as for the DV standard.

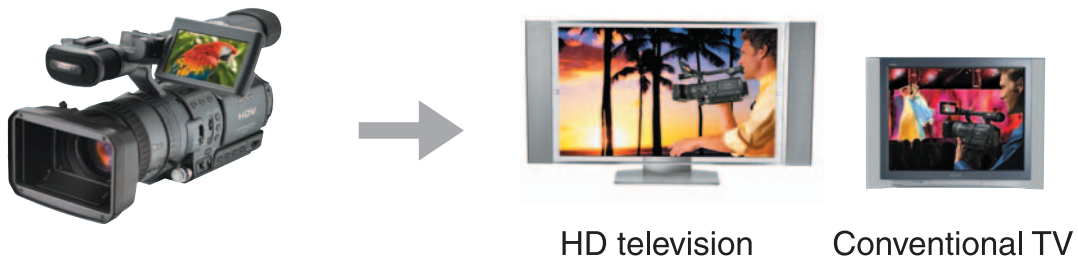
Error Correction

With the interframe compression of HDV, missing data has potentially bigger impact on picture quality than with the DV standard. That's why HDV increases the amount of data devoted to error correction redundancy. And while DV error correction operates within tracks only, HDV error correction operates across multiple tracks at one time. In this way, HDV offers greatly improved error correction and much higher tolerance for missing data.

HDV Playback

The full benefit of HDV quality requires an HD television.

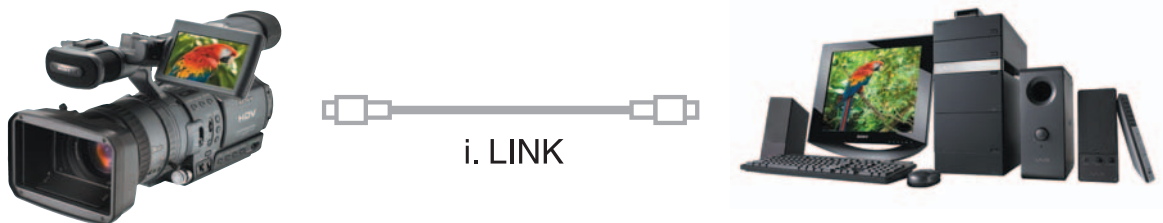
HDV is a High Definition medium. So naturally, to see its full quality, you'll want to connect your HDV™ camcorder to a High Definition television. Connections will vary by product and may include both analog and digital interfaces. Analog connections include Y/Pb/Pr component video with three RCA plugs and a D terminal (D3 or higher). Digital connection is possible through the i.LINK® IEEE 1394 interface.*



HDV camcorders will also play back on Standard Definition televisions through composite video (RCA plug) or S-Video (S terminal) connections. You will, however be limited to the picture quality of your Standard Definition television.

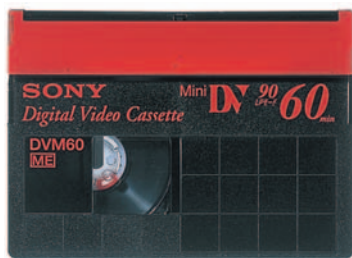
Playback and editing on a PC.

You can connect an HDV device to a compatible PC using the i.LINK IEEE 1394 interface.* In this way, HDV data can be uploaded to the PC, edited and recorded back to the HDV device. This requires a compatible interface in the computer and HDV compatible editing software. For a list of the latest companies that support HDV, visit www.hdv-info.org.



HDV tapes will not play on conventional DV devices.

DV tapes recorded with HDV images will not play back on camcorders and decks designed to accept conventional DV tapes only. If you try to play an HDV tape on a DV device, you will not get picture and sound. Depending on the product, you may see a message that this is an HDV tape and a warning not to record over it. Please play HDV recordings on HDV compatible products.



No playback compatibility



Questions and Answers

FORMATS

Q What are the HDV formats?

A The HDV™ system records both 720p and 1080i formats. The 720p format uses progressive scanning, with 720 scanning lines and 1280 pixels per line. The 1080i format uses interlace scanning, with 1080 scanning lines and 1440 pixels per line.

Q What companies support the HDV standard?

A The standard was established by four companies: Canon Inc., Sharp Corporation, Sony Corporation, and the Victor Company of Japan, Limited. Many other companies, including many nonlinear editing software manufacturers, have expressed their support for the HDV standard. For the latest list of supporting companies, visit www.hdv-info.org.

Q Why are so many companies supporting HDV?

A Many companies recognize the advantages of HDV. It records on the DV cassette tape, a worldwide standard. And it uses the global MPEG-2 standard for video compression, making it easy to connect HDV products to televisions and home computers.

Q What kind of media does HDV use?

A The same DV cassettes already used in millions of DV-format camcorders the world over.

Q What is the HDV recording time?

A The same as DV recording time. Note: With the HDV 1080i format there is no long-playing (LP) mode.

Q How is it possible to record a High Definition picture onto standard DV tapes with the same running time as DV?

A The difference is MPEG-2, which is much more efficient than DV compression because it adds interframe techniques. In this way, HDV can record High Definition at the same bitrates that DV uses for Standard Definition.

Q Which has better picture quality: HDV or DV?

A HDV and DV have different video compression and tape recording methods. Since HDV was developed to handle High Definition, HDV has higher resolution, capturing more horizontal scanning lines and more pixels per scanning line.

- Q** **What is the HDV video compression method?**
- A** HDV uses MPEG-2 compression, Main Profile at High-14 Level. The bitrate after compression is 25 Mbps (1080i format).
- Q** **Doesn't MPEG-2 introduce artifacts such as block noise?**
- A** MPEG-2 compression can deliver very good performance as long as appropriate bitrates are used. Since HDV uses a bitrate of up to 25 Mbps after compression, the format achieves excellent picture quality.
- Q** **What audio compression does the HDV format use?**
- A** The format uses MPEG-1 Audio Layer II compression, starting with 16-bit samples at a 48 kHz sampling frequency and resulting in a compressed bitrate of 384 Kbps.
- Q** **Which has better sound quality, HDV or DV?**
- A** HDV uses compressed audio at the high bitrate of 384 Kbps. In 2-channel mode, DV offers 16-bit uncompressed audio. For this reason, the sound quality of HDV is almost on a par with DV.
- Q** **How does HDV sound quality compare to a music CD?**
- A** Since HDV audio is compressed, it theoretically cannot match the sound quality of CD. However, by using a high bitrate of 384 Kbps after compression, the sound quality is almost on a par with audio CDs.
- Q** **Will HDV replace DV?**
- A** DV represents the current mainstream in both price and popularity. As High Definition broadcasting becomes accepted worldwide, we expect that the HDV format will also become the worldwide standard for personal content. We expect HDV camcorders to follow the familiar trend in consumer electronics, with more models on the market at progressively lower entry-level prices.
- Q** **What is the difference between 1080i and 720p?**
- A** The 720p format employs progressive scanning with 720 effective scanning lines and 1280 samples per line. The 1080i format uses interlace scanning with 1080 effective scanning lines and 1440 samples per line.
- Q** **Why are there two formats, 1080i and 720p, for the HDV standard?**
- A** The two formats meet the needs of different HD infrastructures around the world.
- Q** **Which has better picture quality: HDV 1080i or HDV 720p?**
- A** The picture quality will depend on the performance of individual products. Select the format that best meets your needs.

Q How does HDV error correction differ between 1080i and 720p?

A The two differ in correction coding ratio and the method for error correction across multiple tracks.

Q Can I record HDV and DV segments onto the same DV tape?

A It is possible under the standard. But it depends on the operation of specific equipment. Manufacturers may or may not develop products to support mixed recording on the same tape.

PLAYBACK AND EDITING

Q Can I play an HDV tape on a DV camcorder?

A No. Tapes with HDV™ recordings are only guaranteed for playback on HDV camcorders. If you try to play an HDV recording on a DV camcorder you will not get picture and sound. Depending on the product, you may get a message alerting you that the tape has an HDV recording and warning you not to record over it.

Q Can I play tapes recorded in HDV 720p format on camcorders that use the HDV 1080i format?

A The HDR-FX1 can playback tapes recorded in 720p and 1080i modes.

Q If I play an HDV recorded tape on a conventional, Standard Definition television, will the result be better than playing a DV tape?

A The performance and quality of video is dependent upon the camcorder used.

Q Can I store data from an HDV recorded tape onto my PC hard drive? In what format would the file be saved?

A Yes, using compatible HDV software applications. Refer to the software specifications.

Q Can I upload HDV data to my computer and edit the video and audio, just like DV data?

A Yes, if your HDV software application supports it. Refer to the software specifications.

Q Can I upload HDV data to my computer and save it on a DVD disc?

A If your HDV application software converts the data to Standard Definition, you can save your content in DVD-Video format. You can also save your content as data on a DVD data disc; however this type of disc will not play back on a DVD player.

Q After uploading my HDV data to my PC and editing it, can I then write the edited content back to a DV tape using either the HDV or DV standard?

A Yes, if your HDV software application supports it.



What type of PC would I need for uploading and editing HDV data?



The following recommendations are a general guideline. Be sure to check the "system requirements" of any application software you are considering.

Processor: Pentium® 4 processor, 3.06 GHz or higher

RAM: 256 MB minimum (1 GB recommended)

Hard Disk Drive: UltraATA100

i.LINK® IEEE 1394 terminal*: standard equipment

Display: XGA resolution or higher

Video memory: 32 MB or higher

Operating System: Windows® XP SP2 or higher



How big is the HDV file uploaded to a computer?



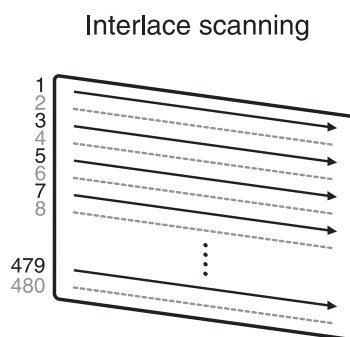
If the data is uploaded in MPEG-2 format without conversion, the file will be about the same size as a DV file of the same running time. A ten-minute video is about 2 GB.

Appendix 1: Advantages of HDTV

High Definition Television (HDTV) is literally the biggest change in television in 50 years! There's been nothing like it since the introduction of color television back in 1954. The benefits are so powerful, so profound, that they deserve careful explanation.

1. More scanning lines

In the early days of television, the camera had a pickup tube with an electron beam that scanned a photo-sensitive surface to generate the television picture. This scan followed a specified pattern of "horizontal scanning lines," beginning at the top right, tracing across to the left, and then moving down to trace the next line, and so on. In the home, the picture tube of the television set followed the camera's scan pattern, using its own electron beam to recreate the picture on the screen.



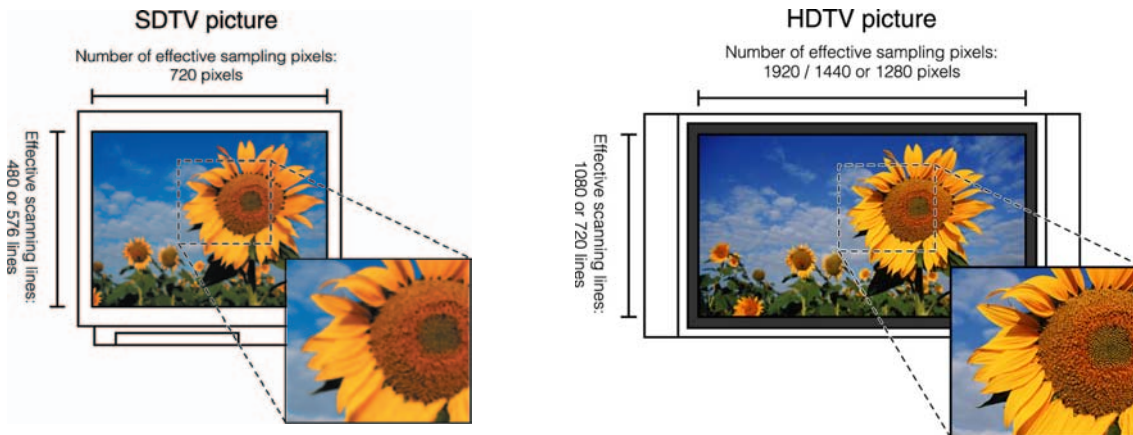
The NTSC television system uses 480 effective horizontal scanning lines.

In Japan, the United States and other countries that use the NTSC system, the Standard Definition TV picture includes 525 horizontal scanning lines, of which about 480 "effective" scanning lines appear on the screen. In countries that use the PAL and SECAM systems, the numbers are 625 total scanning lines and 576 "effective."

High Definition goes way beyond this, with a choice of 720 or 1080 effective scanning lines! This enables the High Definition picture to have far more detail.

2. More pixels per scanning line

In the early decades of television, the picture was not defined in terms of discrete "picture elements"—pixels. As you know, more pixels in a video image equal more detail available for viewing. In the late 1980s, when professional digital video systems became available, both the PAL and NTSC picture were defined as having 720 pixels per line (ITU-R.BT-601 standard).

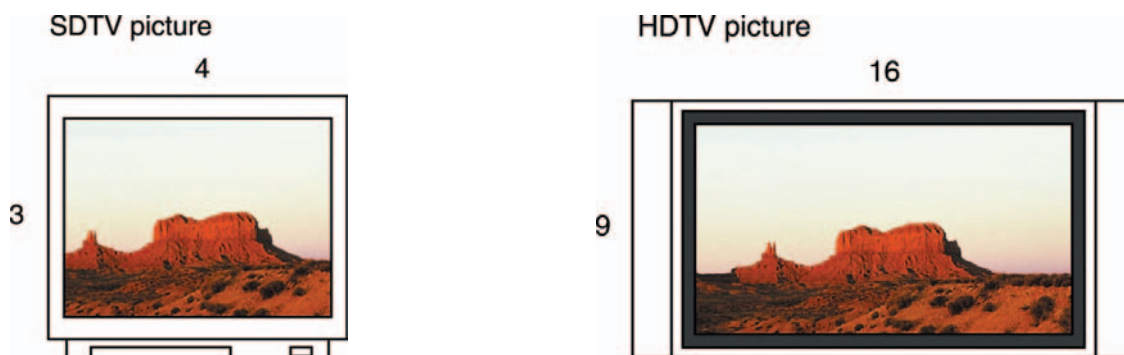


The Standard Definition picture (left) has fewer scanning lines and far fewer pixels per scanning line than the High Definition picture (right).

High Definition systems go far beyond this benchmark. The 720-line HD system provides 1280 pixels per line. And depending on implementation, 1080-line HD offers 1440 or 1920 pixels per line. The effect is vastly greater picture information, making television come alive with detail. This type of television picture is also perfect for big-screen viewing, where the increased detail can have maximum impact.

3. Widescreen 16:9 picture

The shape of the television screen is measured by the "aspect ratio," the proportion of screen width to screen height. Conventional television uses an aspect ratio of 4:3. This means that the screen is 4/3 or 1.333 times wider than it is high. This screen shape is almost square. In contrast, the human field of vision substantially wider, about 140 degrees wide by 90 degrees high. That's why High Definition television uses a wider screen, with an aspect ratio of 16:9. This wider screen is 16/9 or 1.778 times wider than it is high. In this way, the wider 16:9 screen is a better match for the human visual field. The result is an even more lifelike, more immersive experience—closer to the feeling of "being there."



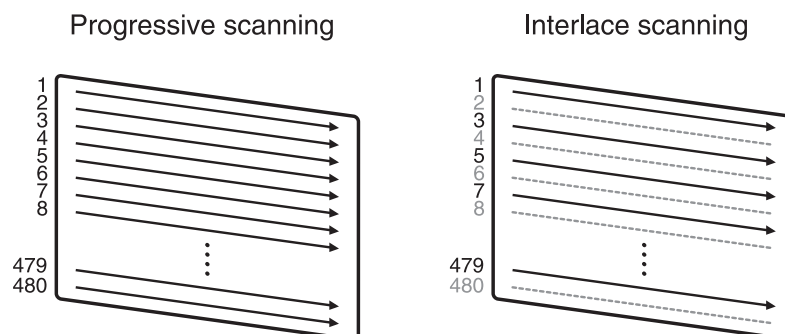
Standard Definition (left) uses a 4:3 aspect ratio that's almost square. High Definition (right) uses a 16:9 aspect ratio that's more panoramic—and closer to the actual field of human vision.

4. Interlace and progressive scanning

In video, what appears to be a continuously moving image is actually a series of discrete still pictures, called frames. In NTSC Standard Definition, each frame lasts 1/30 second and contains 480 effective scanning lines that appear on the screen.

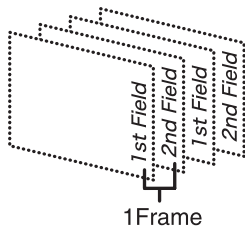
Because of limitations in the early days of television, these 480 lines were divided into two "fields," each of which lasts 1/60 second. At the studio camera; the first field captures the odd-numbered scanning lines, skipping every other line. The second field comes back and captures the even-numbered scanning lines. This is "interlace" scanning and it displays only 240 scanning lines at any one time. Interlace scanning in the studio camera is mirrored by interlace scanning in the home television, for accurate display of motion.

In PAL and SECAM countries, interlace works the same way, but the specific numbers are different. Each frame lasts for 1/25 second and includes 576 effective scanning lines. These are divided into fields that last 1/50 second and contain 288 scanning lines, each.

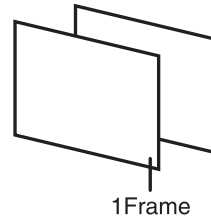


Interlace scanning (right) displays the video frame in two fields, one for the odd-numbered scanning lines and one for the evens.

Interlace scanning



Progressive scanning



Interlace scanning (left) divides each frame into two fields.

Progressive scanning (right) does not divide the frame.

Depending on the country and the implementation, High Definition retains interlace scanning, but adds the additional option of "progressive scanning." In the progressive system, every scanning line is shown in sequence. The video frames are not subdivided into fields.

The 1080-line interlace High Definition system offers superior horizontal resolution. But because the interlace process sacrifices some clarity in the vertical direction, the 720-line progressive system has slightly better vertical resolution.

With line rate, frame rate and scanning type all variable, special notation, such as "1080/60i" is used to describe each choice. This expression defines the picture as 1080 effective scanning lines, 60 fields per second with interlace scan.

1080/60i

"i" indicates interlace scanning
"p" indicates progressive scanning
Frame / field frequency
Number of effective scanning lines

5. Digital video instead of analog

Conventional television broadcasting is analog, a system that exposes the picture to distortions and noise that can degrade picture quality. In particular, analog composite video broadcasting degrades the color. Digital video can deliver a far cleaner, more convincing picture. And because digital video systems employ separate channels for the Y/B-Y/R-Y components, the color reproduction can be far superior. Even a Standard Definition digital source, such as a DVD-Video movie, can deliver noticeably higher quality than typical analog broadcasting, and dramatically higher quality than analog VHS tape.

High Definition offers all these digital video advantages. You'll see pictures with low noise, high accuracy and incredibly rich, vivid color.

6. Digital audio instead of analog

As with DVD, High Definition is accompanied by digital audio, with options for room-shaking digital surround sound. You'll hear dialog, background music and sound effects with a frequency response and dynamic range comparable to Compact Disc.

SDTV and HDTV compared

	SDTV		HDTV	
	NTSC	PAL/SECAM	720p	1080i
Total scanning lines	525	625	750	1125
Effective scanning lines	480	576	720	1080
Effective pixels per line	720		1280	1440 or 1920
Scanning format	Interlace		Progressive	Interlace
Aspect Ratio	4:3		16:9	

Appendix 2: HDTV as a Global Movement

The early years of HDTV

Research into HDTV started in the 1960s at the NHK Science and Technical Research Laboratories (NHK STRL) in Japan. The lab began looking at viewing angles and aspect ratios that enhance realism. Eventually, researchers determined the screen size, the number of scanning lines, and the standard viewing distance to achieve the next generation of realism. In 1984 after 20 years of research, the NHK STRL established the MUSE system, an analog method of HDTV broadcasting. The laboratory also suggested the term "Hi-Vision," as a popular name for HDTV.

A unified standard for HD studio production

Conventional TV broadcasting fragments the world into three camps: the NTSC system adopted by North America and Japan; the PAL system adopted by the UK, Germany, and China; and the SECAM system adopted by France, Eastern Europe, and Russia. Unfortunately, these systems differ in the number of scanning lines, which define the resolution of the images. Television content needed to be produced using the standard of the corresponding regional broadcasting system. International distribution of programming often required clumsy scanning line and frame rate conversions.

Japanese technologists were concerned that these incompatibilities from country to country could be repeated in the new age of HDTV. To facilitate international program distribution, the Japanese suggested that a single, global standard should be developed for HD studio production. These discussions started in the Comité Consultatif International Radiophonique (CCIR), which has since become the International Telecommunications Union – Radiocommunication Sector (ITU-R). Although the HD standard for studio production was established in 1990, major issues such as the number of scanning lines remained unresolved. After three versions, the number of scanning lines was unified in the fourth revision, approved in 2000.

Today, even though the world's major HDTV broadcasting formats differ in their specifics, they all adopt the number of scanning lines determined in the HD studio standard. The approval of the HD studio standard provided the foundation for HDTV.

HDTV and digital broadcasting converge

The idea behind digital video broadcasting began with the NHK Science and Technical Laboratories in Japan in 1982. Their concept was Integrated Services Digital Broadcasting (ISDB), which combines moving images, sound, text, and still pictures into a digital broadcast signal.

The technologies required for digital video broadcasting, including data compression and error correction were developed by the late 1980s. Today, digital terrestrial broadcasting, digital satellite broadcasting, and digital cable services are all marketplace realities. HDTV technology is also digital. Currently major digital HDTV broadcasting systems include the ISDB format developed in Japan, the Digital Video Broadcasting (DVB) format developed in Europe, and the Advanced Television Systems Committee (ATSC) format developed in the US. Over-the-air terrestrial digital broadcasts in these formats have begun in 12 countries. Digital HDTV has gone global.

HD in movie production

For years, producers in Hollywood and elsewhere have been hoping to take advantage of digital technologies to supplement or replace conventional production on 35mm motion picture film. Film-based production requires chemical development and the creation of "dailies," film prints that the director reviews the following day. In contrast, digital production is immediate. Directors enjoy what-you-see-is-what-you-get feedback, with full-resolution real-time monitoring and playback, right on the set. And digital production is perfectly suited for today's digital effects, including green-screen compositing, Computer-Generated Imagery (CGI) and digital color correction. In 1999, Sony introduced the first production system to combine the advantages of digital High Definition with the 24 frames per second capture rate of motion picture film. Sony's CineAlta™ 1080/24p system was quickly adopted by Hollywood directors such as George Lucas, Robert Rodriguez and Robert Altman for movies as diverse as "Star Wars: Episode 2, Attack of the Clones," "Once Upon a Time in Mexico" and "The Company."

HDTV Timeline

- 1964** *NHK Science and Technical Laboratories in Japan (NHK STRL) began research into high definition television.*
- 1982** *NHK STRL put forward Integrated Services Digital Broadcasting (ISDB).*
- 1984** *NHK STRL established Multiple Sub-Nyquist-Sampling Encoding (MUSE), a system of analog HDTV.*
- 1985** *NHK STRL announced "Hi-Vision" as its name for HDTV.*
- 1987** *The Federal Communications Commission (FCC) of the US invited public applications for terrestrial broadcasting systems of HDTV.*
- 1990** *The International Telecommunications Union - Radiocommunication Sector (ITU-R) approved the broadcasting studio standard for HDTV.*
- 1993** *The Digital Video Broadcasting (DVB) project was established.*

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- 1994** *The European Telecommunications Standards Institute (ETSI) approved DVB-S, a standard for satellite digital broadcasting.*
 - 1994** *The ETSI approved DVB-C, which is a standard for digital cable television.*
 - 1996** *BskyB launched satellite broadcasting with the DVB system in the UK.*
 - 1996** *Canal+ started satellite broadcasting with the DVB system in France.*
 - 1997** *The ETSI approved DVB-T, a standard for terrestrial digital broadcasting.*
 - 1997** *The FCC approved ATSC (Advanced Television Systems Committee), a standard for terrestrial digital broadcasting.*
 - 1998** *The Telecommunications Technology Council (TTC) in Japan approved ISDB-S, a standard for satellite digital broadcasting.*
 - 1998** *The United Kingdom began terrestrial digital broadcasting with the DVB system.*
 - 1998** *The United States began terrestrial digital broadcasting with the ATSC system.*
 - 1999** *Sweden began terrestrial broadcasting system with the DVB system.*
 - 2000** *The fourth edition of the HD studio production standard, which unified the number of scanning lines, was approved.*
 - 2000** *The ITU-R recommended ISDB-T as the standard for terrestrial digital broadcasting.*
 - 2000** *Japan began satellite digital broadcasting with the ISDB-S system.*
 - 2000** *Spain began terrestrial digital broadcasting with the DVB system.*
 - 2001** *Australia began terrestrial digital broadcasting with the DVB system.*
 - 2001** *Singapore began terrestrial digital broadcasting with the DVB system.*
 - 2001** *South Korea began terrestrial digital broadcasting with the ATSC system.*
 - 2003** *Japan began terrestrial digital broadcasting with the ISDB-T system.*
 - 2003** *Canada began terrestrial digital broadcasting with the ATSC system.*

Appendix 3: Glossary

4:3. Aspect ratio of conventional, Standard Definition television.

16:9. Aspect ratio of High Definition television.

720p. High Definition system with 720 effective scanning lines and progressive scanning.

1080i. High Definition system with 1080 effective scanning lines and interlace scanning.

Analog. A means of representing information as continuous waves, as opposed to the computer 1s and 0s of digital systems.

Aspect Ratio. The ratio of picture width to picture height. Conventional TV has an aspect ratio of 4:3. HDTV has an aspect ratio of 16:9.

ATSC. Advanced Television Systems Committee. This group, composed of private companies, made digital TV recommendations in the United States. The term ATSC is now used to indicate the family of digital TV broadcast formats proposed by this committee. There are standards for both terrestrial broadcasting and cable TV service. MPEG-2 is the video coding system and Dolby® AC-3 compression is the audio coding system.

Blu-ray Disc™. A recordable High Definition video medium the same size as a DVD that can store 27 GB or six times the data of a DVD. Blu-ray Disc is a product of the Blu-ray Disc Founders, a group of companies that includes Dell Inc.; Hewlett Packard; Hitachi, Ltd.; LG Electronics Inc.; Mitsubishi Electric Corporation; Panasonic (Matsushita Electric); Pioneer Corporation; Royal Philips Electronics; Samsung Electronics Co., Ltd.; Sharp Corporation; Sony Corporation; TDK Corporation; and Thomson (as of August 1, 2004).

CCIR. Short for Comité Consultatif International Radiophonique, the former international standards-setting body for television. The CCIR is now called the ITU-R. Component video. The method of recording or transmitting images using separate channels for luminance (black-and-white, or Y), B-Y (blue color difference) and R-Y (red color difference) signals. In the analog domain, these signals are often abbreviated Y/Pb/Pr. In the digital domain, they are termed Y/Cb/Cr.

Component video terminals. Equipment connections with separate channels for Y/Pb/Pr. Component video connections typically use three RCA plugs.

Compression. A process that reduces the data required to represent an audio or video signal. Compression works because digital audio and video are highly redundant. Modern coding can reduce the data by 96% or more with little or no perceptible change in quality.

Digital. A means of representing information as computer 1s and 0s, as opposed to the continuous waves of analog systems.

Digital cable television. Digital TV distribution over coaxial cable. Standards include ISDB-C and DVB-C.

Digital satellite broadcasting. TV distribution from orbiting satellites. Standards include ISDB-S and DVB-S.

D terminal. A connector that can transmit the three signals that make up component video: Y (luminance), B-Y (blue color difference) and R-Y (red color difference). The connector is shaped like the letter "D." The terminals include D1 for 480i; D2 for 480p and 480i; D3 for 1080i, 480p and 480i; and D4 for 720p, 1080i, 480p and 480i. For High Definition, the D terminals on both sending and receiving devices must be D3 or D4.

DVB. Digital Video Broadcasting, the TV broadcast standard developed by the DVB project established jointly by European manufacturers. DVB embraces both High Definition and Standard Definition. DVB can be used to reduce data requirements and provide multiple channels. It includes standards for terrestrial broadcast (DVB-T), satellite broadcast (DVB-S), and cable service (DVB-C). MPEG-2 is the video coding system and MPEG-2 Layer I and II are the audio coding systems.

DV standard. The Digital Video cassette format. DV records images and sound onto dedicated, miniature cassette tapes. The DV format has the advantages of superb digital quality and compatibility with PC editing systems.

Effective scanning lines. Scanning lines that are actually available for display on the television screen. This excludes scanning lines devoted to the vertical blanking interval, which are not displayed.

Error correction. Methods that detect and correct missing or garbled digital information. Behind the scenes, modern digital recording and transmission systems employ powerful error correction.

FCC. Short for Federal Communications Commission, the United States government body that regulates telecommunications, including radio, television, cable TV, and telephone service.

Field. In interlace scanning, a picture with alternating scanning lines that includes half the information of a video frame.

Field frequency. The number of fields per second.
Frame. One picture in a sequence of moving pictures. In interlace scanning, each frame contains two fields.

Frame frequency. The number of frames per second.

HD standard for studio production. An international standard that enables easy program exchange among nations. Standardizes the number of scanning lines. All HDTV broadcasting follows the studio standard, even though the specific broadcasting formats differ.

HDTV. High Definition Television, the digital TV broadcast technology that provides a dramatic increase in picture realism. Advances include vastly improved picture detail, superior color, digital surround sound and a wide, 16:9 aspect ratio screen.

HDTV is the next-generation standard, a complete departure from the existing broadcast formats: NISTC, PAL and SECAM.

HDV™ standard. The videocassette format that is the subject of this handbook. HDV records and plays back High Definition video and digital audio using widely-available DV tapes. Thanks to MPEG-2 compression, HDV achieves the same running time as the DV standard, despite the higher resolution. HDV includes the 1080i format and the 720p format.

Hi-Vision. The name of the ground-breaking HDTV service developed by Japan's NHK. Digital HDTV is now called Digital Hi-Vision in Japan.

i.LINK® interface.* Sony's name for the IEEE 1394 digital interface used to connect computers to peripheral equipment, including digital camcorders. The interface enables up to 63 devices to be linked together and has a maximum transmission speed of 400 Mbps. Other features include power through the cable and hot plug connection and disconnection without first turning equipment off. The i.LINK interface is used to connect DV camcorders and is sometimes called a DV terminal.

Interlace. Television scanning method that divides a video frame into two separate fields. In the camera, fields are captured skipping every other line. First the odd-numbered lines are captured, then the even-numbered lines.

ISDB. Integrated Services Digital Broadcasting, an HDTV system based on work by the NHK Science & Technical Research Laboratories (NHK STRL) in Japan. It includes terrestrial broadcast (ISDB-T), satellite broadcast (ISDB-S) and cable service (ISDB-C) standards. MPEG-2 is the video codec while the MPEG-2 Advanced Audio Codec (AAC) is used for audio. ISDB also supports Electronic Program Guides and data broadcasting. With ISDB, a single home receiver can handle terrestrial, satellite and cable transmission.

ITU-R. Short for the International Telecommunications Union – Radiocommunication Sector. The international standards-setting body for television.

MPEG. Moving Picture Experts Group, an international standards-setting body. The name MPEG now also stands for the family of audio/video compression standards from this group, which includes MPEG-2. MPEG-2 compression is now used for DVD, digital broadcast satellite, digital cable and all of the world's HDTV broadcast standards.

MUSE. Multiple Sub-Nyquist-Sampling Encoding, an HDTV broadcasting system based on an analog format developed by the NHK Science & Technical Research Laboratories (NHK STRL) in Japan. This format was a precursor to today's HDTV broadcasting.

NHK. Japan Broadcasting Corporation. This is the national broadcaster of Japan—the Japanese equivalent of the BBC or CBC. Through the NHK Science and Technical Research Laboratories, the company has been a leader in the development of High Definition television.

NTSC. National Television Systems Committee, the Standard Definition broadcasting system used in the United States, Japan, Canada and other countries. NTSC uses interlace scanning with 525 total scanning lines, 480 active scanning lines, 30 frames per second and 60 fields per second.

PAL. Phase Alternation by Line, the Standard Definition broadcasting format developed in the former West Germany and used in the United Kingdom and China. PAL uses interlace scanning with 625 total scanning lines, 576 active scanning lines, 25 frames per second and 50 fields per second.

Pixel. Short for "picture element," the smallest unit of a digital picture.

Progressive. Television scanning method that captures and displays all the scanning lines in a video frame in order, from the top of the screen to the bottom.

RCA plug. The connector used for composite video, line-level audio, and separate Y/Pb/Pr component video connections. It was developed by RCA in the United States.

Resolution. The amount of detail a television picture conveys. Higher resolution means better picture quality. Resolution can be measured in television lines per picture height (TVL/PH) or in pixels. Common resolutions are 720 x 480 and 720 x 576 for Standard Definition, 1280 x 720, 1440 x 1080 and 1920 x 1080 for High Definition.

Scanning. The process of creating a television picture in a camera pickup tube or a home television cathode ray tube. The scan begins at the top left of the picture and moves in a horizontal line to the top right. Then the next line underneath is scanned and so on until the bottom of the picture.

Scanning lines. The horizontal lines traced in the scanning process. The more lines, the sharper the picture.

SDTV. Standard Definition Television, indicating the picture quality before HDTV, using the conventional, 4:3 aspect ratio.

SECAM. Sequential Colour A Memoire (Sequential Color with Memory). This Standard Definition broadcasting format was developed in France. SECAM uses interlace scanning with 625 total scanning lines, 576 active scanning lines, 25 frames per second and 50 fields per second.

S-Video terminal. A connection that divides composite video into separate channels for chrominance and luminance to achieve better picture quality than conventional, composite video.

Terrestrial. Broadcasting from TV towers built on the ground, as opposed to cable services or satellite broadcasting.

Terrestrial digital broadcasting. Digital broadcasting from TV towers built on the ground. Standards include ATSC, ISDB-T and DVB-T.

Widescreen. Term used to describe the 16:9 aspect ratio of High Definition programming and HD televisions.

HDV TECHNOLOGY HANDBOOK

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* i.LINK is a trademark of Sony used only to designate that a product contains an IEEE 1394 connection. All products with an i.LINK connection may not communicate with each other.