# HDTV COMPENDIUM

## Technical Information in Paperback format compiled by

JVC

The Perfect Experience




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Dear Readers,

The World Football Championships in Germany have ensured a high-pressure boost to the spread of HDTV. Just before this mass sporting event, HDTV-capable screens suddenly appeared on the market as if by magic. What was previously being talked about as merely the "myth of High Definition" is now becoming reality. The four driving forces of content, receiver sets, production techniques and distribution have finally come together and are now able to pull in the same direction. The hen-egg problem seems to have been solved.

Everybody is talking about HD as a new trend for television and for film production, but what do these initials actually conceal? What thoughts does this issue conjure up in your mind and what exactly are the differences between HDTV and conventional TV and cinema?

In order to give you a brief idea of what it's all about, JVC has compiled most of the important technical information into this paperback-sized HD booklet for you.

We wish you much reading pleasure with this practical pocket-sized HD booklet.

JVC
The Perfect Experience

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## ACQUISITION / RECORDING

Digital images are the result of a mathematical calculation which store a defined number of pixels. The number of pixels determines the resolution. Each pixel is assigned a certain level of brightness (luminance) and colour (chrominance) with a set bit-depth. The higher the resolution and the higher the number of colour and brightness levels, the better the picture quality. Of course, the quantity of data is also greater. With higher-definition images, all image information in the camera head is processed and output as HD or HDV video signals, as in a conventional video camera.

While PAL video cameras generally record using the conventional interlaced process, with HD you can choose between interlaced and progressive as a recording format. The choice of recording format has a considerable influence on the resulting pictures. In the interlaced mode cameras typically work with a vertical deep pass filter which reduces the resolution in a vertical direction by up to 30 per cent. This filtering is necessary, as otherwise an annoying flickering occurs between the lines on valve equipment. When recording in progressive mode this problem does not occur; this also does away with the filtering requirement. As well, recorded pictures progressively offer better resolution of moving objects, as all lines are recorded at once (see also → FRAME RATES). This is why progressively recorded images are considerably clearer with the same number of lines than those recorded in interlaced mode.

Internally, all new display equipment such as plasma and TFT screens and projectors work progressively. If a display of this type is supplied with an interlaced signal, it must first "de-interlace", which is a very complex and involved process and does not always succeed. On the other hand, these displays process progressive signals directly as the "de-Interlacing" becomes superfluous here. Over the long term the progressive formats may therefore be expected to prevail.



## BIT RATE

The bit rate defines the quantity of data transmitted for the picture and sound information per time unit. If the compression procedure and the resolution are similar, a higher bit rate will result in a higher quality signal. If differing compression procedures are used, the efficiency of the compression procedure and the bit rate decide the quality. For example, given the same bit rate an MPEG-2 signal is of superior quality to a DV signal, as MPEG-2 works more efficiently.

## COMPRESSION PROCEDURE

The compression procedure for video data is based on the condensation of similar pixels within a picture or across picture frames. Similarities with consecutive pictures are analysed and condensed within a defined number of pictures, the GOPs, or "Group of pictures". In the compression of audio data "inaudible" information is simply removed.

**MPEG** is the generic term for a technology platform (Moving Pictures Experts Group) which is made up of the American International Standards Organisation (ISO) and the International Electrotechnical Commission (IEC). This commission developed several standards for the source coding of audio and video image signals which are referred to as the MPEG standard. MPEG is involved with the standardisation of technologies for the compression of digital audio-visual data. An MPEG standard is made up of a basic framework with a lot of freedom for configuration and has several levels. Each level describes certain characteristics and does not necessarily constitute a version number.

The **MPEG2** standard covers the technology which every DVD player around the world operates with and which is used in every form of digital television. Digital HD platforms use MPEG2 video compression in MP@HL (Main Profile at High Level) in the following bit rates: 720p50 = 15 MBit/s and 1080i25 = 19 MBit/s. As progressive signals are easier to compress, this results in a lower data rate with comparable quality for 720p50. For this reason the → EBU has suggested 720p50 as the broadcasting format for HDTV in Europe

**MPEG4** is a new standard for the compression of every form of multimedia data. HDTV is transmitted in MPEG4/H.264, also known as AVC (Advanced Video Coding). MPEG4 combines various multi-media plat-

forms as a technological format and will be also used in future in the internet and in mobile telephony. Transmitters can save up to 30% of expensive transmission capacity at play-out if they switch from the current MPEG2 to the space-saving MPEG4 standard. HD bit rates will only be 3-10 MBit/s.

**Windows Media Version 9 (VC1)**, also known as SMPTE standard VC1/WM9, supports HD resolutions and multi-channel audio (5.1 to 6-channel) and has copy protection as an integrated digital rights management system (DRM). The HD bit rates for the TV transmission are 6 to 10 MBit/s at VC1/WM9.

Both MPEG4/H.264 and VC1 use more complex coding algorithms for compression than MPEG2, so more computing power is required to decode them. While a computer with a 3 GHz processor can decode a MPEG2 compressed HDTV data stream without any problems, a computer with 2x 3.4 GHz is required to decode a comparable MPEG4/H.264 signal. Even with set-top boxes, more effort is required that can only be achieved with a new semiconductor chip. But the first sets are already available.

## DOLBY DIGITAL 5.1

More sophisticated multi-channel audio signals (surround sound) are often mentioned in connection with the better-quality HDTV picture. Dolby Digital 5.1 is usual here, which stands for five full-range audio channels plus a low frequency audio channel. On its own each channel can reproduce a frequency range of 20 to 20,000 Hertz. With Dolby Digital 5.1 six speakers are set up around the audience in order to produce a three-dimensional audio impression. The positions of the speakers are: centre-front for the dialogues, front-left and front-right for the front loud speaker, with which one normally listens to stereo. The sound-effects loudspeakers are positioned to the rear left and the rear right and the sub-woofer is at the centre-rear. This allows a left-right orientation which gives the feeling that a train is passing through the middle of the room, that an explosion is taking place at the rear or a chase through the room is being acoustically simulated. Dolby Digital is also known as AC-3 (Audio Codec 3) and is a strongly compressed digital audio format in DVB standard. The data stream from Dolby 5.1 can be transferred using special compression techniques to the space-saving Dolby-E. The picture and the 5.1 sound can be carried via a Digital Beta and HDCAM tape to the station with a single media. Two different language versions in Dolby Digital and two others in Dolby Surround are possible on one master.



## DOLBY-E

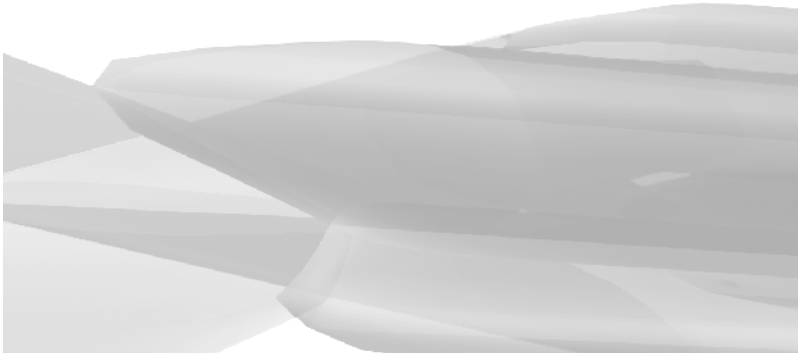
The Dolby 5.1 data stream can be transferred by a special compression technique to the space-saving Dolby E. The picture and the 5.1 sound can be carried via a Digital Beta and HDCAM tape to the station with a single media. Two different language versions in Dolby Digital and two others in Dolby Surround are possible on one master.

## DTE

= "Direct To Edit", a technology developed by Focus Enhancements and which enables direct access to clips stored in a hard disc recorder. The use of DTE technology makes the time-consuming "captures" of recorded material form the tape redundant, which saves a lot of time during editing → TAPELESS.

## DV

Stands for Digital Video and describes a world-wide format for the digital recording of SD video signals onto tape. Because it offers high quality and because over 50 manufacturers agreed on this format in the 1990's, it has a high level of customer acceptance and market penetration. The accompanying low-cost cassettes made DV the format of choice for low-cost recording in HDTV. This was the reason why the established tape format was also chosen as the recording medium for HDV.



## DVD-STANDARDS FOR HD

The HD-DVD and the Blu-ray™ disc will be the storage media of the future for DVD-HD formats. Both formats are currently involved in a bitter race for entry to the market. Both use a laser with a shorter wavelength of blue light. This can be focussed better and can thus write and read much finer structures, so that more data can be written on the discs. With the Blu-ray™ disc the information layer is very close to the surface. This enables even finer structures and hence a higher capacity. Of course, this technology is more susceptible to scratches and dirt and requires new production plants.

The HD-DVD is a continued development of the advanced optical disc (AOD) and has slightly lower capacity. The distance between the information layer and the surface is 0.6 mm, as with other conventional DVD's. This makes it more resistant to scratches and dirt. Due to the structure of the HD-DVD, which is similar to that of the DVD, existing DVD production plants can be converted with little cost and effort.

| High-Resolution DVD's | Consortium | Cooperation with Majors (Studios) | Compression | Capacity |
|---|---|---|---|---|
| HD-DVD | Toshiba, NEC, Sanyo, Memory-Tech etc. Call themselves HD-DVD Promotion Group | Paramount, Universal Pictures, Warner Bros., New Line Cinema | H.264, Windows Media 9 (VC1) MPEG2, AC3, DTS | 15 GB to 30 GB |
| Blu-ray™-Disc (BRD) | Sony, Philips, Samsung, Pioneer, Matsushita, Dell, Thomson, Hewlett-Packard with a total of more than 20 companies form the Blu-Ray Disc Association | 20th Century Fox, Columbia Pictures, MGM Studios, Disney | H.264, Windows Media 9 (VC1) MPEG2, AC3, DTS | 27 GB to 50 GB TDK has developed a prototype with up to 100 GB (9 hours) |



## EBU

The European Broadcasting Union. This is the umbrella organisation of European broadcasting corporations with their headquarters in Geneva (www.ebu.ch). The EBU has 74 members in 54 countries in Europe, North Africa and the middle East. It is responsible for the operation of the "Eurovision" network, which distributes most news and sports programmes for Europe. Besides many other areas of activity, the EBU is involved in technical developments both actively and in an advisory capacity in the fields of DAB, DVB and HDTV.

## FRAME RATES

The frame rate is the number of recorded and broadcast full pictures per second respectively. Essentially the picture can be transmitted entirely as a full picture (p = progressive) or in 2 chronologically sequential fields (i = interlaced). The look and the technical processes are different.

**p** "p" stands for "progressive", as the lines of the picture are recorded in their natural order (1, 2, 3, 4, 5, ...). As this process always stands for an entire picture per second (full frame), it is highly compatible with computer systems, plasma and TFT screens and projectors, as these generally work with full frames. Example: A moving football is caught, i.e., suspended, in the air in a single recorded picture.

**i** "i" stands for "interlaced" and indicates a 2-field or interlaced scanning. In video formats, fields, or "interlaced" pictures, were used in order to save bandwidth. There is a chronological and content-related difference between the first and the second field. The first field contains odd lines (1, 3, 5, 7, ...) and the second field contains only even lines (2, 4, 6, 8, ...). An example of "i" (interlaced) is, to use the previous football example, the following: the moving football is actually recorded twice – first in flight on the first field (all the odd lines) and then in flight in the second field (all the even lines). If we put the two fields together, we can see the movement of the football displaced between the even and odd lines. This annoying displacement is removed in modern displays with a de-interlacer.

**sf** "sf" is the abbreviation for "segmented frames". A full HD picture (24p) is divided into two equal fields with no chronological displacement, then processed and put together again. An example of "sf" (segmented frame): The odd lines of the recorded, moving football are in the first half-picture and the even lines of the same image of the football are in the second half-picture. If we put the two half-pictures together, we get an entire football suspended in the air again which looks just like the progressively recorded picture. In other words, "sf" material means progressive pictures which have been "packed" in the interlace process. The advantage here is the compatibility of such signals with technical infrastructures that are designed for interlace. For example, a 1080psf/25 signal can run over the same mixers, cross-point switchers and transmission channels as a 1080i/25 signal.

The frame rate primarily determines the display of movement and a higher frame rate results in more fluid movements. If the frame rate is low, a so-called "shuttering" effect occurs, where the picture jerks during rapid movements. That explains the typical film-look shown by pictures recorded at 24p or 25p. A typical liquid video depiction can be achieved from a frame rate of 50 pictures. Interlaced pictures have a more liquid appearance due to the higher frequency of the fields, which is twice the frame rate. However this is achieved at the cost of the loss of resolution in moving objects.

But apart from the matter of appearance, the decision to record progressive images (p) or interlaced images (i) also has technical and economic implications. The questions "Where is the product to be sold? (sales) and "At what quality-level are the pictures to be sold (budget) determine the frame rate in making the recording.

## 24P

This is a synonym for the production at the refresh rate of 24 pictures customary in film. Modern HD and HDV camcorders such as the GY-HD100 support this mode to enable film-makers to transfer their project 1:1 onto film after completion. The use of an HDV camera as the primary recording instrument considerably reduces the costs of a film production, which also makes film projects possible for producers of low-budget films. The pre-requisite for a good result is the use of a camera which works progressively, as only then is the full resolution of the HD format used in this mode available.



## HD READY

The EICTA (European Information, Communications and Consumer Electronic Industry Technology Association), the European Consumer Electronics Association, has issued the specifications listed below for HD-capable television sets. A special label, "HD ready" marks those sets aimed exclusively at the consumer market as a guide for retail customers.

**Specifications for HD-Capable Displays**

- supports all international resolutions such as 720 vertical lines x 1280 pixels and 1080 vertical lines x 1920 pixels (but at least 720 lines)
- image format of the display is 16:9 wide-screen
- frame rate frequencies 50 and 60 Hertz in both interlaced and progressive mode
- interfaces for video signal transmission in HD quality
- analogue component inputs (signal is transferred via three separate leads)
- digital interfaces according to DVI and HDMI standard, both support the HDCP copy protection coding

**Specifications for HD-Capable Set-Top Boxes**

- satellite reception with the DVB-S2 modulation process
- picture decoding:
  MPEG2 (HighProfile@MainLevel) and MPEG4 AVC (H.264), Microsoft VC-1
- sound decoding:
  MPEG, DolbyDigital, AAC-HE
- 1260 x 720p with 50 Hz and 60Hz and 1920 x 1080i with 50 Hz and 60 Hz
- HDMI output for HDTV (picture and sound)

## HDCP

High Bandwidth Digital Content Protection is a scrambling procedure for digital HD video interfaces. HDCP is designed to prevent the copying of HDTV programmes.

## HDMI

High Definition Multimedia Interface is a fully digital interface for transmitting high-resolution picture and sound data. The video part of HDMI is based on DVI and is compatible with it downwards. Most equipment supports the HDCP scrambling process on the HDMI interface. But HDCP is not a mandatory part of HDMI.

## HDTV

The initials HDTV stand for High Definition Television and is a digital recording and reproduction technology for picture and sound. As no internationally uniform standard has been established to date, any resolution higher than the current line resolution (PAL/SECAM 625 or NTSC 525) may be designated HDTV. The 16:9 image format of high-resolution television approaches cinema viewing habits very closely.

## HDCAM

This is the digital video format based mechanically on digital-betacam. With a resolution of 1,920 x 1,080 pixel in 16:9 format, HDCAM is capable of storing 185 MBit/s in 24p mode. After pre-filtering (band-width restriction to about 23 MHz and 1,440 instead of 1,920 horizontal pixels), the data is stored in compressed form so that it fits onto the 14 micrometer-thick metal particle tape. An HDCAM tape is Dolby E-capable and can store a choice of 16 different language versions in mono or 8 different language versions in stereo or two language versions in 5.1 Dolby Digital with another two versions in Dolby Surround.

## HDSDI

Stands for High Definition Serial Digital Interface. This is a professional interface for transmitting uncompressed digital HD signals via co-axial cable. The data rate is about 1.5 Gbit/s and the cable can be up to 100m long. HDSDI is able to use existing SDI (Serial Digital Interface) cabling, which makes re-equipping studios easier. However, components such as input cards for editing systems are considerably more expensive compared to IEEE1394.



## IEEE1394

A digital data interface, also known as FireWire™. This interface can be used to connect PC peripherals such as hard discs. However, its popularity is due to its use as a low-cost interface for connecting camcorders and peripherals in non-linear editing systems. The data is transmitted in compressed form as DV (25 Mbit) or HDV (19,7 Mbit/s or 25 Mbit/s).

## HDV

The high definition video (HDV) format is a combination of HD and DV technology. With HDV high-resolution video signals are recorded in MPEG2 compression (HD-MPEG) on a conventional mini-DV tape.

A HDV drive records at a constant data rate. With HDV-1 at 720p the data rate is 19 MBit/s and with HDV-2 at 1080i it is 25 MBit/s. The generated data can be transferred in real time via fire-wire cable on a computer (PC or laptop) and then edited there.

| | 720p (HDV-1) | 1080i (HDV-2) |
|---|---|---|
| storage medium | DV tape | DV tape |
| resolution/picture rate | 720/25p, 720/50p<br>720/30p, 720/60p | 1080/50i and 1080/60i |
| effective pixels | 1280 x 720 | 1440 x 1080 |
| aspect ratio | 16:9 | 16:9 |
| compression | MPEG2@H-14 | MPEG2@H-14 |
| sampling rate | 75.25 MHz | 55.6875 MHz |
| colour sampling | 4:2:0 | 4:2:0 |
| quantisation | 8 Bit | 8 Bit |
| data rate | 19 Mbit/s | 25 Mbit/s |

## HDV CAMCORDER FROM JVC

JVC's JY-HD10 was the first of the new HDV camcorder generation. It records in full frame mode (progressive) with a 1/3" CCD chip with 1.18 million pixels on a DV cassette, and either a DV signal or an MPEG2 data stream in SD- and HD resolution. The material in 16:9 full screen mode (30 fps for NTSC) can be converted via an integrated format converter and reproduced in various resolutions and formats.

JVC's GY-HD100E is a 3-CCD camcorder with an effective resolution of 1,280 x 720 pixels in 16:9-format. It records HDTV with 24, 25 or 30 frames and, like the JY-HD10 model described above, can also be switched over to DV recording if desired. Recording can be carried out on tape or external/dockable hard disk. A reproduction of the recording can be made in PAL, 720p, or 1080i format as desired. The corresponding tape deck is called BR-HD50E. Interchangeable lenses with manual focus and zoom are also among the accessories that come with this light and compact shoulder camera.

Its successor the GY-HD251 offers recording of 50 or 60 frames. By an optional studio adapter it will be operational in studio environments as an HD or SD camera as well.



## IMAGE SENSORS

CCD and CMOS sensors consist of pixels, which produce an analogue output voltage (electrical charge) depending on the incident light. These charges are then converted to digital data. The acquisition process always remains analogue, as all digital image acquisition equipment use analogue components. From a theoretical point of view, it is comparable with the digital scanning of an analogue film where the analogue brightness values are digitised. Of course, there is an aesthetic difference between the photochemical process and the electronic process.

**CMOS**

Complementary metal oxide semiconductors ("CMOS" for short). The highly dynamic CMOS image sensors consist of complementary pairs of metal oxide semiconductor transistors with low power-consumption, high processing speed and are tolerant of fluctuations in power supply. Each light-sensitive sensor pixel has its "own" CMOS transistor which controls the charge flow and allows the individual selection of information. This prevents "smear" effects. Apart from the currently highest resolution, the semiconductor chips guarantee very good colour fidelity and contrast. The size of the image frame of a CMOS chip may correspond to the size of the image frame of a 35mm film, so the same primes, zooms and special lenses as those used in 35mm cameras can be used. But there are also smaller sensors in 1/3" or ½" format.

**CCD**

The CCD image sensor is a chip with several sensor pixels whose charges are selected line by line through a sort of "charge trough". CCD chips are very light sensitive and produce little image background noise. However, in the case of higher light incidence excess charge may spill outside the "trough", which leads to disturbing smear effects. The size of the image frame in a conventional 2/3 inch CCD sensor chip for HD cameras is 9.6 x 5.4 millimetres. Together with various read-out techniques of the CCD chips, a few abbreviations should be explained: IT = Interline-Transfer, FT = Frame-Transfer, FIT = Frame-Interline-Transfer.

The image generation with three CCD sensor sets in the cameras takes place mostly in RGB and is converted internally according to the YUV component standard. Y is the luminance (brightness) signal, U and V are colour differentiation signals (chrominance signals) of the three colours red, green and blue. The YUV component signal is obtained from an RGB signal according to the following formula:

**YUV**

$$Y = 0{,}3R + 0{,}59G + 0{,}11B$$
$$U = R - Y$$
$$V = B - Y$$

## K

K means 1000 horizontal lines each, AKA pixels. 2K = 2048 horizontal lines/pixel x vertical 1536 columns/pixels, which is equal to half the resolution of 35 mm film material. The horizontal line resolution of HDTV with 1920 pixels is almost equal to 2K.

## PICTURE FORMATS

"Format" is defined as a standardised relationship between height and width. A picture format is defined by the aspect ratio. The relationship of the width of the picture to the height of the picture in a conventional TV standard PAL/SECAM is 4:3 or 1:1.33. The relationship of the width of the picture to the height of the picture as used for HDTV (wide screen) is 16:9 and 1:1.78. It differs from the international cinema standard of 1:1.85 by only 4% and is therefore very close to cinema viewing habits.
When a 16:9 format is shown on a 4:3 television set, the picture must be scaled. The scaling from a 16:9 picture to a 4:3 television format while retaining the aspect ration is called Letterbox. Reducing the size of the screen causes black bars to appear at the top and bottom of the screen. This wastes valuable screen-space for showing the pictures.

**A Summary of Aspect Ratio**

| Aspect Ratio | Picture Formats |
|---|---|
| 1:1 | photography (e.g. the square 6x6 medium format) |
| 1:1,17 | Scope |
| 1:1,31 | IMAX |
| 1:1,33 | 4:3 = standard television for PAL/SECAM and (earlier) the 35 mm silent film screen |
| 1:1,37 | 35 mm-Academy (the sound film format of the 1930's) |
| 1:1,66 | 35 mm wide screen film (Europe) |
| 1:1,68 | PAL Plus (Wide PAL), Super 16 mm |
| 1:1,78 | 16:9 for HDTV and HD cinematography wide-screen |
| 1:1,85 | 16,65:9 cinema standard for the 35 mm wide-screen film (USA) |
| 1:2,2 | 70 mm wide screen |
| 1:2,35 | 35 mm CinemaScope and Panavision format (anamorphotic) |
| 1:4 | three 4:3 pictures are shown side by side (Multivision) |



## PIXEL

A pixel is a square picture element and represents the smallest unit of a digital video picture (bit-mapped graphics). "Pixel" is a made-up word from the abbreviated forms of "picture" and "element". The size of a pixel is not set but depends on the display medium. The bigger the number of pixels, the more details can be perceived in the display.

## PROHD

Is not a new standard but a concept developed by JVC to enable professional users to switch to cost-effective HDTV. ProHD uses the HDV recording on DV tapes and is thus fully compatible. The requirements of professional users have been taken into consideration in constructing the ProHD products and have been put into practice to a large extent. Camcorders in the ProHD series have features such as exchangeable lenses and manual zoom, focus and light control. They can be hand-held without the hand tiring and forego functions such as special effects and auto-focus which professionals do not need.

ProHD tape

## PRESENTATION TECHNOLOGIES

Modern presentation technologies do not use CRTs to show HDTV pictures as such equipment with picture diagonals of 1 meter and more is very heavy and expensive. Rather, the two technologies plasma and LCD/TFT have prevailed for flat-screens.
A feature that all the above-mentioned display technologies have in common is that as a matter of principle and in contrast to CRT equipment they do not display interlaced. First of all, supplied picture signals are read into a storage memory and are not displayed until the picture is complete. Then the full image is shown until a second memory has been filled with the next picture in the background. The memories are then exchanged and the next picture appears and so on. As the exchange of the pictures takes place in a split second, the picture is more or less static and does not flicker even at frame rates of 50 or 60 Hz. However, these displays must first put both fields of an interlace signal in the

memory and eliminate comb artefacts and similar effects accompanying interlace with various clever de-interlacing techniques. The quality at which this happens depends very much on the circuit inside the display and its expense – in other words, ultimately on the price. As progressive signals do not contain fields, they can be read entirely into the memory. This means that relatively simply equipped displays can display progressive pictures without the quality suffering.

## Plasma-Display (Gas-Discharging Technology)

Plasma technology activates single, tiny picture cells or pixels in which an inert gas and phosphorus (small neon lamps) are located. Each pixel consists of three single elements containing phosphorus which light up in the three primary colours red, green and blue when stimulated by UV light. When an electrical current is applied, the gas is ignited in the required pixels similar to a neon tube and causes the UV rays to ignite the phosphorus. This happens several hundred times a second and requires top performance from controlling electronics as all the "ignited" pixels must naturally be extinguished in a split second. Plasma is the most luxurious and expensive variation of flat-screen monitors.

CON-42" bis 50" PDP

**Special Features**

- high luminosity (rich colours)
- excellent image definition
- high contrast even in daylight
- rich black possible even in the dark
- perfect geometry and convergence, even at the border of the image
- a light and very flat construction is possible
- wide viewing angle
- no image persistence
- large display: up to 80" (= approx. 2m diagonal) and more are in preparation



## LCD (Liquid Crystal Display)

LCD technology is based on liquid crystals and is also used with a corresponding connection in PCs or laptops as a computer screen. An LCD screen consists of two glass plates separated by spacers. On the uppermost plate the pixels are condensed in the form of microscopically small transparent electrodes. Each electrode is controlled by its own, super-thin TFT (thin film transistor). The clearance separating the glass plates is filled with liquid crystal. In front of the glass plates there is a polarisation filter foil which only lets through light of a certain polarisation plane. A strong lamp on the back side of the rear glass plate, lets a constant light shine into it. Depending on the charge applied, which control the transistors (TFT), the crystals change their direction and thereby change the polarisation of the light that passes through them. This results in a lot, little or no light at all penetrating the polarisation filter foil to the viewer. Corresponding colour filters produce a colour picture.

Special Features

- hardly any loss of quality over the life of the set
- low power consumption (up to 150 Watt)
- radiation-free
- undisturbed, flicker-free picture
- high resolution
- excellent brilliance (even in the daytime)
- no reflection on the screen
- also suitable as a computer screen
- little operating noise
- static images do not "burn in"

JVC professional display
GM-H40
1366 x 768 pixels
10 Bit video processing
slot system for optional
input board, like SDI/HDSDI

# PROJECTION TECHNIQUES

While the light output (Ansi Lumen) is the most important quality feature for presentations, followed by resolution (pixels), the contrast, the colorimetry and other factors such as the uniformity of the white point and the display of movement play an important role for the natural depiction of (HD)video. For video projection, on the other hand, a light output of 600-1000 Ansi Lumen is sufficient as most projections are shown in (partly) darkened rooms. Neither should the inherent nature and quality of the screen be underestimated.

There are three types of projection technologies - DLP, LCD and LCOS. D-ILA technology used in projection by JVC is a form of LCOS and was developed in the USA in cooperation with Hughes.

## DLP Projection (Digital Light Processing)

The core of the DLP projection system (digital light processing) is a chip which acts as an optical switch with millions of tiny mirrors consisting of a highly-reflective aluminium foil. An electronic circuit below the reflectors supplies the picture formatting by tipping the mirrors, depending on the desired brightness, at various durations into the ray of a lamp. Every projector contains three optical semiconductors which break down the picture into the primary colours (RGB) which beam out individually via a digital mirror device (DMD). The three DMD projections overlap on the screen again and the video picture is reproduced pixel by pixel. This technology was conceived especially for digital advertising, trailers, film trailers, presentations and live events. Some projectors even allow parallel viewing by means of a film video split-screen procedure in order to make quality comparisons, for example. The highest resolution in DLP projectors currently is enough for 2048 x 1080 pixels. There are single-chip versions for the consumer market. For a fluid picture formatting a complex control is necessary.

Special Features

- high contrast levels
- high brightness levels
- high definition



## LCD Projection (Liquid Crystal Device)

LCD technology is comparable to the principle of a slide projector. The light from a strong projector lamp is led through an LED display. The component that shows the picture, the TFT panel (thin-film-transistor), is the main part of this technology. Depending on their switching status, the electrodes on the panel cause an alteration in the polarisation of the light falling through the liquid crystals. This light then falls through a polarisation filter, so that more or less light can pass through the projector lens to the screen. Currently the Sanyo PLV-HD10 is the world's first LCD projector in genuine HDTV format (1920 x 1080 pixels). The resolution is achieved by three 1.65 inch-large LCD panels in 16:9-format.

Special Features

- brightness comparable with film projection
- use of auxiliary lenses possible
- large zoom area (interchangeable lenses)
- light (can also be fixed to ceiling)

## LCOS Technology (Liquid Crystal On Silicon)

The LCOS technology is an elegant further development of LCD technology with three-chip technology for cinema, or just one chip for home movies. With the LCOS technology the surface consists of a liquid crystal film. Underneath there is a light-reflecting aluminium surface. The light falls from the projector lamp through a polarisation filter and onto the chip there. It is reflected, passes through polarisation again and generates the picture. The electronic circuits are etched onto the chip.

Special Features

- low-cost
- high level of brightness
- small, light projectors which can even be operated by battery

### D-ILA Projection (Direct Drive Image Light Amplifier)

JVC developed the D-ILA principle from ILA technology (Image Light Amplifier). With the D-ILA chip reflection element, a liquid crystal layer and a driver-IC are linked to a component. The light is divided and projected through lenses onto the coloured segments. The individual crystals of the liquid crystal layer are aligned in the same direction in which the lights rays are directed through the elements.(light phase modulation) The chip has the highest pixel density and offers extremely high resolution (prototype up to 8K), almost without screen door effect.

DLA-HD10K and DLA-HD10KS
Three 0.8" D-ILA chips with native 1080p (60/50/48) resolution. Achieves 2K (= 2,1 Mio. pixel). Contrast 2000:1

Special Features

- high level of brightness
- very high resolution possible
- natural colours also possible with types of lamps other than Xenon
- no pixel structure visible
- less image persistence
- less heat-sensitive
- built-in software for decoding and decompressing the film file



## RESOLUTION

Resolution describes the number of vertical active lines and the number of horizontal pixels. If we were to multiply the number of vertical lines by the number of horizontal pixels, we would get the resolution of the image in pixels. The higher the resolution is, the more detail is visible on the screen. An HD signal with 1,080 lines x 1,920 pixels delivers almost four to five times as much picture information than a conventional television signal. In cinema terms that is 2K.

| Description | Active Vertical Lines and Horizontal Pixels | Total No. of Pixels |
|---|---|---|
| NTSC (480i) | 480 (2x240) x 720 | 345.600 ( 2x 172.800 ) |
| PAL (576i) | 576 (2x288) x 720 | 414.720 ( 2x 207.360 ) |
| HD 720p | 720 x 1280 | 921.600 |
| HD 1080i | 1080 (2x 540) x 1920 | 2.073.600 ( 2x 1.036.800 ) |
| HD 1080p | 1080 x 1920 | 2.073.600 |
| 2K | 1556 x 2048 | 3.186.688 |
| 4K (35 mm-full picture) | 3112 x 4096 | 12.746.752 |
| 5K | 2500 x 5000 | 12.500.000 |

## SD(TV)

Standard Definition Television. This refers to our current television formats with resolution of 576i and 480i – in other words, this is classic television with PAL, SECAM and NTSC colour modulation.

## STORAGE MEDIA

### Magnetic Tape: DVCProHD

Panasonic's storage memory is a direct continuation of the develop-
Panasonic's storage media is a direct continuation of the development of DVCPro. In order to store the higher data rate, the tape moves at four times the speed. As with all variations of the DVCpro format, the compression of DVCproHD is based on the DV algorithm. The uncompressed HD signal is distributed onto four DV compressors working in parallel, which compress the signal together at a ratio of 1:6.7. The resulting data rate is 100Mbit/s.

### Magnetic Tape: HDV

HDV uses DV cassettes to record HD material. In order to get the large quantity of data occurring at HD onto the tape, the tape speed was not increased; rather, more efficient compression with MPEG-2 was chosen.
With HDV this still allows 60 minutes of footage to fit onto a miniDV cassette, as the recorded data rate is only 25 Mbit/s or less due to the efficiency of the MPEG-2 compression as in DV.

BR-HD50E-Recorder/Player

### Hard Disk Storage

The Firestore™ DR-HD100 is a classic example of the new hard disc storage technology. Video data is recorded directly as DV or HDV files. In order to ensure the direct access to the files in the editing system, the user can choose the recording format that suits the existing editing system such as Quicktime™ for Apples™ Final Cut Pro™ or OMF for Avid™ etc. This function is also referred to as → DTE (direct to edit). At the editing system the fixed disc storage acts like a normal hard disc and appears in Explorer or on the desktop as a disk drive.
FAT32 is used as a file system as it is compatible with almost all operating systems and platforms. Windows™, Apple ™ and Linux systems can read and write data with FAT32-formatted hard discs without any problems. The attraction of a fixed disk storage is the time that can be saved through the absence of the capturing process and in the new functions such as loop recording. For example, a two-minute long endless sequence can always be recorded in this mode. Only when the trigger is activated is the sequence finally stored and placed in front of the then linear recorded material. A loss of important footage by too-late triggering is thus no longer possible as the endless sequence contains the footage before triggering. Due to the high capacity of modern hard disk, recorders with eight hours or more running time are available today. The DR-HD100 in conjunction with JVC's GY-HDxxx camera series superimposes important information such as remaining hard disk capacity and recording status directly into the view finder, thus saving the camera man from having to look at the DR-HD100.


## STANDARD

A standard for recording, transmission and reproduction of a high-definition picture is defined by the number of vertical lines and horizontal pixels as well as the frame rate. The concept of a "standard" is a general description and definition of a recognised and verified basic technology for a given area of application. A standard is limited by strict technical norms and clearly and generally defined. A standard is thus standardised but is not a norm itself. At the moment no worldwide HDTV standard has been established.

## TAPELESS

This is a synonym for the recording of SD and HD material onto media that do not use magnetic tapes. Alternatives such as optical media e.g. (XDCAM™), hard discs (Firestore™) and solid state memory (SD Card, P2™) are now available.
The advantage of the tape-less working method is the quick access to the recordings without having to transfer the material in real time from a tape to an editing system and the opportunity to store additional accompanying information such as meta data. Typical equipment for the tape-less recording is the DR-HD100 hard disc recorder. It offers up to 8 recording hours and allows direct access to the recorded material via the integrated Firewire interface.

## TRANSPONDER

A transponder is a high-frequency channel on a satellite which receives a signal emanating from an earth station, converts it to another frequency then emits it again in the new frequency. Today's satellites have a large number of transponders. In the days of analogue transmission it was only possible to transmit a single television programme and several sound programmes on a single transponder.

Digital technology on the other hand works with so-called multiplexes. Various radio and television programmes are transmitted together and in compressed form via a transponder. The higher the compression, the higher the number of transmittable programmes and the lower the cost. This has unfortunately led to the poor technical quality of some programmes.

While 6-8 SD programmes can be transmitted with 3-6 Mbit/s in MPEG2 compression via a transponder with 27Mbit/s capacity, an HD programme compressed in MPEG2 with its 16-19 Mbit/s already occupies the biggest share of band-width. Only the use of more modern compression techniques such as MPEG4/H.264 also makes the efficient use of transponder capacity possible for HD.



## TV TRANSMISSION STANDARDS (SD INTERNATIONAL)

In TV transmission from the station to the receiver, the picture and sound data are coded. All over the world three television standards for colour picture transmission – known as modulation in technical jargon – have prevailed: PAL (Phase Alternating Line), SECAM (Séquentiel Couleur à Mémoire = Engl. sequential colour with temporary storage) and NTSC (National Television Systems Committee).

| Features | PAL | SECAM | NTSC |
|---|---|---|---|
| No. of scanning lines | 625 (576 active) | 625 | 525 (486 active) |
| Frame rate | 25 Hz | 25 Hz | 30 Hz |
| Line frequency | 15,625 kHz | 15,625 kHz | 15,734 kHz |
| Colour sub carrier signal and colour modulation | 4,433619 MHz | 4,40625 MHz / 4,250 MHz | 3,579545 MHz / 4,433619 MHz |
| Countries | Western Europe. former European colonies (except French) Australia, China | France and its former colonies, former Eastern (European) block | USA, Japan, South America, Philippines |

## TV TRANSMISSION (HDTV INTERNATIONAL)

An HDTV transmission is defined by the number of scanning lines, the frame rate, the line frequency, the colour signal and colour sampling and the compression standard. The international consultative Broadcasting Committee (CCIR) has been working since 1986 on the development of an internationally uniform production standard for high definition television of the future. But there is still no international agreement on a standard. Two different standards, 1080i and 720p, are being discussed for high-end applications, but it is also possible to work with 1080p but as this requires twice the data rate compared to 1080i and 720p it is currently not economical for broadcasting. 1080i and 720p offer roughly the same detail resolution. With 1080i there are slight resolution advantages with static pictures but 720p offers better display of moving objects and avoids interlace artefacts.

**Possible HDTV Transmission Standards for Europe**

| Formats | Lines x Pixels | Pictures per Second | Pixel per Second | Data Rate with MPEG4/H.264 |
|---|---|---|---|---|
| 720/24p or 25p | 720 x 1280 | 24/25 | 23.040.000 | 4–5 Mbit/s |
| 720/50p | 720 x 1280 | 50 | 46.080.000 | 7–9 Mbit/s |
| 1080/50i | 1080 (2 x 540) x 1920 | 50 | 51.840.000 | 8–10 Mbit/s |
| 1080/24p o. 25p | 1080 x 1920 | 24/25 | 51.840.000 | 7–9 Mbit/s |
| 1080/50p | 1080 x 1920 | 50 | 103.680.000 | 14–18 Mbit/s |

With current MPEG2 MP@HL compression, HD channels need about four times the transmission capacity as standard channels. MPEG4/H.264 or even SMPTE VC-1 are future video coding techniques for transmitting digital HDTV signals with even stronger compression.

**International Transmission Procedures for HDTV**

| Abbreviation | Meaning | Countries |
|---|---|---|
| DVB-S2 | Digital Video Broadcasting (Satellite) | Germany/Europe |
| ATSC | Advanced Television Systems Committee | USA, South Korea |
| ISDB | Integrated Services Digital Broadcast | Japan |



## TV TRANSMISSION HDTV VIA DVB-S2 (DIGITAL VIDEO BROADCAST – SATELLITE 2)

The term DVB-S2 has been developed in connection with the dissemination of HDTV via satellite broadcasting. The new modulation standard DVB-S2 is a further development of DVB-S with improved error correction (forward error correction, or FEC) and a modulation procedure which enables a higher data density. In this way up to 40% more data can be transmitted via a transponder. For HDTV transmissions in 720p with MPEG4 or WMV9-(VC1) coding at 8 MBit/s, six HD programmes can be broadcast per transponder. A regionally limited broadcast through adaptive coding and modulation (ACM) is possible with DVB-S2.

With the new DVB-S2 standards as modulation procedures and the MPEG4 coding technology for transmission, Europe will be getting the most up-to-date HDTV system in the world. Reception of DVB-S2 functions the same way as for DVB-S, but the television set or receiver needs an HDTV-capable HDMI connection instead of a Scart connection. The DVI connection on the TV receiver and the HDMI connection on the receiver can be connected by an adapter. Current DVB-S receiver cards can receive HDTV if plugged into a fast computer and can even store programmes on a hard disk. However, with current MPEG2 encoding, the hard discs fills quite rapidly – two hours of film take up over 14 GB of memory.

## SUMMARY

HDTV is the coming thing in Europe as well. But in Japan, the USA and South Korea, HDTV is already part of daily life. In order to market their work internationally in the future, many smaller production firms are now considering whether to invest in new HD equipment.

The great pressure on prices in film productions requires cost-effective solutions. This is exactly where JVC comes in with the ProHD concept. It makes possible small, low-budget HD projects of excellent quality. It has always been JVC's goal to make the constant progress in video technology available to users in a simple yet effective way and at lower cost, therefore, JVC has made sure that all ProHD equipment offers excellent performance in HD as well as in DV. This enables a gentle transition from today's SD production technology to the HD production of tomorrow.

We hope this little booklet has made your decision-making a little easier and we wish you every success in the world of high-definition images.


Sources:
"Digital Media und HD – Entscheidungsgrundlagen und Produktionswege für Film- und Medienschaffende" von Inka Pallister und Renate de Graaff erschienen im Mediabook-Verlag (2005)

### Masthead

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