# BSC film, digital and HD Day Glossary

No getting away from it, this is the science bit! The good news is you don't have to learn or fully understand all of it unless you're a DoP, and even we have to look things up occasionally!

**1,080-line HD**
The most common HD format is the 1,080-line system. Unlike standard definition systems, HD systems quote the number of actual visible lines used for the picture. A 1080-line frame is 1920 pixels across and therefore has an aspect ratio of 16/9 or 1.78:1 which has become the standard for all widescreen television systems. This format has five times the resolution of the 625-line picture currently in use. A 1080-line picture can run at:
23.98 fps used for film effect transfers to be transmitted at 29.97 fps
24 fps used for transfer to 35mm film
25 fps used for European film look transmitted in PAL
29.97 fps used in the NTSC areas of the world (particularly USA) for HD transmission
30 fps used occasionally.

All of these frame rates are progressive and give film like motion. Progressive segmented frame (Psf) is used for television

The 1080-line system also supports interlace (see below) images at:
50 fields per second
59.94 fields per second
60 fields per second

**720-line HD**
One of the systems proposed for American high definition transmission is the 720-line system. The 720-line system is 1280 pixels across, so the resolution is 1280 x 720 pixels, just over twice the resolution of a 625-line picture and also results in a 16/9 aspect ratio. 720-line images are usually Progressive, and have frame rates up to 60 frames per second.
One of the major HD camera manufacturers (e.g. Panasonic) make the Varicam line of cameras that shoot at a variable frame rate in 720p from 4 ~ 60 fps Progressive and is useful for the type of slow motion shooting used by nature cameramen.

**2K**
The 2K-transfer process was originally developed to transfer 35mm film material into graphics computers for visual effects work.
2K refers to the number of pixels scanned across a frame, 2K is actually 2048x 1556 pixels, the number of vertical pixels depends on the aspect ratio; a 16:9 frame would be 2048 x 1152 pixels. There are however many variations, just as there are many different film aspect ratios, however most work is done at full aperture to provide the maximum useable image so as to be able to correct camera shake etc. without having to crop the image. Visual effects specialists and animators now use 2K, 4K and even 8K resolutions. 2K is often used for DI (Digital Intermediate) production of film prints for theatrical release, although high end movies are starting to move to 4k scans (4096 x 3112 pixels) which preserve even more of the detail and range captured by modern film stocks which currently have a resolution of approximately 6K

**BIT RATE**
Bit rate is measured as "bits per second" (bps) and refers to the rate at which data is transmitted. As a general rule the more data the better the resulting pictures/sound.

**CODEC: Co**mpression / **Dec**ompression also **Co**der / **De**coder. This has come to mean both a device and piece of software for converting one digital format to another or a method of reducing the amount of data/information in a digital signal so that it can be recorded or broadcast more efficiently. High Def transmission is highly compressed as there is simply too much information in a full High Def image to transmit over the limited bandwidth available. Viewers watching High Def broadcasts at home are in fact watching a very highly compressed version of the original, this can result in artifacts such as 'blockiness' or 'mosquito noise' in uniform or smoky areas and in areas of fast motion.

**CHROMA SUBSAMPLING** - 4:4:4 and 4:2:2 Scary looking numbers you might hear bandied about by people who don't necessarily know what they mean either! Due to storage and transmission limitations, there has been, until very recently, a need to reduce or compress the signal. Since the human eye is much more sensitive to variations in brightness than colour, a video system can afford to devote less 'space' or 'bandwidth' to the part of the signal that deals with colour than to the part that deals with brightness. A system that records in 4:2:2 devotes twice as much space to brightness versus the colour; it requires two-thirds the bandwidth of the full 4:4:4 signal and the human eye can't tell the difference. The reason why 4:4:4 is used is that there is more colour and exposure latitude stored in the image for a greater range of post production grading and visual effects. Chroma keying (blue or green screen work) is also easier and cleaner in 4:4:4 because there is no loss of colour data. HDCAM SR can record in 4:4:4 or 4:2:2, whilst HDCAM and DVCPro HD record in 4:2:2 whilst HDV only records in 4:2:0, the further reduction in colour information making it unsuitable for chroma key work.

**DIGITAL INTERMEDIATE**
Generally a digital intermediate is a digital file or files resulting either from a scan of a negative film original or ingest of digital files from digital acquisition, which is used for editing, effects and colour grading. It is the material that is used in DI labs and constitutes the whole film. As such it should carry all the useful information that is contained in the original camera negative to provide both the latitude and sharpness of the original.

**DIT**
Digital Imaging Technician. This grade came about (in America) due to the increasingly complex menus found in HD cameras. Setting up, running and monitoring an HD camera can be more technical than a film trained Cinematographer or crew might feel comfortable with. Some DITs promote themselves as being able to provide the 'look' the DoP wants through manipulating the menus in-camera. As described elsewhere, this can be a risky practice as it often involves 'throwing' away data, although it is now possible to manipulate the 'look' without throwing anything away through the use of a 'Look up Table' which can be applied to the image when viewed on set or by the editing and visual effects departments. Newer cameras tend to have much simpler menus, and should require less in-field maintenance. Current practice is to capture as much information as possible, lighting and composing the scene as you wish it to look, leaving any final manipulation of the image until the on-line grade, just as one would when shooting film. A competent film crew will have no problem transitioning to HD / digital in terms of setting up and running the cameras, but having a DIT with specialist knowledge may prove useful on larger productions using multiple cameras. A good video assist technician plus assistant is however becoming more essential at every level of production.

**DOWN CONVERSION**
The process of changing high definition pictures to standard definition (e.g 625-line) for transmission or inclusion in standard definition programmes or for monitoring or recording on set. There are specialist down conversion units that can change the aspect of HD pictures or even pan and scan wide screen for 4:3 delivery. Most broadcast HD VTRs and some cameras have built in down converters and these are often used for direct transfers of 16:9 HD to 16:9 DigiBeta or DV tapes.

**DVCProHD (Varicam)**
Panasonic 720p 4:2:2 HD 1/4-inch tape developed from DVCPro 50, but with 100Mb/sec recording capability. Can be used in camcorders (e.g. Varicam) or as a studio / OB record tape for HD. Varicam allows 4 – 60 fps recording

**DVI**
Digital Video Interface. A high-bandwidth digital connection between a video source and a display device.

**FIBRE OPTIC**
A type of connection which modulates a laser to carry a signal (such as a single or dual link HDSDI signal) over a fine glass core contained within a robust sheath. Allows much longer cable lengths and much thinner cables than conventional copper cables, as well as being immune from electrical interference. However, fibre optic connections can be susceptible to dust and dirt and may require specialist cleaning.

**FRAME RATES**
There have always been three main frame rates:
24 frames per second used for film acquisition and cinema projection
25 frames per second for European television (actually 50i fields/sec)
30 frames per second for US and Japanese television (actually 60i fields/sec)
The rate of 30fps is always quoted for convenience; it is actually 29.97 frames (or 59.94 fields) per second.

**FLASH MAGS / P2**
These are solid state (no moving parts) recording devices that can record the full HD signal. At present the ones used with the Arriflex D-20, Panvision Genesis or the Thomson Viper can record 10 minutes in 4:4:4 or 15 minutes in 4:2:2 at 24 or 25fps. The data must then be transferred to tape or to a hard drive for more permanent storage. P2 is used by Panasonic in some of their DVCPro HD cameras, and can store 1 minute per Gb. P2 cards are currently available up to 32Gb, a figure likely to increase. They can be imported directly into non-linear editing programmes such as Apple's Final Cut Pro.

**GAMMA**
Roughly speaking, a description of the contrast of an image or a setting, which should be used to correctly view an image.

**HDCAM**
Sony 4:2:2 HD 1/2-inch tape format using a cassette developed from DigiBeta. Always 4:2:2 and 8 bit, with significant compression applied. Can be used in camcorders (e.g. HDW-900R) or as a studio / OB record tape for HD. Copying one tape to another will result in generational quality loss unlike HDCAM SR.

**HDCAM SR**

Sony 1/2-inch tape format with full colour resolution (i.e. 4:4:4) and less compression. Both the Arri D-20 and the Panavision Genesis often use this format to record in.

**HD-D5**
Well established 4:2:2 HD recording format developed by Panasonic. Due to its early availability widely used for recording telecine transfers of film elements for HD post. Particularly popular in USA but under a threat for supremacy by HDCAM SR. Panasonic has never made an attempt to develop companion HD-D5 camcorder.

**HDV**
**H**igh **D**efinition **V**ideo. A 1/4 inch 4:2:0 JVC / Sony / Canon prosumer HD format, not to be confused with DVCProHD. Not acceptable for full HD production and no good for Chromakeying.
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**HDMI**
High Definition Multimedia Interface. A high-bandwidth digital connection for both video and audio data. HDMI ensures the best video signal is sent from the source (HDTV signal) to the display (LCD, Plasma, DVL). It does this by sending video and multi-channel audio data to the display through one single cable.

**HD SDI**
The digital signal format that allows HD images to be sent over a single BNC cable (in the case of 4:2:2 HD) or over a pair of BNC cables ('dual link' for 4:4:4 HD). With a typical bandwidth of 1.85 Gb/sec for 4:2:2 the cable length is limited to around 50m with typical cable and to a maximum of about 100m with high quality cable without any joints. The use of fibre optic links allows much longer transmission paths without quality loss, although care must be taken to keep connections free of dust and dirt.

**INTERLACED (also see progressive)**
An interlaced picture is an image separated into two fields consisting of its even and uneven lines. This was originally done because there isn't enough bandwidth (space) to send the picture through 'complete' in one go, so the picture is divided into odd and even lines and combined later to make a frame. Interlace records and transmits less information than Progressive but at a faster rate. Interlace is used for sport, news current affairs etc. as it is good for slow motion and fast moving objects as it displays less strobing and motion blur. It is also partially responsible for the 'video' look and the feeling of immediacy that it engenders.

**LINEAR**
A term loosely used to describe a type of image suited to direct viewing on a conventional HD monitor. Grading linear images is generally preferred as the results are more controllable and predictable than dealing with Log since they can more easily be viewed on standard video displays without the need for correction. If you are shooting HD for television broadcast it is most likely you will shoot linear.

**LOG**
'LOG' reproduces how the human eye perceives luminance, giving more data to the shadows (where the human eye can differentiate more detail) than to the highlights. An image recorded in 'LOG' will appear to have low contrast and lifted black levels if viewed directly on a conventional monitor, but can be corrected for viewing with a suitably programmed preview processor (or "LUT box"). Shooting ' LOG' can have advantages as a recording mode for feature film work, where post production will follow a DI route. Film projects going through a DI process conventionally use images scanned in a LOG mode so as to capture as much of the original film image as possible. In certain HD cameras, shooting in LOG may achieve slightly

increased shadow and / or highlight detail. Anything shown on television will have to be converted back to linear.

**LUT**
Look Up Table: not a piece of furniture, but a way of changing the look of an image in contrast and/or colour without affecting the original (non-destructive grading). If one attempts to control the image in terms of contrast or colour 'in camera' using the in-built menus, one is potentially throwing data away. e.g. If you make something monochrome in camera, you will never get the colour back later. Applying a LUT using appropriate equipment (e.g. Truelight, LUTher, Speedgrade etc.) allows the DoP to demonstrate a particular look with the director on-set as well as with the editing and visual effects departments later on, without changing or throwing away any of the recorded image data. A 2D LUT controls contrast, brightness and gamma but not colour. A 3D LUT effectively controls all that a 2D LUT does per colour. Hence adding control of colour saturation and hue as well as secondary colour correction.

**MPEG 4**
Motion Picture Experts Group
MPEG2 was the first practical compression scheme for HD images.
MPEG4 is an efficient mechanism for compressing data. H264 is a popular variant used in HD TV in the UK.

**2-PERF, 3-PERF, 4 PERF**
A normal 'Academy frame of 35mm film, is 'pulled' through the camera gate four perforations at a time. This will allow for all aspect ratios including anamorphic. To save film stock (more than 25%), the camera can be modified to 'pull' 3 perforations through at a time. This still works for the normal cinema screen aspect ratio of 1:1.85 and also works for the 16:9 aspect ratio currently used by television broadcasters. A recently revived option is where the camera only pulls through 2-perfs at a time, saving over 50% in stock and processing and allowing for 20 minutes of filming per 1000 feet of stock. This is only suitable if you want to shoot the widescreen aspect ratio of 2.39:1 for feature projection, however, by cropping the sides, it can also be used in 16/9 mode for possible television transmission. This results in less grain than Super 16mm and all the benefits of 35mm in terms of stability, range of lenses etc.. Another benefit of 3 and 2 perf. modified cameras is that they run more quietly as less film is passing through the gate every second. On the minus side there is less space between frames to hide a hair in the gate.

**PIXEL**
The basic "element" of a picture. The resolution of a television picture can be defined (horizontally and vertically) in pixels just like a computer image. Rows of horizontal pixels making up a television picture are more usually known as lines.

Standard Definition TV is 720 pixels x 576 (active) lines
High Definition TV is 1920 x 1080 or 1280 x 720
'Stuck' and 'Hot' pixels are not recalcitrant or sexy! They are visible as bright blue, green, red or white static dots on the screen and are caused by a faulty pixel in the sensor (you can also get these on LCD screens, which can be a problem if using an HD LCD monitor as it's hard to tell if it's the camera or the monitor at fault). Stuck/hot pixels are not usually fixed, but can be 'mapped out' (hidden) so that the camera no longer sees them. They can often be removed in post in a similar manner to dust and dirt removal on film

**PROGRESSIVE (also see interlaced)**

The complete frame exposed in one go – all the lines scanned from top to bottom, like a snapshot rather than the normal TV system of interlaced capture (see above). Progressively scanned pictures have around thirty percent more resolution than an interlaced picture and appear less busy, as they don't have the problem of interlace line twitter with strong horizontal lines i.e. Venetian blinds.
Shooting in Progressive mode gives HD video a more filmic, less 'video' look that may be more suited to a drama production aesthetic. Progressive images are also more suited to viewing on large screens and displays. Progressive frames are preferred by visual effects departments as they have a smaller file size, and are easier to handle within software packages.

**RAW**
Raw image data is acquired when no processing or compression is carried out in-camera and only the pure data from the sensor is recorded. This data requires subsequent processing outside the camera in order to both view and use the material, but can result in better image quality.

**RESOLUTION**
The amount of detail a device can capture or show. This depends on the number of pixels in a frame. The resolution of a frame is described as: the number of pixels horizontally across the picture by the number of pixels (or lines) vertically. HD has 1920x1080 (2,073,600 pixels) or 1280x720 (921,600 pixels). In a film image the resolution is measured in lines per millimetre – current medium speed filmstocks are roughly 6144x4668.

**HD STANDARDS**
There are a variety of standards. You have a choice of a number of line, field and frame rates. With careful discussion before you start shooting your production, everything will work fine.
Examples;
720 line, 50 Frames, Progressive (labeled as - 720p50)
1080 line, 50 Frames, Interlaced (labeled as - 1080i50)
As time progresses we would ideally master on
1080 line, 50 Frames, Progressive (labeled as - 1080p50)

**STANDARD DEFINITION**
In the UK our current Standard Definition television system is known as the 625-line system. Not all the lines are used for the picture though. Only 576 lines are actually used for picture information. So a Standard Definition 625 line picture is 576 active lines or pixels high. A standard definition digital picture is 702 pixels across, so the resolution of the picture is 702 x 576 pixels. There are the same numbers of pixels across the frame for both 4:3 and 16:9 images. HD is always 16:9.

**The BBC considers the following formats to be standard definition:**
1: All Standard Definition video formats
2: HDV from all manufactures
3: Cameras with image sensors under 1/2"
4: Super16mm film whether transferred to tape in high definition or not.
Many people debate and refute this point. Super 16mm film telecined in High Definition **IS** unquestionably HD, The present challenge lies with compressing it sympathetically enough for broadcast. Various de-graining technologies exist that combined with better codecs than the BBC currently use could allow Super 16mm film to be broadcast successfully.
5: 35mm film transferred to standard definition tape formats
6: Non-linear editing codecs with bit rates below 160Mbs

7: Live contributions via links at less than 60Mbs (MPEG2)

The BBC will accept High Definition programme material acquired using either of the following:
1920 x 1080 interlace at 25 frames a second (now called 1080i25) or
1920 x 1080 progressive at 25 frames a second (now called 1080p25)

All delivered high definition master tapes must be 1080i25 (whether acquired 1080p25 or 1080i25).
Rollers and moving captions must be added in 1080i25 to prevent unacceptable judder.
High Definition Film Effect. Most High Definition cameras can capture in both Interlace and Progressive modes. It is not acceptable to add film effect to high definition images for high definition delivery.

**SHUTTERS**
Electronic cameras usually have electronic shutters. These are, by default, at 1/25$^{th}$ second averaged over two fields so each field is exposed for 1/50$^{th}$ second. Shutters are important for low frame rate progressive images in HD i.e. 24 and 25 fps. As you're only exposing one frame rather than two fields the exposure time for your progressive image is 1/25th sec, which will cause movement in the frame to smear. To overcome this you have to set the shutter to 1/50th sec. A shutter is used to shorten the time the camera has to capture the frame without changing the frame rate. Film cameras have a mechanical shutter, which mostly rely on a spinning disc with a variable slot cut in it.

**SHUTTER SPEED**
The length of time a shutter is open can be measured either as a speed (e.g. 1/50$^{th}$ of a second) or as an angle. The term 'angle' refers to the mechanical shutters in film cameras and certain digital cameras. A 180° shutter is open for half the frame rate - i.e. at 25 frames a second a 180° shutter is open for 1/50th of a second.

**UP CONVERSION**
The process of changing standard definition (576-line) to high definition. Although some broadcast VTRs have 'up converters' built in, currently these are not recommended for the high quality images HD broadcasters require. Specialist 'up converters' are available that can deal with some of the problems (e.g. dirt, video noise, grain etc) that can make 'up conversion' look poor.

**WAVEFORM MONITOR**
Often asked for or included in HD kit. This can either be a small on-camera monitor, a stand-alone unit or a feature on the main monitor. It allows the DoP to correctly expose the image by checking for clipped highlights (visible as peaks with the top cut off) or clipped blacks (visible as a flat line at the bottom of the scale). The waveform monitor provides the DoP with an absolute indicator of how the camera is responding to light levels, even if the HD monitor has not been correctly set up. If it is clipped on the waveform, it won't be recorded and cannot be rescued later on.

Compiled By Gavin Finney

Main Sources to be credited: BBC Website, Paul Wheeler's HD book, Gavin Finney.