

RECOMMENDATION ITU-R BR.1375-2*,**

High-definition television (HDTV) recording

(Question ITU-R 108/11)

(1998-2001-2002)

The ITU Radiocommunication Assembly,

considering

- a) that the common image format, having $1\,080 \times 1\,920$ square pixels, is now recommended as the image capture format for HDTV;
- b) that the digital broadcasting service for HDTV programmes is gaining in momentum. There are several services in operation or being planned in many countries;
- c) that various analogue and digital format video tape recorders (VTRs) for HDTV tape recording have been developed;
- d) that many countries hold large archives of valuable, irreplaceable HDTV programmes, based on the signal formats defined in Recommendation ITU-R BT.709, Part 1;
- e) that analogue HDTV open-reel recording formats are considered to be obsolete for use in programme production today, but the programmes recorded on those formats in the past are often valuable;
- f) that digital recording of HDTV programmes is now widely used in HDTV production and post-production;
- g) that there are several types of equipment available for digital HDTV recording today, that differ in the recording medium (e.g. open-reel tape or cassette), in recording format (e.g. use or not of bit-rate compression) and in recorder type (e.g. deck or portable camcorder);
- h) that bit-rate compression techniques based on DCT and VLC coding can provide highly efficient methods of recording HDTV programmes, whose source data rate exceeds 1 Gbit/s;
- j) that the operational and handling characteristics of digital HDTV VTRs have improved to the point that they can be used not only in the studios but also in the field, with a level of convenience similar to that of conventional VTRs;
- k) that HDTV cameras using two-million pixel CCD imaging devices and digital signal processing with advanced VLSI chip(s) can provide high quality HDTV pictures while offering the operating features and small size of conventional cameras;
- l) that the use of 24 frame¹ formats will be used to supplement and augment film production,

* This Recommendation should be brought to the attention of the International Electrotechnical Commission (IEC).

** *Note by the Secretariat:* This Recommendation was amended in April 2006 to correct Table 6 (ECC).

¹ 24 frame applications in HDTV recording will be considered in a separate new Recommendation.

recommends

1 that digital HDTV recording should be preferred for HDTV programme origination and production, and for storage for programme exchange;

2 that analogue HDTV tape recordings should preferably be transferred to a digital recording format for post-processing and archiving;

3 that the 1080×1920 common image format specified in Recommendation ITU-R BT.709, Part 2 shall be preferred for HDTV recording, while the other image formats specified in Recommendation ITU-R BT.709, Part 1 will retain their value especially in view of the need to ensure the possibility of reusing archived HDTV programme assets;

4 that HDTV programmes intended for extensive and complex post-processing should preferably be recorded on a digital format that does not use lossy compression, while HDTV programmes intended for limited or no post-processing should preferably be recorded on a digital format, which may use a modest amount of compression;

5 that for the purpose of international programme exchange², operators should take into account that, at the present time and depending on the application, the two HDTV recording formats generally known as HDCAM and HD-D5 are the ones in most widespread use.³

NOTE 1 – The Tables in Appendix 1 recall specifications of commercially available recording devices for programme production in the HDTV formats specified in the latest version of Recommendation ITU-R BT.709.

Appendix 1

Among the various recording formats listed in the Tables of this Appendix, there are two predominant formats available for international exchange for HDTV recordings. These are those generally known as HDCAM and HD-D5.

Both formats have their own design objectives, as each data rate shows. A lower data rate gained from a higher compression ratio provides a longer recording time and is suitable for handy camcorder operations. A higher data rate provides a better picture quality suitable for subsequent video processing and is suitable for studio operation.

Some key parameters for these two formats are shown for information in Table 1. All formats are described in the other Tables of this Appendix.

² International programme exchange is defined as the transmission of television or sound programme material (or components thereof) among professional parties in different countries. It should be based on internationally agreed and widely employed technical standards or operating practices, except by prior bilateral agreement among the parties involved.

³ This provision is not intended to exclude the possibility that other formats may be used in house, or for programme exchange subject to mutual agreement among the parties concerned.

TABLE 1

Major specifications of the recommended HDTV recording formats

Manufacture specification		HDCAM				HD-D5				
Video specification	Quantization	8				10 or 8				
	Compression	1/7				1/5 for 10 bits 1/4 for 8 bits				
	Sampling structure	3:1:1				4:2:2				
	DCT (luminance)	1/3.6				1/5 for 10 bits 1/4 for 8 bits				
	DCT (chrominance)	1/7.2				1/5 for 10 bits 1/4 for 8 bits				
	Data rate (Mbit/s)	140				235				
Audio specification	Bit/sample	20				20 or 24				
	Number of AES3 ⁽¹⁾ channels	2				2 or 4				
	Multi-channel audio and/or AES3/EBU non-audio data	Yes								
Recording/ playback length	Size of cassette (mm)	L	254 × 145 × 25				296 × 167 × 25			
		M	None				212 × 124 × 25			
		S	156 × 96 × 25				161 × 98 × 25			
	System (see Recommendation ITU-R BT.709, Part 2)	25/P	30/P*	50/i	60/i*	25/P	30/P*	50/i	60/i*	
	Time (min)	L	148	124	148	124	148	124	148	124
		M	--	--	--	--	75	63	75	63
		S	48	40	48	40	27	23	27	23

(1) An AES3 channel may carry two linear PCM audio channels or it may carry data as indicated by status channel bit 1.

NOTE 1 – The mark “*” shows inclusion of the frame or field frequency having those values divided by 1.001.

S: small, M: medium, L: large.

The following Tables describe the major features and specifications for the available HDTV storage devices:

Table 2: Tape recorder for 1125/60 (59.94) – *Overview*

Table 3: Disk recorder for 1125/60 (59.94) – *Overview*

Table 4: HDTV digital VTR for 1125/60 (59.94) – *Details*

Table 5: Tape recorder for 1125/50 – *Overview*

Table 6: HDTV digital VTR for 1125/50 – *Details*

Table 7: HDTV analogue VTR for 1125/60 – *Details*

TABLE 2
Tape recorder for 1125/60 (59.94) – Overview

Digital/analogue		Digital					Analogue
Compressed/non-compressed		Compressed			Non-compressed		
Package type		Cassette			Cassette	Open reel	Cassette
Manufacture specification		HDCAM	HD-D5	DVCPRO HD	D6	HDD/HDDP	HDV, AU-HD
Recording/playback time (maximum)		40/124 min	23/63/124 min	46 min	8/28/64 min	96 min	63 min
Video bandwidth	Luminance (MHz)	23	30	20	30		20
	Chrominance (MHz)	7	15	10	15		7
	Number of lines	1080			1080	1035	1036
Audio specification	Digital or analogue	PCM			PCM		PCM
	Number of AES3 channels	2	2 or 4	4	5	4 (Digital) + 1 (Analogue)	2
	Sampling frequency	48 kHz, 20 bits	48 kHz, 20 or 24 bits	48 kHz, 16 bits	48 kHz, 20/24 bits	48 kHz, 16 bits	48 kHz, 16 bits
Ancillary data		–	5.8 kbytes/Frame	7.4 kbytes/Frame	38.4 kbytes/Frame	38.4 kbytes/Frame (5 VBI lines)	
Media	Tape width (mm)	12.65		6.35	19.01	25.4	12.65
	Size of cassette (mm)	S: 156 × 96 L: 254 × 145	S: 161 × 98 M: 212 × 124 L: 296 × 167	L: 125 × 78	S: 172 × 109 M: 254 × 150 L: 366 × 206	14 in. reel	205 × 121.5
	Substance	Metal particle			Metal particle		Metal particle
Application example		Camcorder	Portable	Camcorder	Studio deck		Portable studio deck

PCM: pulse code modulation

VBI: vertical blanking interval.

TABLE 3
Disk recorder for 1125/60 (59.94) – Overview

Digital/analogue		Digital	Analogue	
Compressed/non-compressed		Compressed	Compressed	
Handling		Removable	Removable	
Recording and/or playback		Recording and playback	Playback only	Write-once
Media		MO	Optical	Optical wobbling
Manufacture specification			HDL-2000	HDL-5800
Recording/playback time		32 min	15 min (CLV)	20 min (CLV)
Video bandwidth	Luminance	44.55 MHz, 8 bits	20 MHz	
	Chrominance	14.85 MHz, 8 bits	6 MHz	
Audio specification	Number of lines	1088		
	Digital or analogue	PCM	PCM	
	Number of AES3 channels	2	1	
	Sampling frequency	48 kHz, 20 bits	48 kHz, 16 bits	
Ancillary data		256 kbytes/frame		
Media	Size of caddy (mm)	300	300	
	Substance	Magnetic coat	Aluminium coated	Alloy coat
Notes		Intra frame 94 Mbit/s drive, double sided	Single sided	

CLV: constant linear velocity

MO: magneto optical.

TABLE 4

HDTV digital VTR for 1125/60 (59.94) – Details

Manufacture specification		HDD/HDDP	D6	HDCAM	HD-D5	DVCPRO HD
Sampling frequency	Video (MHz)	74.25 (74.25/1.001)				
	Audio (kHz)	48				
Quantization	Video (bits)	8			10/8	8
	Audio (bits)	20	20/24	20	20/24	16
Number of AES3 channels		4 (Digital) + 1 (Analogue)	5	2	2 or 4	4
Video specification	Compression	N.A.	N.A.	Intra field/frame 1/7	Intra field 1/5 (10 bits); 1/4 (8 bits)	Intra frame 1/10
	Sampling structure	4:2:2	4:2:2	3:1:1	4:2:2	2.7:1.3:1.3
	DCT (luminance)	N.A.	N.A.	1/3.6	1/5;1/4	1/6.6
	DCT (chrominance)	N.A.	N.A.	1/7.2	1/5;1/4	1/6.6
Channel coding		8-8 map	8-12 map	S-NRZI	8-14 map	24-25 I-NRZI
Total rate (Mbit/s)		1 188	1 212	185	301	167
Video rate (Mbit/s)		958.5	995.3	140	235	100
Number of recording RF channels		8		4 (camcorder)/ 2 (studio)	4	4 (camcorder)/ 2 (studio)
ECC	Inner	110, 104	237, 221	231, 219	95, 87	85, 77
	Outer	64, 60	254, 240	250, 226	128, 120	149, 138
Drum diameter (mm)		134.6	96.5	81.4	76.0	21.7
Drum rotation (rps)		120	150	45 (camcorder)/ 90 (studio)	90	150 (camcorder)/ 300 (studio)
Number of tracks (/field)		16	40	6	12	40/frame
Tape speed (mm/s)		805.2	497	96.8	167.228	135.28
Track pitch (µm)		37	22	21.7	20.0	18
Minimum wavelength (µm)		0.69	0.81	0.49	0.63	0.49
Tape width (mm)		25.4	19.01	12.65		6.35
Media substance		Metal particle				
Tape Hc (kA/m)		115	127	135	143	184
Cassette size (mm)		11.75/14 in. reel	S: 172 × 109 M: 254 × 150 L: 366 × 206	S: 156 × 96 L: 254 × 145	S: 161 × 98 M: 212 × 124 L: 296 × 167	L: 125 × 78
Recording time (min)		63/94	8/28/64	40/124	32/63/124	46

ECC: error correction code

N.A.: not applicable.

TABLE 5
Tape recorder for 1125/50 – Overview

Digital/analogue		Digital			
Compressed/non-compressed		Compressed			Non-compressed
Package type		Cassette			
Manufacture specification		HDCAM	HD-D5	DVCPRO HD	D6 ⁽¹⁾
Recording/playback time (maximum)		48/148 min	27/75/148 min	46 min	8/28/64 min
Video bandwidth	Luminance (MHz)	23	30	23	30
	Chrominance (MHz)	7	15	11	15
	Number of lines	1080			1080
Audio specification	Digital or analogue	PCM			
	Number of AES3 channels	2	4		6
	Audio sampling	48 kHz, 24 bits		48 kHz, 16 bits	48 kHz, 20/24 bits
Ancillary data		–	5.8 kbytes/Frame	8.9 kbytes/Frame	23 kbytes/Frame
Media	Tape width (mm)	12.65	12.65	6.35	19.01
	Size of cassette (mm)	S: 156 × 96 L: 254 × 145	S: 161 × 98 M: 212 × 124 L: 296 × 167	L: 125 × 78	S: 172 × 109 M: 254 × 150 L: 366 × 206
	Substance	Metal particle			

⁽¹⁾ The D6 Society for Motion Picture and Television Engineers (SMPTE) Document may not reflect the latest numbers in this Table.

TABLE 6
HDTV digital VTR for 1125/50 – Details

Manufacture specification		D6 ⁽¹⁾	HDCAM	HD-D5	DVCPRO HD
Sampling frequency	Video (MHz)	74.25			
	Audio (kHz)	48			
Quantization	Video (bits)	Y: 10, Cr/Cb: 8	8	8/10	8
	Audio (bits)	20/24	20	24	16
Number of AES3 channels		6	2	4	
Video specification	Compression	N.A.	Intra field/frame 1/7	Intra field 1/5 (10 bits); 1/4 (8 bits)	Intra frame 1/8.9
	Sampling structure	4:2:2	3:1:1	4:2:2	3:1.5:1.5
	DCT (luminance)	N.A.	1/3.6	1/5;1/4	1/6.6
	DCT (chrominance)	N.A.	1/7.2	1/5;1/4	1/6.6
Channel coding		8-12 map	S-NRZI	8-14 map	24-25 I-NRZI
Total rate (Mbit/s)		1 212	154	269	167
Video rate (Mbit/s)		933.1	117	196	100
Number of recording RF channels		8	4/2	4	4 (camcorder)/ 2 (studio)
ECC	Inner	237, 221	231, 219	95, 87	85, 87
	Outer	254, 240	250, 226	128, 120	149, 138
Drum diameter (mm)		96.5	81.4	76.0	21.7
Drum rotation (rps)		150	37.5/75	75	150 (camcorder)/ 300 (studio)
Number of tracks (/field)		48	6	12	48/frame
Tape speed (mm/s)		497	80.7	139.496	135.415
Track pitch (µm)		22	21.7	20	18
Minimum wavelength (µm)		0.81	0.49	0.59	0.49
Tape width (mm)		19.01	12.65		6.35
Media substance		Metal particle			
Tape Hc (kA/m)		127	132	144	184
Cassette size (mm)		S: 172 × 109 M: 254 × 150 L: 366 × 206	S: 156 × 96 L: 254 × 145	S: 161 × 98 M: 212 × 124 L: 296 × 167	125 × 78
Recording time (min)		8/28/64	48/148	27/75/148	46

⁽¹⁾ The D6 SMPTE Document may not reflect the latest numbers in this Table.

TABLE 7
HDTV analogue VTR for 1125/60 – Details

Manufacture specification		1 inch	UNIHI ⁽¹⁾
Video	Luminance (MHz)	20	
	Chrominance (MHz)	10	7
Audio sampling (kHz)		–	48
Number of audio channels		2 analogue channels	2 (AES3 channel)
Number of recording RF channels		4	2
Drum diameter (mm)		134.6	76
Drum rotation (rsp)		60	90
Number of tracks (/field)		4	6
Tape speed (mm/s)		483	119.709
Track pitch (µm)		89	24.8
Tape width (mm)		25.4	12.650
Media substance		Metal particle	
Tape Hc (kA/m)		55.7	123.3
Cassette size (mm)		–	205 × 121.5
Recording time (min)		63	

⁽¹⁾ The UNIHI format is still widely used for the international exchange of HDTV programmes for viewing purpose.