RECOMMENDATION ITU-R BR.1375-3*

High-definition television (HDTV) digital recording formats

(Question ITU-R78/6)

(1998-2001-2002-2007)

Scope

This Recommendation is intended to provide end users with an overview of currently available tape-recording formats for HDTV signals.

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 has gained in momentum. There are many 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, and the analogue formats are being replaced with digital formats;

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, and technical support for many analogue formats is no longer offered;

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. cassette, optical disc, or solid-state memory), 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 2 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 as part of camcorders, with a level of convenience similar to that of conventional SDTV 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 frame formats will be used to supplement and augment film production,

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

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 1 080 × 1 920 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 exchange[1], operators should take into account that, at the present time and depending on the application, the three HDTV recording formats generally known as HDCAM-SR, HDCAM and HD-D5 are the ones in most widespread use.[2]

NOTE 1 – Attention is drawn to the fact that analogue formats are no longer in use, and that some early digital formats are no longer available or in use.

NOTE 2 – The Tables in Appendix 1 recall specifications of available recording formats 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 three predominant formats available for international exchange for HDTV recordings. These are those generally known as HDCAM-SR, HDCAM and HD-D5.

Each of these formats has 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 three formats are shown for information in Table 1. All formats are described in the other Tables of this Appendix.

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[1] 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.

[2] 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-SR				HDCAM				HD-D5			
Video specification	Quantization		10				8				10 or 8			
	Compression		1/2 for HQ[(1)] mode 1/2.7 for SQ[(2)] mode				1/7				1/5 for 10 bits 1/4 for 8 bits			
	Sampling structure		4:4:4 for HQ mode 4:2:2 for SQ mode				3:1:1				4:2:2			
	DCT (luminance)		1/2 for HQ mode 1/2.7 for SQ mode				1/3.6				1/5 for 10 bits 1/4 for 8 bits			
	DCT (chrominance)		1/2 for HQ mode 1/2.7 for SQ mode				1/7.2				1/5 for 10 bits 1/4 for 8 bits			
	Data rate (Mbit/s)		880 for HQ mode 440 for SQ mode				140				235			
Audio specification	Bit/sample		24				20				20 or 24			
	Number of AES3[(3)] channels		6				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				254 × 145 × 25				296 × 167 × 25			
		M	None				None				212 × 124 × 25			
		S	156 × 96 × 25				156 × 96 × 25				161 × 98 × 25			
	System (see Recommendation ITU-R BT.709, Part 2)		24*/25/P	30/P*	50/I/P	60/I/P*	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	148	124	148	124
		M	--	--	--	--	--	--	--	--	75	63	75	63
		S	48	40	48	40	48	40	48	40	27	23	27	23

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.

(1) HQ (high quality) mode allowing for 2 × speed recording yielding 880/738 Mbit/s to tape with a 2:1 compression ratio in full band RGB 4:4:4, and 3D mode.

(2) SQ (standard quality) providing 440/369 Mbit/s video payload to tape in both 4:4:4 or 4:2:2.

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

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

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

Table 3: Digital VTR for 1125/60 (59.94) – *Details*

Table 4: Digital tape recorder for 1125/50 – *Overview*

Table 5: Digital VTR for 1125/50 – *Details*

TABLE 2

Digital tape recorder for 1125/60 (59.94) – *Overview*

Compressed/non-compressed		Compressed				Non-compressed
Package type		Cassette				Cassette
Manufacture specification		HDCAM-SR	HDCAM	HD-D5	DVCPRO HD/HD-LP	D6[(1)]
Recording/playback time (maximum)		40/124 min	40/124 min	23/63/124 min	46/92/126 min	8/28/64 min
Video bandwidth	Luminance (MHz)	30	23	30	20	30
	Chrominance (MHz)	15	7	15	10	15
	Number of active lines	1080				1080
Audio specification	Number of AES3 channels	6	2	2 or 4	4	5
	Sampling frequency	48 kHz, 24 bits	48 kHz, 20 bits	48 kHz, 20 or 24 bits	48 kHz, 16 bits	48 kHz, 20/24 bits
Ancillary data	Capacity	14.4 kbytes/Frame	1.53 kbytes/Frame	5.8 kbytes/Frame	7.4 kbytes/Frame	38.4 kbytes/Frame
Media	Tape width (mm)	12.65			6.35	19.01
	Size of cassette (mm)	S: 156 × 96 L: 254 × 145	S: 156 × 96 L: 254 × 145	S: 161 × 98 M: 212 × 124 L: 296 × 167	L: 125 × 78 XL: 172 × 102	S: 172 × 109 M: 254 × 150 L: 366 × 206
	Substance	Metal particle				Metal particle
Application example		Camcorder	Camcorder	Portable	Camcorder	Studio deck

(1) The D6 format is included in this Table only for information purposes, as it is rarely used.

TABLE 3

Digital VTR for 1125/60 (59.94) – *Details*

Manufacture specification		HDD/HDDP	HDCAM-SR	HDCAM	HD-D5	DVCPRO HD/HD-LP
Sampling frequency	Video (MHz)	74.25 (74.25/1.001)				
	Audio (kHz)	48				
Quantization	Video (bits)	8	10	8	10/8	8
	Audio (bits)	20	24	20	20/24	16
Number of AES3 channels		4 (Digital) + 1 (Analogue)	6	2	2 or 4	4
Video specification	Compression	N.A.	Intra field/ frame 1/2.7	Intra field/ frame 1/7	Intra field 1/5 (10 bits); 1/4 (8 bits)	Intra frame 1/10
	Sampling structure	4:2:2	4:4:4 HQ 4:2:2 SQ	3:1:1	4:2:2	2.7:1.3:1.3
	DCT (luminance)	N.A.	1/2.7 SQ	1/3.6	1/5;1/4	1/6.6
	DCT (chrominance)	N.A.	1/2.7 SQ	1/7.2	1/5;1/4	1/6.6
Channel coding		8-8 map	S-NRZ	S-NRZI	8-14 map	24-25 I-NRZI
Total rate (Mbit/s)		1 188	593 SQ 1 186 HQ	185	301	167
Video rate (Mbit/s)		958.5	440 SQ 880 HQ	140	235	100
Number of recording RF channels		8	4	4 (camcorder)/ 2 (studio)	4	4 (camcorder)/ 2 (studio)
ECC	Inner	110, 104	244, 228	231, 219	95, 87	85, 77
	Outer	64, 60	126, 114	250, 226	128, 120	149, 138
Drum diameter (mm)		134.6	81.4	81.4	76.0	21.7
Drum rotation (rps)		120	90 SQ 180 HQ	45 (camcorder)/ 90 (studio)	90	150 (camcorder)/ 300 (studio)
Number of tracks (/field)		16	12	6	12	40/frame
Tape speed (mm/s)		805.2	117.62 SQ 235 HQ	96.8	167.228	135.28
Track pitch (μm)		37	13.2	21.7	20.0	18
Minimum wavelength (μm)		0.69	0.294	0.49	0.63	0.49
Tape width (mm)		25.4	12.65	12.65		6.35
Media substance		Metal particle				
Tape Hc (kA/m)		115	215	135	143	184
Cassette size (mm)		11.75/14 in. reel	S: 156 × 96 L: 254 × 145	S: 156 × 96 L: 254 × 145	S: 161 × 98 M: 212 × 124 L: 296 × 167	L: 125 × 78
Recording time (min)		63/94	40/124	40/124	32/63/124	46

ECC: error correction code

N.A.: not applicable.

TABLE 4

Digital tape recorder for 1125/50 – *Overview*

Compressed/non-compressed		Compressed			
Package type		Cassette			
Manufacture specification		HDCAM-SR	HDCAM	HD-D5	DVCPRO HD
Recording/playback time (maximum)		48/148 min	48/148 min	27/75/148 min	46 min
Nominal video bandwidth	Luminance (MHz)	30	23	30	23
	Chrominance (MHz)	15	7	15	11
	Number of active lines	1080			
Audio specification	Number of AES3 channels	6	2	4	
	Audio sampling	48 kHz, 24 bits			48 kHz, 16 bits
Ancillary data	Capacity	14.4 kbytes/ Frame	1.5 kbytes/ Frame	5.8 kbytes/ Frame	8.9 kbytes/ Frame
Media	Tape width (mm)	12.65	12.65	12.65	6.35
	Size of cassette (mm)	S: 156 × 96 L: 254 × 145	S: 156 × 96 L: 254 × 145	S: 161 × 98 M: 212 × 124 L: 296 × 167	L: 125 × 78
	Substance	Metal particle			

TABLE 5

Digital VTR for 1125/50 – *Details*

Manufacture specification		HDCAM-SR	HDCAM	HD-D5	DVCPRO HD/ HD-LP
Sampling frequency	Video (MHz)	74.25			
	Audio (kHz)	48			
Quantization	Video (bits)	10	8	8/10	8
	Audio (bits)	24	20	24	16
Number of AES3 channels		6	2	4	
Video parameters	Compression	Intra field/frame 1/2.7	Intra field/frame 1/7	Intra field 1/5 (10 bits); 1/4 (8 bits)	Intra frame 1/8.9
	Sampling structure	4:4:4 HQ 4:2:2 SQ	3:1:1	4:2:2	3:1.5:1.5
	DCT (luminance)	1/2.7 SQ	1/3.6	1/5;1/4	1/6.6
	DCT (chrominance)	1/2.7 SQ	1/7.2	1/5;1/4	1/6.6
Channel coding		S-NRZ	S-NRZI	8-14 map	24-25 I-NRZI
Total rate (Mbit/s)		495 SQ 990 HQ	154	269	167
Video rate (Mbit/s)		369 SQ 738 HQ	117	196	100
Number of recording RF channels		4	4/2	4	4 (camcorder)/ 2 (studio)
ECC	Inner	244, 228	231, 219	95, 87	85, 87
	Outer	126, 114	250, 226	128, 120	149, 138
Drum diameter (mm)		81.4	81.4	76.0	21.7
Drum rotation (rps)		75 SQ 150 HQ	37.5/75	75	150 (camcorder)/ 300 (studio)
Number of tracks (/field)		12	6	12	48/frame
Tape speed (mm/s)		98.115 SQ 196.2 HQ	80.7	139.496	135.415
Track pitch (μm)		13.2	21.7	20	18
Minimum wavelength (μm)		0.294	0.49	0.59	0.49
Tape width (mm)		12.65	12.65		6.35
Media substance		Metal particle			
Tape Hc (kA/m)		215	135	143	184
Cassette size (mm)		S: 156 × 96 L: 254 × 145	S: 156 × 96 L: 254 × 145	S: 161 × 98 M: 212 × 124 L: 296 × 167	125 × 78
Recording time (min)		48/148	48/148	27/75/148	46