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CODING OF MOVING PICTURES AND ASSOCIATED AUDIO INFORMATION

ISO/IEC JTC1/SC29/WG11 **N0905**

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1. 4:2:2 Profile (normative)

1.1 Profile_and_level indication

The 4:2:2 profile does not have a hierarchical relationship to other profiles. Consequently the MSB ('escape bit') of the profile_and_level indication shall be set. Note that levels for a non-hierarchical profile does not necessarily have any relationship to similarly named levels associated with hierarchical profiles.

Table 1-1. Meaning of bits in profile_and_level indication for non-hierarchical profiles

Profile Name	Field [7:7]	Field [6:0]
4:2:2 profile @ Main level	1	000 0101

1.2 Syntactic constraints of 4:2:2 profile

Table 1-2. Syntactic constraints for 4:2:2 profile

Syntactic element	Permitted values
Chroma format	4:2:2 or 4:2:0
frame rate extension n	0
frame rate extension d	0
Picture coding type	I, P, B
repeat first field	Unconstrained
sequence scalable extension()	No
Scalable mode	-
Picture_spatial_scalable_extension( )	No
intra dc precision	8, 9, 10, 11
Slice structure	Restricted
Max. number of bits in a macroblock	Unconstrained
Separate luma & chroma quant. tables	Unconstrained

1.3 Parameter contraints for 4:2:2 profile@Main level

The parameter constraints for 4:2:2 profile@Main level are the same as for Main profile@Main level, except as indicated in Table 1-3.

Table 1-3. Parameter constraints for 4:2:2 profile@Main level

Parameter	Maximum value
Upper bounds for sampling density	720 samples/line 608lines/frame † 30 frames/sec
Upper bound for luminance sample rate	11 059 200 pels
Upper bound for bitrate	50 Mbps
Max. VBV Buffer size	9 437 184 bits

† Note: 512 lines/frame for 525/60, 608 lines/frame for 625/50

1.4 Relationship to hierarchical profiles

A 4:2:2 profile@Main level decoder shall be able to decode Main profile@Main level, Main profile@Low level and Simple profile@Main level bitstreams, as well as ISO/IEC 11172-2 constrained parameter bitstreams.

Table 1-4. Forward compatibility between different profiles and levels

Profile & Level indication in bitstream	Decoder											
	HP @ HL	HP @ H-14	HP @ ML	Spatial @ H-14	SNR @ ML	SNR @ LL	MP @ HL	MP @ H-14	MP @ ML	MP @ LL	SP @ ML	4:2:2 @ ML
HP@HL	X											
HP@H-14	X	X										
HP@ML	X	X	X									
Spatial@H-14	X	X		X								
SNR @ML	X	X	X	X	X							
SNR @LL	X	X	X	X	X	X						
MP@HL	X						X					
MP@H-14	X	X		X			X	X				
MP@ML	X	X	X	X	X		X	X	X			X
MP@LL	X	X	X	X	X	X	X	X	X	X	X*	X
SP@ML	X	X	X	X	X		X	X	X		X	X
ISO/IEC 11172	X	X	X	X	X	X	X	X	X	X	X	X
4:2:2@ML												X

X indicates the decoder shall be able to decode the bitstream including all relevant lower layers.
* Note that SP@ML decoders are required to decode MP@LL bitstreams.

NOTE - For Profiles and Levels which obey a hierarchical structure, it is recommended that each layer of the bitstream should contain the **profile_and_level_indication** of the "simplest" decoder which is capable of successfully decoding that layer of the bitstream. In the case where the **profile_and_level_indication** Escape bit = 0, this will be the numerically largest of the possible valid values of **profile_and_level_indication**.

2. Informative clauses

2.1 Performance

The MPEG 2 compression algorithm exploits temporal redundancy, spatial redundancy, and human psycho-visual properties and is not a lossless algorithm. For sequences with substantial spatial and temporal redundancies, or without many sharp lines/edges, the quality of the sequences obtained after decompression will be higher than that obtained for sequences with lower redundancy, or with a large number of sharp lines/edges.

The 4:2:2 profile can provide higher video quality, better chroma resolution and allows a higher bitrate (at Main level, up to 50 Mbps) than MP@ML. It also provides the capability to encode all active lines of video.

Although it is not part of the hierarchy of profiles and levels, the 4:2:2 profile @ Main level decoder is required to decode all the bitstreams decodable by MP@ML decoders.

The 4:2:2 profile does not support scalability. This allows implementation architectures to be similar to those of MP@ML.

This profile can be used for applications requiring multiple generations of encoding and decoding. In the case of multiple generations without picture manipulation or change in picture coding type between generations, the quality remains nearly constant after the first generation. Use of picture manipulation or change in picture coding type between generations causes some degradation in quality. Nevertheless, the resulting quality is acceptable for a broad range of applications.

The 4:2:2 profile permits all I-picture encoding. This enables fast recovery from transmission errors and can simplify editing applications. This profile allows the high bit rates required to maintain high quality while using only I-picture coding. The 4:2:2 profile also allows the use of P- and B-picture coding types which can further improve quality or reduce bit rate for the same quality.

2.2 Syntax element restrictions in 4:2:2 profile

This Clause tabulates all of the syntactic elements defined in this Specification. Each syntactic element is classified to indicate whether it is required to be supported by a decoder compliant to a particular profile and level. Normative specifications for compliance are given in ISO/IEC 13818-4.

In the tables that follow a number of abbreviations are used as shown in Table 2-1.

Table 2-1. Abbreviations used in the Tables of Clause 2

Abbreviation	Used in	Meaning
x	Status	must be supported by the decoder
o	Status	need not be supported by the decoder
D	Type	item with Level-dependent parameters
I	Type	item independent of the Level in the Profile
P	Type	item for post-processing after decoding; the decoder must be capable of decoding bitstreams which contain these items, but their use is beyond the scope of this Recommendation | International Standard.

NOTE - "Status" is kept blank if an entry is not a syntactic element.

Table 2-2. Sequence header

#	Syntactic elements	Status	Type	Comments
01	**horizontal size value**	x	D	see Table 1-3
02	**vertical size value**	x	D	see Table 1-3
03	**aspect ratio information**	x	P	
04	**frame rate code**	x	D	see Table 1-3
05	(pel rate) NOTE - this is not a syntactic element		D	see Table 1-3; pel rate is a product of pels/line, lines/frame and frames/sec
06	**bit rate value**	x	D	see Table 1-3
07	**vbv buffer size value**	x	D	see Table 1-3
08	**constrained_parameters_flag**	x	I	set to '1' if MPEG-1 constrained, set to '0' if MPEG-2
09	**load intra quantiser matrix**	x	I	
10	**intra quantiser matrix[64]**	x	I	
11	**load non intra quantiser matrix**	x	I	
12	**non intra quantiser matrix[64]**	x	I	
13	sequence_extension()	x	I	always present if MPEG-2
14	sequence_display_extension()	x	P	
15	sequence_scalable_extension()	o	I	
16	user_data()	x	I	decoder may skip this data

Table 2-3. Sequence extension

#	Syntactic elements	Status	Type	Comments
01	**profile_and_level_indication**	x	D	escape bit: set to '1' 4:2:2 profile@Main level: '000 0101'
02	**progressive sequence**	x	I	
03	**chroma format**	x	I	see Table 1-2
04	**horizontal size extension**	x	D	input picture size related
05	**vertical size extension**	x	D	input picture size related
06	**bit rate extension**	x	D	input picture size related
07	**vbv buffer size extension**	x	D	input picture size related
08	**low delay**	x	I	
09	**frame rate extension n**	x	I	set to 0
10	**frame rate extension d**	x	I	set to 0

Table 2-4. Sequence display extension elements

#	Syntactic elements	Status	Type	Comments
01	**video format**	x	P	
02	**colour description**	x	P	input format related
03	**colour primaries**	x	P	
04	**transfer characteristics**	x	P	
05	**matrix coefficients**	x	P	
06	**display horizontal size**	x	P	input format related
07	**display vertical size**	x	P	input format related

Table 2-5. Sequence scalable extension

#	Syntactic elements	Status	Type	Comments
01	**scalable mode**	o	I	
02	**layer id**	o	I	
	if(spatial scalable)			
03	**lower_layer_prediction_ horizontal size**	o	D	
04	**lower_layer_prediction_ vertical size**	o	D	
05	**horizontal_subsampling_ factor m**	o	I	
06	**horizontal_subsampling_ factor n**	o	I	
07	**vertical_subsampling_ factor m**	o	I	
08	**vertical_subsampling_ factor n**	o	I	
	if(temporal scalable)			
09	**picture mux enable**	o	I	
10	**mux to progressive sequence**	o	I	
11	**picture mux order**	o	I	
12	**picture mux factor**	o	I	

Table 2-6. Group of pictures header

#	Syntactic elements	Status	Type	Comments
01	**time code**	x	I	decoder may skip this data
02	**closed gop**	x	I	
03	**broken link**	x	I	

Table 2-7. Picture header

#	Syntactic elements	Status	Type	Comments
01	**temporal reference**	x	I	
02	**picture coding type**	x	I	
03	**vbv delay**	x	I	
04	**full pel forward vector**	x	I	'0' for MPEG-2
05	**forward f code**	x	I	'111' for MPEG-2
06	**full pel backward vector**	x	I	'0' for MPEG-2
07	**backward f code**	x	I	'111' for MPEG-2
08	**extra information picture**	x	I	
09	picture_coding_extension()	x	I	
10	quant_matrix_extension()	x	I	
11	picture_display_extension()	x	P	
12	picture_spatial_scalable_extension()	o	I	
13	picture_temporal_scalable_extension()	o	I	

Table 2-8. Picture coding extension

#	Syntactic elements	Status	Type	Comments
01	f code[0][0] (forward horizontal)	x	D	Main level [1:8]
02	f code[0][1] (forward vertical)	x	D	Main level [1:5]
03	f code[1][0] (backward horizontal)	x	D	Main level [1:8]
04	f code[1][1] (backward vertical)	x	D	Main level [1:5]
05	intra dc precision	x	I	4:2:2 profile: [8:11]
06	picture structure	x	I	
07	top field first	x	I	
08	frame pred frame dct	x	I	
09	concealment motion vectors	x	I	
10	q scale type	x	I	
11	intra vlc format	x	I	
12	alternate scan	x	I	
13	repeat first field	x	I	
14	chroma 420 type	x	P	
15	progressive frame	x	P	
16	composite display flag	x	P	
17	v axis	x	P	
18	field sequence	x	P	
19	sub carrier	x	P	
20	burst amplitude	x	P	
21	sub carrier phase	x	P	

Table 2-9. Quant_matrix_extension

#	Syntactic elements	Status	Type	Comments
01	load_intra_quantiser_matrix	x	I	
02	intra_quantiser_matrix[64]	x	I	
03	load_non_intra_quantiser_matrix	x	I	
04	non_intra_quantiser_matrix[64]	x	I	
05	load_chroma_intra_quantiser_matrix	x	I	
06	chroma_intra_quantiser_matrix[64]	x	I	
07	load_chroma_non_intra_quantiser_matrix	x	I	
08	chroma_non_intra_quantiser_matrix[64]	x	I	

Table 2-10. Picture_display_extension.

#	Syntactic elements	Status	Type	Comments
01	frame_centre_horizontal_offset	x	P	input format related
02	frame_centre_vertical_offset	x	P	input format related

Table 2-11. Picture_temporal_scalable_extension

#	Syntactic elements	Status	Type	Comments
01	reference_select_code	o	I	
02	forward_temporal_reference	o	I	
03	backward_temporal_reference	o	I	

Table 2-12. Picture_spatial_scalable_extension

#	Syntactic elements	Status	Type	Comments
01	lower_layer_temporal_reference	o	I	
02	lower_layer_horizontal_offset	o	D	input format related
03	lower_layer_vertical_offset	o	D	input format related
04	spatial_temporal_weight_code_table_index	o	I	
05	lower_layer_progressive_frame	o	I	
06	lower_layer_deinterlaced_field_select	o	I	

Table 2-13. Slice_layer

#	Syntactic elements	Status	Type	Comments
01	slice_vertical_position_extension	x	D	input format related
02	priority_breakpoint	o	I	only required for data partitioning
03	quantiser_scale_code	x	I	
04	intra_slice_flag	x	I	
05	intra_slice	x	I	decoder may skip this data
06	extra_information_slice	x	I	decoder may skip this data
07	macroblock()	x	I	

Table 2-14. Macroblock layer

#	Syntactic elements	Status	Type	Comments
01	**macroblock escape**	x	I	
02	**macroblock address increment**	x	I	
03	macroblock_modes()	x	I	
04	**quantiser scale code**	x	I	
05	motion_vectors(0)	x	I	forward motion vector
06	motion_vectors(1)	x	I	backward motion vector
07	coded_block_pattern()	x	I	
08	block(i)	x	I	

Table 2-15. Macroblock modes

#	Syntactic elements	Status	Type	Comments
01	**macroblock type**	x	I	
02	**spatial temporal weight code**	o	I	
03	**frame_motion_type**	x	I	01: Field-based prediction 10: Frame-based prediction 11: Dual-prime
04	**field_motion_type**	x	I	01: Field-based prediction 10: 16x8 MC 11: Dual-prime
05	**dct type**	x	I	

Table 2-16. Motion vectors

#	Syntactic elements	Status	Type	Comments
01	**motion vertical field select**	x	I	
02	motion_vector()	x	I	

Table 2-17. Motion vector

#	Syntactic elements	Status	Type	Comments
01	**motion horizontal code**	x	I	
02	**motion horizontal r**	x	I	
03	**dmv horizontal**	x	I	
04	**motion vertical code**	x	I	
05	**motion vertical r**	x	I	
06	**dmv vertical**	x	I	

Table 2-18. Coded Block Pattern

#	Syntactic elements	Status	Type	Comments
01	**coded block pattern 420**	x	I	
02	**coded block pattern 1**	x	I	4:2:2
03	**coded block pattern 2**	o	I	4:4:4

Table 2-19. Block layer

#	Syntactic elements	Status	Type	Comments
01	DCT coefficients	x	I	
02	End of block	x	I	