INTERNATIONAL STANDARD

ISO/IEC
14496-29

Information technology — Coding of audio-visual objects —

Part 29:
Web video coding

Technologies de l'information — Codage des objets audiovisuels —

Partie 29: Codage vidéo Web

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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The committee responsible for this document is ISO/IEC JTC 1, *Information technology*, SC 29, *Coding of audio, picture, multimedia and hypermedia information*.

ISO/IEC 14496 consists of the following parts, under the general title *Information technology — Coding of audio-visual objects*:

— *Part 1: Systems*

— *Part 2: Visual*

— *Part 3: Audio*

— *Part 4: Conformance testing*

— *Part 5: Reference software*

— *Part 6: Delivery Multimedia Integration Framework (DMIF)*

— *Part 7: Optimized reference software for coding of audio-visual objects*

— *Part 8: Carriage of ISO/IEC 14496 contents over IP networks*

— *Part 9: Reference hardware description*

— *Part 10: Advanced Video Coding*

— *Part 11: Scene description and application engine*

— *Part 12: ISO base media file format*

— *Part 13: Intellectual Property Management and Protection (IPMP) extensions*

— *Part 14: MP4 file format*

— *Part 15: Advanced Video Coding (AVC) file format*

— *Part 16: Animation Framework eXtension (AFX)*

— *Part 17: Streaming text format*

— *Part 18: Font compression and streaming*

— *Part 19: Synthesized texture stream*

— *Part 20: Lightweight Application Scene Representation (LASeR) and Simple Aggregation Format (SAF)*

— *Part 21: MPEG-J Graphics Framework eXtensions (GFX)*

— *Part 22: Open Font Format*

— *Part 23: Symbolic Music Representation*

— *Part 24: Audio and systems interaction*

— *Part 25: 3D Graphics Compression Model*

— *Part 26: Audio conformance*

— *Part 27: 3D Graphics conformance*

— *Part 28: Composite font representation*

— *Part 29: Web video coding*

Introduction

This International Standard specifies Web Video Coding, a technology that is compatible with the Constrained Baseline Profile of ISO/IEC 14996-10. Only the subset that is specified in Annex A for the Constrained Baseline Profile is a normative specification, while all remaining aspects are informative. This text is derived from ISO/IEC 14996-10, with which the section numbers in this specification are aligned, and that specification may additionally be consulted if desired, as an aid to understanding this Specification.

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Information technology — Coding of audio-visual objects — Part 29: Web video coding

1 Scope

This Part of ISO/IEC 14496 specifies Web Video Coding for coding of audio-visual objects.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

– ISO 11664-1, *Colorimetry – Part 1: CIE standard colorimetric observers*.

– ISO/IEC 14496-10: *Information technology – Coding of audio-visual objects – Part 10: Advanced Video Coding*

3 Definitions

For the purposes of this document, the following definitions apply:

3.1 **access unit**: A set of *NAL units* that are consecutive in *decoding order* and contain exactly one *primary coded picture*. In addition to the *primary coded picture*, an access unit may also contain one *auxiliary coded picture*, or other *NAL units* not containing *slices* of a *coded picture*. The decoding of an access unit always results in a *decoded picture*.

3.2 **AC transform coefficient**: Any *transform coefficient* for which the *frequency index* in one or both dimensions is non-zero.

3.3 **bitstream**: A sequence of bits that forms the representation of *coded pictures* and associated data forming one or more *coded video sequences*. Bitstream is a collective term used to refer either to a *NAL unit stream* or a *byte stream*.

3.4 **block**: An MxN (M-column by N-row) array of samples, or an MxN array of *transform coefficients*.

3.5 **[void]**

3.6 **broken link**: A location in a *bitstream* at which it is indicated that some subsequent *pictures* in *decoding order* may contain serious visual artefacts due to unspecified operations performed in the generation of the *bitstream*.

3.7 **byte**: A sequence of 8 bits, written and read with the most significant bit on the left and the least significant bit on the right. When represented in a sequence of data bits, the most significant bit of a byte is first.

3.8 **byte-aligned**: A position in a *bitstream* is byte-aligned when the position is an integer multiple of 8 bits from the position of the first bit in the *bitstream*. A bit or *byte* or *syntax element* is said to be byte-aligned when the position at which it appears in a *bitstream* is byte-aligned.

3.9   **byte stream**: An encapsulation of a *NAL unit stream* containing *start code prefixes* and *NAL units* as specified in Annex B.

3.10   **can**: A term used to refer to behaviour that is allowed, but not necessarily required.

3.11   **[void]**

3.12   **chroma**: An adjective specifying that a sample array or single sample is representing one of the two colour difference signals related to the primary colours. The symbols used for a chroma array or sample are Cb and Cr.

> NOTE – The term chroma is used rather than the term chrominance in order to avoid the implication of the use of linear light transfer characteristics that is often associated with the term chrominance.

3.13   **coded frame**: A *coded representation* of a *frame*.

3.14   **coded picture**: A *coded representation* of a *picture*.

3.15   **coded picture buffer (CPB)**: A first-in first-out buffer containing *access units* in *decoding order* specified in the *hypothetical reference decoder* in Annex C.

3.16   **coded representation**: A data element as represented in its coded form.

3.17   **[void]**

3.18   **coded slice NAL unit**: A *NAL unit* containing a *slice* that is not a *slice* of an *auxiliary coded picture*.

3.19   **coded video sequence**: A sequence of *access units* that consists, in decoding order, of an *IDR access unit* followed by zero or more non-IDR *access units* including all subsequent *access units* up to but not including any subsequent *IDR access unit*.

3.20   **component**: An array or single sample from one of the three arrays (*luma* and two *chroma*) that make up a *frame* in 4:2:0 colour format.

3.21   **DC transform coefficient**: A *transform coefficient* for which the *frequency index* is zero in all dimensions.

3.22   **decoded picture**: A *decoded picture* is derived by decoding a *coded picture*. A *decoded picture* is a decoded *frame*.

3.23   **decoded picture buffer (DPB)**: A buffer holding *decoded pictures* for reference, output reordering, or output delay specified for the *hypothetical reference decoder* in Annex C.

3.24   **decoder**: An embodiment of a *decoding process*.

3.25   **decoder under test (DUT)**: A *decoder* that is tested for conformance to this International Standard by operating the *hypothetical stream scheduler* to deliver a conforming *bitstream* to the *decoder* and to the *hypothetical reference decoder* and comparing the values and timing of the output of the two *decoders*.

3.26   **decoding order**: The order in which *syntax elements* are processed by the *decoding process*.

3.27   **decoding process**: The process specified in this International Standard that reads a *bitstream* and derives *decoded pictures* from it.

3.28   **[void]**

3.29   **display process**: A process not specified in this International Standard having, as its input, the cropped decoded *pictures* that are the output of the *decoding process*.

3.30   **emulation prevention byte**: A *byte* equal to 0x03 that may be present within a *NAL unit*. The presence of emulation prevention bytes ensures that no sequence of consecutive *byte-aligned bytes* in the *NAL unit* contains a *start code prefix*.

3.31   **encoder**: An embodiment of an *encoding process*.

3.32   **encoding process**: A process, not specified in this International Standard, that produces a *bitstream* conforming to this International Standard.

3.33   **flag**: A variable that can take one of the two possible values 0 and 1.

3.34   **frame**: A *frame* contains an array of *luma* samples and two corresponding arrays of *chroma* samples in 4:2:0 format.

3.35   **frame macroblock**: A *macroblock* representing samples of a *coded frame*. All *macroblocks* of a *coded frame* are **frame macroblock**s.

3.36   **[void]**

3.37   *frequency index*: A *one-dimensional or two-dimensional* index associated wit*h a transform coefficient* prior to an *inverse transform* part of the *decoding process*.

3.38   **hypothetical reference decoder (HRD)**: A hypothetical *decoder* model that specifies constraints on the variability of conforming *NAL unit streams* or conforming *byte streams* that an encoding process may produce.

3.39   **hypothetical stream scheduler (HSS)**: A hypothetical delivery mechanism for the timing and data flow of the input of a *bitstream* into the *hypothetical reference decoder*. The HSS is used for checking the conformance of a *bitstream* or a *decoder*.

3.40   **I slice**: A *slice* that is decoded using *intra prediction* only.

3.41   **informative**: A term used to refer to content provided in this International Standard that is not an integral part of this International Standard. Informative content does not establish any mandatory requirements for conformance to this International Standard.

3.42   **instantaneous decoding refresh (IDR) access unit**: An *access unit* in which the *primary coded picture* is an *IDR picture*.

3.43   **instantaneous decoding refresh (IDR) picture**: A *coded picture* for which the variable IdrPicFlag is equal to 1. An IDR picture causes the *decoding process* to mark all *reference pictures* as "unused for reference" immediately after the decoding of the IDR picture. All *coded pictures* that follow an IDR picture in *decoding order* can be decoded without *inter prediction* from any *picture* that precedes the IDR picture in *decoding order*. The first *picture* of each *coded video sequence* in *decoding order* is an IDR picture.

3.44   **inter coding**: Coding of a *block, macroblock, slice*, or *picture* that uses *inter prediction*.

3.45   **inter prediction**: A *prediction* derived from decoded samples of *reference pictures* other than the current *decoded picture*.

3.46   **interpretation sample value**: A possibly-altered value corresponding to a decoded sample value of an *auxiliary coded picture* that may be generated for use in the *display process*. Interpretation sample values are not used in the *decoding process* and have no normative effect on the *decoding process*.

3.47   **intra coding**: Coding of a *block, macroblock, slice*, or *picture* that uses *intra prediction*.

3.48   **intra prediction**: A *prediction* derived from the decoded samples of the same decoded *slice*.

3.49   **intra slice**: See *I slice*.

3.50   **inverse transform**: A part of the *decoding process* by which a set of *transform coefficients* are converted into spatial-domain values, or by which a set of *transform coefficients* are converted into *DC transform coefficients*.

3.51   **layer**: One of a set of syntactical structures in a non-branching hierarchical relationship. Higher layers contain lower layers. The coding layers are the *coded video sequence, picture, slice*, and *macroblock* layers.

3.52   **level**: A defined set of constraints on the values that may be taken by the *syntax elements* and variables of this International Standard. The same set of levels is defined for all *profiles*, with most aspects of the definition of each level being in common across different *profiles*. Individual implementations may, within specified constraints, support a different level for each supported *profile*. In a different context, a level is the value of a *transform coefficient* prior to *scaling* (see the definition of *transform coefficient level*).

3.53   **list**: A one-dimensional array of *syntax elements* or variables.

3.54   **luma**: An adjective specifying that a sample array or single sample is representing the monochrome signal related to the primary colours. The symbol or subscript used for luma is Y or L.

> NOTE – The term luma is used rather than the term luminance in order to avoid the implication of the use of linear light transfer characteristics that is often associated with the term luminance. The symbol L is sometimes used instead of the symbol Y to avoid confusion with the symbol y as used for vertical location.

3.55   **macroblock**: A 16x16 *block* of *luma* samples and two corresponding *blocks* of *chroma* samples of a *picture* that has three sample arrays, or a 16x16 *block* of samples of a monochrome *picture* or a *picture* that is coded using three separate colour planes. The division of a *slice* into macroblocks is a *partitioning*.

3.56   **macroblock address**: a macroblock address is the index of a *macroblock* in a *macroblock raster scan* of the *picture* starting with zero for the top-left *macroblock* in a *picture*.

3.57   **macroblock location**: The two-dimensional coordinates of a *macroblock* in a *picture* denoted by (x, y). For the top left *macroblock* of the *picture* (x, y) is equal to (0, 0). x is incremented by 1 for each *macroblock* column from left to right. y is incremented by 1 for each *macroblock* row from top to bottom.

3.58   **macroblock partition**: A *block* of *luma* samples and two corresponding *blocks* of *chroma* samples resulting from a *partitioning* of a *macroblock* for *inter prediction* for a *picture* that has three sample arrays or a *block* of *luma* samples resulting from a *partitioning* of a *macroblock* for *inter prediction* for a monochrome *picture* or a *picture* that is coded using three separate colour planes.

3.59   **matrix**: A two-dimensional array of *syntax elements* or variables.

3.60   **may**: A term used to refer to behaviour that is allowed, but not necessarily required. In some places where the optional nature of the described behaviour is intended to be emphasized, the phrase "may or may not" is used to provide emphasis.

3.61   **memory management control operation**: Seven operations that control *reference picture marking*.

3.62   **motion vector**: A two-dimensional vector used for *inter prediction* that provides an offset from the coordinates in the *decoded picture* to the coordinates in a *reference picture*.

3.63   **must**: A term used in expressing an observation about a requirement or an implication of a requirement that is specified elsewhere in this International Standard. This term is used exclusively in an *informative* context.

3.64   **NAL unit**: A *syntax structure* containing an indication of the type of data to follow and *bytes* containing that data in the form of an *RBSP* interspersed as necessary with *emulation prevention bytes*.

3.65   **NAL unit stream**: A sequence of *NAL units*.

3.66   **non-reference frame**: A *frame* coded with nal_ref_idc equal to 0.

3.67   **non-reference picture**: A *picture* coded with nal_ref_idc equal to 0. A *non-reference picture* is not used for *inter prediction* of any other *pictures*.

3.68   **note**: A term used to prefix *informative* remarks. This term is used exclusively in an *informative* context.

3.69   **output order**: The order in which the *decoded pictures* are output from the *decoded picture buffer*.

3.70   **P slice**: A *slice* that may be decoded using *intraprediction* or *inter prediction* using at most one *motion vector* and *reference index* to *predict* the sample values of each *block*.

3.71   **parameter**: A *syntax element* of a *sequence parameter set* or a *picture parameter set*. Parameter is also used as part of the defined term *quantisation parameter*.

3.72   **partitioning**: The division of a set into subsets such that each element of the set is in exactly one of the subsets.

3.73   **picture**: A collective term for a *frame*.

3.74   **picture parameter set**: A *syntax structure* containing *syntax elements* that apply to zero or more entire *coded pictures* as determined by the pic_parameter_set_id *syntax element* found in each *slice header*.

3.75 **picture order count**: A variable that is associated with each *coded picture* and has a value that is non-decreasing with increasing *picture* position in *output order* relative to the first output *picture* of the previous *IDR picture* in *decoding order* or relative to the previous *picture*, in *decoding order*, that contains a *memory management control operation* that marks all *reference pictures* as "unused for reference".

3.76 **prediction**: An embodiment of the *prediction process*.

3.77 **prediction process**: The use of a *predictor* to provide an estimate of the sample value or data element currently being decoded.

3.78 **predictive slice**: See *P slice*.

3.79 **predictor**: A combination of specified values or previously decoded sample values or data elements used in the *decoding process* of subsequent sample values or data elements.

3.80 **primary coded picture**: The coded representation of a *picture* to be used by the *decoding process* for a bitstream conforming to this International Standard. The primary coded picture contains all *macroblocks* of the *picture*. The only *pictures* that have a normative effect on the *decoding process* are primary coded pictures. *e.*

3.81 **profile**: A specified subset of the syntax of this International Standard.

3.82 **quantisation parameter**: A variable used by the *decoding process* for *scaling* of *transform coefficient levels*.

3.83 **random access**: The act of starting the decoding process for a *bitstream* at a point other than the beginning of the stream.

3.84 **raster scan**: A mapping of a rectangular two-dimensional pattern to a one-dimensional pattern such that the first entries in the one-dimensional pattern are from the first top row of the two-dimensional pattern scanned from left to right, followed similarly by the second, third, etc. rows of the pattern (going down) each scanned from left to right.

3.85 **raw byte sequence payload (RBSP):** A *syntax structure* containing an integer number of *bytes* that is encapsulated in a *NAL unit*. An RBSP is either empty or has the form of a *string of data bits* containing *syntax elements* followed by an *RBSP stop bit* and followed by zero or more subsequent bits equal to 0.

3.86 **raw byte sequence payload (RBSP) stop bit:** A bit equal to 1 present within a *raw byte sequence payload (RBSP)* after a *string of data bits*. The location of the end of the *string of data bits* within an *RBSP* can be identified by searching from the end of the *RBSP* for the *RBSP stop bit*, which is the last non-zero bit in the *RBSP*.

3.87 **recovery point**: A point in the *bitstream* at which the recovery of an exact or an approximate representation of the *decoded pictures* represented by the *bitstream* is achieved after a *random access* or *broken link*.

3.88 **reference frame**: A *reference frame* may be used for *inter prediction* when *P slices* of a *coded frame* are decoded. See also *reference picture*.

3.89 **reference index**: An index into a *reference picture list*.

3.90 **reference picture**: A *picture* with nal_ref_idc not equal to 0. A *reference picture* contains samples that may be used for *inter prediction* in the *decoding process* of subsequent *pictures* in *decoding order*.

3.91 **reference picture list**: A list of *reference pictures* that is used for *inter prediction* of a *P slice*. For the *decoding process* of a *P slice,* there is one reference picture list.

3.92 **reference picture list 0**: A *reference picture list* used for *inter prediction* of a *Pslice*. All *inter prediction* used for *P slices* uses reference picture list 0.

3.93 **reference picture marking**: Specifies, in the bitstream, how the *decoded pictures* are marked for *inter prediction*.

3.94 **reserved**: The term reserved, when used in the clauses specifying some values of a particular *syntax element*, are for future use by ITU-T | ISO/IEC. These values shall not be used in *bitstreams* conforming to this International Standard, but may be used in future extensions of this International Standard by ITU-T | ISO/IEC.

3.95 **residual**: The decoded difference between a *prediction* of a sample or data element and its decoded value.

3.96 **run**: A number of consecutive data elements represented in the decoding process. In one context, the number of zero-valued *transform coefficient levels* preceding a non-zero *transform coefficient level* in the list of *transform coefficient levels* generated by a *zig-zag scan*. In other contexts, run refers to a number of *macroblocks*.

3.97 **sample aspect ratio**: Specifies, for assisting the *display process*, which is not specified in this International Standard, the ratio between the intended horizontal distance between the columns and the intended vertical distance between the rows of the *luma* sample array in a *frame*. Sample aspect ratio is expressed as *h*:*v*, where *h* is horizontal width and *v* is vertical height (in arbitrary units of spatial distance).

3.98 **scaling**: The process of multiplying *transform coefficient levels* by a factor, resulting in *transform coefficients*.

3.99 **sequence parameter set**: A *syntax structure* containing *syntax elements* that apply to zero or more entire *coded video sequences* as determined by the content of a seq_parameter_set_id *syntax element* found in the *picture parameter set* referred to by the pic_parameter_set_id *syntax element* found in each *slice header*.

3.100 **shall**: A term used to express mandatory requirements for conformance to this International Standard. When used to express a mandatory constraint on the values of *syntax elements* or on the results obtained by operation of the specified *decoding process*, it is the responsibility of the *encoder* to ensure that the constraint is fulfilled. When used in reference to operations performed by the *decoding process*, any *decoding process* that produces identical results to the *decoding process* described herein conforms to the *decoding process* requirements of this International Standard.

3.101 **should**: A term used to refer to behaviour of an implementation that is encouraged to be followed under anticipated ordinary circumstances, but is not a mandatory requirement for conformance to this International Standard.

3.102 **skipped macroblock**: A *macroblock* for which no data is coded other than an indication that the *macroblock* is to be decoded as "skipped". This indication may be common to several *macroblocks*.

3.103 **slice**: An integer number of *macroblocks* ordered consecutively in the *raster scan* within the *primary coded picture*. The *macroblock addresses* are derived from the first *macroblock address* in a slice (as represented in the *slice header*) and, when a *picture* is coded using three separate colour planes, a colour plane identifier.

3.104 **[void]**

3.105 **[void]**

3.106 **slice header**: A part of a coded *slice* containing the data elements pertaining to the first or all *macroblocks* represented in the *slice*.

3.107 **source**: Term used to describe the video material or some of its attributes before encoding.

3.108 **start code prefix**: A unique sequence of three *bytes* equal to 0x000001 embedded in the *byte stream* as a prefix to each *NAL unit*. The location of a start code prefix can be used by a *decoder* to identify the beginning of a new *NAL unit* and the end of a previous *NAL unit*. Emulation of start code prefixes is prevented within *NAL units* by the inclusion of *emulation prevention bytes*.

3.109 **string of data bits (SODB)**: A sequence of some number of bits representing *syntax elements* present within a *raw byte sequence payload* prior to the *raw byte sequence payload stop bit*. Within an SODB, the left-most bit is considered to be the first and most significant bit, and the right-most bit is considered to be the last and least significant bit.

3.110 **sub-macroblock**: One quarter of the samples of a *macroblock*, i.e., an 8x8 *luma block* and two corresponding *chroma blocks* of which one corner is located at a corner of the *macroblock* for a *picture* that has three sample arrays or an 8x8 *luma block* of which one corner is located at a corner of the *macroblock* for a monochrome *picture* or a *picture* that is coded using three separate colour planes.

3.111 **sub-macroblock partition**: A *block* of *luma* samples and two corresponding *blocks* of *chroma* samples resulting from a *partitioning* of a *sub-macroblock* for *inter prediction* for a *picture* that has three sample arrays or a *block* of *luma* samples resulting from a *partitioning* of a *sub-macroblock* for *inter prediction* for a monochrome *picture* or a *picture* that is coded using three separate colour planes.

3.112   **syntax element**: An element of data represented in the *bitstream*.

3.113   **syntax structure**: Zero or more *syntax elements* present together in the *bitstream* in a specified order.

3.114   **transform coefficient**: A scalar quantity, considered to be in a frequency domain, that is associated with a particular one-dimensional or two-dimensional *frequency index* in an *inverse transform* part of the *decoding process*.

3.115   **transform coefficient level**: An integer quantity representing the value associated with a particular two-dimensional frequency index in the *decoding process* prior to *scaling* for computation of a *transform coefficient* value.

3.116   **universal unique identifier (UUID)**: An identifier that is unique with respect to the space of all universal unique identifiers.

3.117   **unspecified:** The term unspecified, when used in the clauses specifying some values of a particular *syntax element*, indicates that the values have no specified meaning in this International Standard and will not have a specified meaning in the future as an integral part of this International Standard.

3.118   **variable length coding (VLC)**: A reversible procedure for entropy coding that assigns shorter bit strings to *symbols* expected to be more frequent and longer bit strings to *symbols* expected to be less frequent.

3.119   **VCL NAL unit**: A collective term for *coded slice NAL units*.

3.120   **zig-zag scan**: A specific sequential ordering of *transform coefficient levels* from (approximately) the lowest spatial frequency to the highest. Zig-zag scan is used for *transform coefficient levels* in *frame macroblocks*.

4   Abbreviations

For the purposes of this International Standard, the following abbreviations apply:

CAVLC   Context-based Adaptive Variable Length Coding

CBR   Constant Bit Rate

CPB   Coded Picture Buffer

DPB   Decoded Picture Buffer

DUT   Decoder under test

FIFO   First-In, First-Out

HRD   Hypothetical Reference Decoder

HSS   Hypothetical Stream Scheduler

IDR   Instantaneous Decoding Refresh

LSB   Least Significant Bit

MB   Macroblock

MSB   Most Significant Bit

NAL   Network Abstraction Layer

RBSP   Raw Byte Sequence Payload

SEI   Supplemental Enhancement Information

SODB   String Of Data Bits

UUID   Universal Unique Identifier