SMPTE ST 2042-2:2017
Revision of SMPTE ST 2042-2:2009

SMPTE STANDARD

VC-2 Level Definitions

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Foreword

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SMPTE Engineering Documents are drafted in accordance with the rules given in its Standards Operations Manual. This SMPTE Engineering Document was prepared by Technology Committee 10E.

Intellectual Property

At the time of publication no notice had been received by SMPTE claiming patent rights essential to the implementation of this Standard. However, attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. SMPTE shall not be held responsible for identifying any or all such patent rights.

Introduction

This section is entirely informative and does not form an integral part of this Engineering Document.

This standard defines levels for the VC-2 video coding standard. Level values, along with profile values, provide a fast look-up for decoders to establish whether they can decode a VC-2 stream. Profile values are defined in the VC-2 specification. VC-2 levels are divided into generalized and specialized categories. Generalized levels are defined to provide identification of a range of encoded video parameters and are defined in this document. Specialized levels are defined for specific applications where other VC-2 level specifications do not suffice.

1 Scope

VC-2 is a video codec that includes parameter values to identify the complexity of the coded VC-2 bit-stream through the use of profiles and levels. These values provide a fast assessment for a decoder to establish whether it has the capability to decode the VC-2 bit-stream.

Profiles are defined in the VC-2 standard (SMPTE ST 2042-1). This standard defines the coding constraints for generalized level values lying in the range 0 to 63. This standard also informatively registers the values of specialized levels with values exceeding 63.

2 Conformance Notation

Normative text is text that describes elements of the design that are indispensable or contains the conformance language keywords: "shall", "should", or "may". Informative text is text that is potentially helpful to the user, but not indispensable, and can be removed, changed, or added editorially without affecting interoperability. Informative text does not contain any conformance keywords.

All text in this document is, by default, normative, except: the Introduction, any section explicitly labeled as "Informative" or individual paragraphs that start with "Note:"

The keywords "shall" and "shall not" indicate requirements strictly to be followed in order to conform to the document and from which no deviation is permitted.

The keywords, "should" and "should not" indicate that, among several possibilities, one is recommended as particularly suitable, without mentioning or excluding others; or that a certain course of action is preferred but not necessarily required; or that (in the negative form) a certain possibility or course of action is deprecated but not prohibited.

The keywords "may" and "need not" indicate courses of action permissible within the limits of the document. The keyword “reserved” indicates a provision that is not defined at this time, shall not be used, and may be defined in the future. The keyword “forbidden” indicates “reserved” and in addition indicates that the provision will never be defined in the future.

A conformant implementation according to this document is one that includes all mandatory provisions ("shall") and, if implemented, all recommended provisions ("should") as described. A conformant implementation need not implement optional provisions ("may") and need not implement them as described.

Unless otherwise specified, the order of precedence of the types of normative information in this document shall be as follows: Normative prose shall be the authoritative definition; Tables shall be next; followed by formal languages; then Figures; and then any other language forms.

3 Normative Reference

The following standard contains provisions which, through reference in this text, constitute provisions of this standard. At the time of publication, the edition indicated was valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent edition of the standard indicated below.

SMPTE ST 2042-1:2017, VC-2 Video Compression

4 VC-2 Levels

The VC-2 profile and level values are present in the parse info header of every VC-2 sequence to provide a fast look-up for decoders to establish their suitability for a given VC-2 sequence. The profile and level values are mutually independent and decoders need both values to determine if a given VC-2 sequence is decodable. Profile values shall be as defined in SMPTE ST 2042-1. Level values identify constrained parameter values in a given VC-2 bitstream.

Generalized levels allow some parameters to be within a range of values. Generalized levels require that decoders claiming compliance with a given level are able to decode VC-2 bitstreams encoded with the corresponding range of parameter values. Generalized level definitions do not overlap.

Level values 0~63 inclusive shall be reserved for generalized level definitions that use the predefined video formats defined in SMPTE ST 2042-1:2017 Annex B. Section 5.2 of this document defines all generalized levels and their values. All generalized level values that are not defined in this document shall be reserved values.

Specialized levels are used to further constrain a VC-2 bitstream in order to satisfy the requirements of a specific application. A particular application domain may impose additional constraints on the requirements for a decoder, for example, to support a specific video interface with real-time decoding. Specialized level definitions may overlap.

Level values >=64 shall be reserved for specialized applications of the VC-2 codec. The VC-2 bitstream constraints shall be defined by an application specification which shall assign a unique VC-2 specialized level value. A VC-2 bitstream identified by a specialized level value may be a specifically constrained sub-set of a generalized level definition with restrictions as defined by the application specification.

This document provides informative Annex A that catalogues all known specialized level values and their defining documents. This annex can be updated as needed to maintain the accuracy of the catalogue through revisions of this document.

5 Generalized Levels

5.1 General

This standard defines the parameters applicable to conformant bit-streams for level values 0 to 7 inclusive. Other generalized level values up to 63 may be defined in future revisions of this document. Unless otherwise specified, custom flags shall be False.

5.2 Level Definitions

5.2.1 Level 0:

A sequence which does not conform to any other level may indicate that it conforms to level 0. A decoder should decode a sequence which indicates it conforms to level 0 if it is able to do so.

5.2.2 Levels 1 to 7: The Default Levels

Levels 1 to 7 shall be used to identify a VC-2 bit-stream that complies with one of the base video formats with an index value >0 as defined in SMPTE ST 2042-1 and where:

- the default video parameters of the base video format shall not be overridden unless otherwise defined in this document.

Decoders claiming conformance to Levels 1 to 7 shall be able to decode a specific sub-set of the VC-2 bit-streams that comply with the base video formats defined in SMPTE ST 2042-1 as follows:

- Level 1 decoders shall be able to decode VC-2 bit-streams that comply with the base video formats 1~6 inclusive.
- Level 2 decoders shall be able to decode VC-2 bit-streams that comply with the base video formats 7, 8 or 22.
- Level 3 decoders shall be able to decode VC-2 bit-streams that comply with the base video formats 9~14 inclusive or 21.
- Level 4 decoders shall be able to decode VC-2 bit-streams that comply with the base video format 15.
- Level 5 decoders shall be able to decode VC-2 bit-streams that comply with the base video format 16.
- Level 6 decoders shall be able to decode VC-2 bit-streams that comply with the base video formats 17 or 18.
- Level 7 decoders shall be able to decode VC-2 bit-streams that comply with the base video formats 19 or 20.

In addition, for Levels 2, 3 and 4 only, decoders shall be able to decode the additional streams specified below which are extensions to the base video formats:

- Level 2 decoders shall be able to decode streams compliant with base video format 7 where the frame size has been over-ridden by a frame size of up to 486 lines (see below for details).

  Note: this provision supports the carriage of component video carried on interfaces defined in SMPTE ST 125, SMPTE ST 259, and SMPTE ST 293.

- Levels 2 and 3 decoders shall be able to decode streams compliant with base video formats 7, 8, 11, 12 and 22, where the scan format has been over-ridden to signal progressive video (see below for details).

  Note: This provision supports the common practice of carrying progressive (“film mode”) video over an interlaced format.

- Level 4 decoders shall be able to decode streams compliant with base video format 15 where the Frame Rate index has been overridden with the value of 11 (48fps).

Decoders may claim compliance with any one or more level numbers as defined above.

5.3 Sequence Header Parameters

The following constraints shall apply to sequence header parameters:

- custom_dimensions_flag shall be **False** with the exception that, for base video format 7 only, the custom_dimensions_flag may be set to **True**.

  If the custom_scan_format_flag is **True**, then frame_width shall be over-ridden with a value of 720 and the frame_height shall be over-ridden with a value between 480 and 486.

- custom_chroma_format_flag shall be **False**
- custom_scan_format_flag shall be **False** with the exception that for base video formats 7, 8, 11, 12 and 22 only, the custom_scan_format_flag may be set to **True**.

  If the custom_scan_format_flag is **True**, then default source_sampling value of 1 (interlaced) may be overridden with the value of 0 (progressive).

- custom_frame_rate_flag shall be **False** with the exception specified above for Level 4.

- custom_pixel_aspect_ratio_flag shall be **False**
- custom_clean_area_flag shall be **False**
- custom_signal_range_flag shall be **False**
- custom_color_spec_flag shall be **False**
- picture_coding_mode, shall correspond to the specified source video format. That is, if the source video format is signaled as progressive, picture_coding_mode shall be 0 (pictures correspond to frames) and if the source video format is signaled as interlaced, picture_coding_mode shall be 1 (pictures correspond to fields).

5.4 Picture Header Parameters

The following constraints shall apply to picture header parameters:

- wavelet_index shall be less than or equal to 4. (Wavelet filters and their indexes are listed in Table 12.1 of SMPTE ST 2042-1:2017.)
- dwt_depth shall be between 0 and 4 inclusive
- in sequences which conform to major version 3 of the specification asym_transform_index_flag shall be **False**
- in sequences which conform to major version 3 of the specification asym_transform_flag shall be **False**
- slices_x and slices_y shall be such that there are the same number of DC (0-LL) coefficients per slice.

  Note: this will always be the case if these values are chosen such that pw is a multiple of slices_x and ph is a multiple of slices_y , where pw and ph are the padded width and height of the picture as defined in SMPTE ST 2042-1:2017, Section 13.2.3)
- values in the quantizer matrix shall lie between 0 and 127 inclusive

5.5 Sequence Structure

The following constraint shall apply to sequence structure:

- The sequence may contain picture fragment data units or picture data units, but shall not contain both.

Annex A Catalogue of Specialized VC-2 Levels (Informative)

The table below identifies those specialized levels defined in other SMPTE documents through the level value and its defining document.

Specialized Level Value	Defining Document
64	SMPTE RP 2047-1 (VC-2 Mezzanine Compression of 1080P High Definition Video Sources)
65	SMPTE RP 2047-3 (VC-2 Level 65 Compression of High Definition Video Sources for Use with a Standard Definition Infrastructure)
66	SMPTE RP 2047-5 (VC-2 Level 66 Compression of Ultra High Definition Video Sources for use with a High Definition Infrastructure)

Bibliography (Informative)

SMPTE ST 125:2013, SDTV Component Video Signal Coding 4:4:4 and 4:2:2 for 13.5 MHz and 18 MHz Systems

SMPTE ST 259:2008, Television - SDTV Digital Signal/Data - Serial Digital Interface

SMPTE ST 293:2003, Television - 720 x 483 Active Line at 59.94-Hz Progressive Scan Production - Digital Representation

SMPTE RP 2047-1:2009, VC-2 Mezzanine Level Compression of 1080P High Definition Video Sources

SMPTE RP 2047-3:2016, VC-2 Level 65 Compression of High Definition Video Sources for Use with a Standard Definition Infrastructure

SMPTE RP 2047-5:2017, VC-2 Level 66 Compression of Ultra High Definition Video Sources for use with a High Definition Infrastructure