

SMPTE RECOMMENDED PRACTICE

VC-1 Decoder and Bitstream Conformance



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3 Barker Avenue, White Plains, NY 10601
White Plains, NY 10601
+1 914 761 1100
Fax +1 914 761-3115
E-mail eng@smppte.org
Web <http://www.smppte.org>

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Foreword

SMPTE (the Society of Motion Picture and Television Engineers) is an internationally-recognized standards developing organization. Headquartered and incorporated in the United States of America, SMPTE has members in over 80 countries on six continents. SMPTE's Engineering Documents, including Standards, Recommended Practices and Engineering Guidelines, are prepared by SMPTE's Technology Committees. Participation in these Committees is open to all with a bona fide interest in their work. SMPTE cooperates closely with other standards-developing organizations, including ISO, IEC and ITU.

SMPTE Engineering Documents are drafted in accordance with the rules given in Part XIII of its Administrative practices.

This SMPTE Recommended Practice was prepared by Technology Committee C24.

Introduction

This section is entirely informative and does not form an integral part of this Recommended Practice.

This conformance document was initiated by C24 in response to the need to test conformance to the VC-1 bitstream syntax and the need for reference decoder software and test bitstreams to ensure proper interpretation of the SMPTE 421M standard.

VC-1 Decoder and Bitstream Conformance

1 Scope

This document specifies the materials, procedures and criteria for verifying conformance of SMPTE VC-1 video decoders and bitstreams.

2 Normative References

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

SMPTE Standard 421M-2006 and Amendment 1-2007, VC-1 Compressed Video Bitstream Format and Decoding Process

SMPTE VC-1 Reference Decoder Software Material

SMPTE VC-1 Test Bitstream Material

3 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.

4 Description of materials

4.1 Reference Decoder Software

The reference decoder shall be used for testing bitstream conformance and shall implement the complete decoding process specified in SMPTE 421M. The reference decoder in the form of an ANSI C utility together with associated documentation (instructions for installing, building and running the software) are available from SMPTE (<http://store.smpte.org/VC-1-Test-Material-p/vc-1.htm>). The output format for the reference decoder is a header-less binary file of YC_bC_r 4:2:0, with the separate planes written in 8-bit sample order (Y, then C_b , then C_r). For interlaced decoded frames, the output comprises full-height frames with interleaved fields.

Because the decoding process is mathematically lossless, the output data from the reference decoder shall be the reference output for any given input bitstream as described in Section 5.1.1 below.

4.2 Test bitstreams

The set of bitstreams to be used for testing decoder conformance is specified in Annex A and is available from SMPTE (<http://store.smpte.org/VC-1-Test-Material-p/vc-1.htm>). All of the bitstreams shall conform to SMPTE 421M as defined in Section 5.2 below. The encoding parameters shown in Tables A.1 – A.11 and metadata shown in Tables A.12 – A.13 are defined in SMPTE 421M. The set of test bitstreams is not intended to represent all possible combinations of encoding parameters and tools specified in SMPTE 421M. Rather, the set of bitstreams was developed according to the following guidelines:

- Encoding parameters and tools normative to the decoding process are tested.
- Parameters and tools specific to the display process are not tested, as the display process is outside the scope of the SMPTE 421M standard.
- Carriage of metadata is tested. Interpretation of metadata is not tested, as post-processing and the display process are outside the scope of the SMPTE 421M standard (see SMPTE 421M Figure 5).
- Parameters and tools are tested in isolation to allow for error diagnosis.
- Combinations of parameters and tools that represent edge conditions for the decoder are tested.
- Parameters and tools that have been thoroughly tested at lower levels of a particular profile are not tested as conformance is already guaranteed by testing at the lower level of the profile.

The Comments column in each table contains notes explaining the general purpose of individual bitstreams.

Simple and Main Profile bitstreams are provided in Bitstream Metadata Serialization format, details of which can be found in Annex L of SMPTE 421M. Advanced Profile bitstreams are provided as elementary bitstreams as defined in SMPTE 421M.

4.3 Sample Encoder Software (Informative)

A sample encoder in the form of an ANSI C utility together with associated documentation (instructions for installing, building and running the software) is available from SMPTE (<http://store.smpte.org/VC-1-Test-Material-p/vc-1.htm>). The sample encoder is included with the test materials described above for informational purposes only and is not used for any of the normative conformance tests described in this document.

5 Conformance Testing Procedure

The following sub-sections specify the normative tests for verifying conformance of a VC-1 video bitstream or decoder to SMPTE 421M. These tests make use of the bitstream test suite (specified in Annex A of this document) and of the reference software decoder available from SMPTE (<http://store.smpite.org/VC-1-Test-Material-p/vc-1.htm>).

5.1 Decoder Testing Procedure

Decoder Testing is a process intended to verify that a candidate decoder implementation is conformant to the decoding process as specified in SMPTE 421M. Although a failure of any of the following tests is sufficient to identify the candidate decoder as non-conformant, successful completion of all tests represents a high confidence of conformance but not absolute certainty.

5.1.1 Order conformance testing

When processing the set of test bitstreams specified in Annex A, a decoder that outputs reconstructed samples and associated display metadata identical to those output by the reference software decoder will be considered order conformant (as specified in Section 5.4 of SMPTE 421M). Order conformance testing is performed statically on the candidate implementation (i.e., with no time restriction on the completion of decoding the test material). Testing is performed by binary comparison of the data output by the candidate decoder at the conformance point to the data output by the reference decoder. Any binary mismatch is considered a failure.

Note: Order conformance testing is intended to verify the algorithmic correctness of a candidate decoder. Such testing is normally performed during the design or development process of an implementation, and as such access to the data required for such testing may not be available in a fully-productized decoder implementation (e.g. a finished product with ancillary support functionality).

Note: Because VC-1 is specified as a bit-exact decoding process, full binary matching of the outputs of the candidate decoder and the reference decoder provides both the highest possible confidence in the comparison and useful troubleshooting information in the event of a failure. Other techniques, such as generating some type of mathematical summary of the decoded output for comparison, have generally been found to be less reliable or excessively computationally intensive.

5.1.2 Time conformance testing

When processing the set of test bitstreams specified in Annex A, a decoder that conforms to the specification of Section C.6 of SMPTE 421M will be considered time-conformant.

Note: Most modern digital video systems implement timing and synchronization at the transport level. Elementary bitstreams, as processed by the decoding process specified in SMPTE 421M, have no intrinsic timing information. Although it may be a natural response to infer a time deadline for the decoding process based on common usage, because such constraints are actually placed on the system by the transport layer, they are outside the scope of the conformance testing process described in this document.

5.1.3 Recommendations (Informative)

Following the loss or corruption of part of a bitstream, it is recommended that a conformant decoder resume the decoding process as soon as possible, for example at the following start code or slice header. In the event that all coded data for a macroblock or video packet is not received, it is further recommended that a conformant decoder perform concealment.

5.2 Bitstream Testing Procedure

A bitstream shall be conformant if and only if all three of the conditions below are satisfied:

- The bitstream conforms to the syntax and semantics specified in SMPTE 421M and

- The reference software decoder completes the decoding process for the bitstream without reporting any warnings and / or errors and
- The reference software decoder successfully and completely produces the following items for the bitstream:
 - a. 4:2:0 YC_bC_r output for all pictures in the bitstream and
 - b. Display metadata output.

Annex A (Normative) Test Bitstream Summary

A.1 Simple Profile @ Low Level and Simple Profile @ Medium Level – Coding Tools

Bitstream Name	Profile@Level	Video Type	Bitrate (kbps)	Source Width	Source Height	Frame Rate	Transform Switching	Overlap Transform	Quantizer Specifier	Range Reduction	Range Mapping (see note below)	Loop Filter	B-Frames	Macroblock Quantization	Intensity Compensation	Long Motion Vectors	Multi-Resolution	Picture vs. Display	Start Codes (see note below)	End of Sequence Code	Slice Coding	User Data	Byte Stuffing	Field Start Code	Field Order	Comments
SSL0013	SP@LL	Prog	20	128	96	10	1	1	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Check bitrate/framerate/resolution combinations with default settings
SSL0014	SP@LL	Prog	30	160	120	10	1	1	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
SSL0015	SP@LL	Prog	60	176	144	15	1	1	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
SSL0016	SP@LL	Prog	30	128	96	10	0	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Check transform switching and overlap transform
SSL0017	SP@LL	Prog	30	160	120	10	0	1	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
SSL0018	SP@LL	Prog	30	176	144	12.5	1	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
SSL0019	SP@LL	Prog	30	160	120	10	0	0	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Check quantizer specifier
SSL0020	SP@LL	Prog	20	160	120	10	0	0	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
SSL0021	SP@LL	Prog	60	176	144	12.5	1	1	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Check multiple modes
SSL0022	SP@LL	Prog	30	100	100	10	1	1	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
SSM0010	SP@ML	Prog	120	320	240	15	1	1	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Check bitrate/framerate/resolution combinations with default settings
SSM0011	SP@ML	Prog	80	176	144	10	1	1	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
SSM0012	SP@ML	Prog	250	352	288	12.5	1	1	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Check transform switching and overlap transform
SSM0013	SP@ML	Prog	120	320	240	15	1	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
SSM0014	SP@ML	Prog	120	352	288	12.5	0	1	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
SSM0015	SP@ML	Prog	80	320	240	10	0	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
SSM0016	SP@ML	Prog	250	352	288	12.5	0	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
SSM0017	SP@ML	Prog	250	176	144	10	1	1	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Check quantizer specifier
SSM0018	SP@ML	Prog	80	320	240	15	1	1	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
SSM0019	SP@ML	Prog	120	220	180	15	1	1	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	