



**International
Standard**

ISO/IEC 23090-5

**Information technology — Coded
representation of immersive
media —**

**Part 5:
Visual volumetric video-based
coding (V3C) and video-based point
cloud compression (V-PCC)**

*Technologie de l'information — Représentation codée de média
immersifs —*

*Partie 5: Codage basé sur la vidéo volumétrique (V3C) et
compression de nuage de points basée sur la vidéo (V-PCC)*

**Fourth edition
2026-06**

Contents

Page

Foreword	v
Introduction	vi
1 Scope	1
2 Normative references	1
3 Terms and definitions	2
4 Abbreviated terms	16
5 Conventions	17
5.1 General	17
5.2 Arithmetic operators	17
5.3 Logical operators	17
5.4 Relational operators	18
5.5 Bit-wise operators	18
5.6 Assignment operators	18
5.7 Other operators	19
5.8 Mathematical functions	19
5.9 Order of operation precedence	19
5.10 Variables, syntax elements, and tables	20
5.11 Text description of logical operations	21
5.12 Processes	23
6 Overall V3C characteristics, decoding operations, and post-decoding processes	23
6.1 V3C characteristics	23
6.2 V3C bitstream characteristics, decoding operations, and post-decoding processes	26
6.3 Extensibility of V3C: V-PCC, MIV and V-DMC	27
7 Bitstream format, partitioning, and scanning processes	28
7.1 General	28
7.2 V3C bitstream formats	28
7.3 NAL bitstream formats	28
7.4 Partitioning of atlas frames into tiles	29
8 Syntax and semantics	30
8.1 Method of specifying syntax in tabular form	30
8.1.1 General	30
8.1.2 Example of the syntax specification format	30
8.2 Specification of syntax functions and descriptors	31
8.3 Syntax in tabular form	33
8.3.1 General	33
8.3.2 V3C unit syntax	35
8.3.3 Byte alignment syntax	36
8.3.4 V3C parameter set syntax	37
8.3.5 NAL unit syntax	42
8.3.6 Raw byte sequence payloads, trailing bits, and byte alignment syntax	43
8.3.7 Atlas tile data unit syntax	50
8.3.8 Supplemental enhancement information message syntax	54
8.4 Semantics	55
8.4.1 General	55
8.4.2 V3C unit semantics	55
8.4.3 Byte alignment semantics	58
8.4.4 V3C parameter set semantics	58
8.4.5 NAL unit semantics	67
8.4.6 Raw byte sequence payloads, trailing bits, and byte alignment semantics	77
8.4.7 Atlas tile data unit semantics	93
8.4.8 Supplemental enhancement information message semantics	100

9	Decoding process	101
9.1	General decoding process	101
9.2	Atlas data decoding process	102
9.2.1	General atlas data decoding process	102
9.2.2	Decoding process for a coded atlas frame	102
9.2.3	Atlas NAL unit decoding process	104
9.2.4	Atlas tile header decoding process	104
9.2.5	Decoding process for patch data units	109
9.2.6	Decoding process of the block to patch map	123
9.2.7	Conversion of tile level patch information to atlas level patch information	124
9.3	Occupancy video decoding process	126
9.4	Geometry video decoding process	128
9.5	Attribute video decoding process	130
9.6	Packed video decoding process	132
9.7	Common atlas data decoding process	133
9.7.1	General common atlas data decoding process	133
9.7.2	Decoding process for a coded common atlas frame	134
9.7.3	Common atlas NAL unit decoding process	134
9.7.4	Common atlas frame order count derivation process	134
9.8	Sub-bitstream extraction process	136
9.8.1	General	136
9.8.2	V3C unit extraction	136
9.8.3	NAL unit extraction process	137
10	Pre-reconstruction process	137
11	Reconstruction process	137
12	Post-reconstruction process	138
13	Adaptation process	138
14	Parsing process	138
14.1	General	138
14.2	Parsing process for 0-th order Exp-Golomb codes	138
14.2.1	General	138
14.2.2	Mapping process for signed Exp-Golomb codes	139
14.3	Parsing process for ASN.1 object identifiers	140
14.3.1	Object identifier syntax	140
14.3.2	Object identifier semantics	140
Annex A (normative)	Profiles, tiers, and levels	141
Annex B (informative)	Post-decoding conversion to nominal video formats	149
Annex C (informative)	V3C sample stream format	176
Annex D (normative)	NAL sample stream format	178
Annex E (normative)	Atlas hypothetical reference decoder	180
Annex F (normative)	Supplemental enhancement information	197
Annex G (normative)	Volumetric usability information	254
Annex H (normative)	Video-based Point Cloud Coding	265
Bibliography		355

Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work.

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 or www.iec.ch/members_experts/refdocs).

ISO and IEC draw attention to the possibility that the implementation of this document may involve the use of (a) patent(s). ISO and IEC take no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, ISO and IEC had received notice of (a) patent(s) which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at www.iso.org/patents and <https://patents.iec.ch>. ISO and IEC shall not be held responsible for identifying any or all such patent rights.

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html. In the IEC, see www.iec.ch/understanding-standards.

This document was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 29, *Coding of audio, picture, multimedia and hypermedia information*.

This fourth edition cancels and replaces the third edition (ISO/IEC 23090-5:2025), which has been technically revised.

The main changes are as follows:

- Additions needed for ISO/IEC 23090-29 video-based dynamic mesh coding.
- Various minor improvements and corrections.

A list of all parts in the ISO/IEC 23090 series can be found on the ISO and IEC websites.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html and www.iec.ch/national-committees.

Introduction

Advances in 3D capturing and rendering technologies have unleashed a new wave of innovation in Virtual/Augmented/Mixed reality (VR/AR/MR) content creation and communication, of which visual volumetric video is an integral part.

Visual volumetric video, a sequence of visual volumetric frames, if uncompressed, may be represented by a large amount of data, which can be costly in terms of storage and transmission. This has led to the need for a high coding efficiency standard for the compression of visual volumetric data.

Visual volumetric frames can be coded by converting the 3D volumetric information into a collection of 2D images and associated data. The converted 2D images can be coded using widely available video and image coding specifications, such as ISO/IEC 14496-10 and ISO/IEC 23008-2 and the associated data can be coded with mechanisms specified in this document. The coded images and the associated data can then be decoded and used to reconstruct the 3D volumetric information. This document specifies a generic mechanism for visual volumetric video coding, i.e. visual volumetric video-based coding. The generic mechanism may be used by applications targeting volumetric content, such as point clouds, immersive video with depth, mesh representations of visual volumetric frames, etc.

In addition to the generic mechanism of coding volumetric content, this document specifies one of the applications of visual volumetric video-based coding targeting point cloud representations of visual volumetric frames. In a point cloud sequence, each point cloud frame contains a collection of points. Each point has a 3D position, i.e. geometry information, and each point may also be associated with a number of attributes, such as colour, reflectance, surface normal, etc.

Information technology — Coded representation of immersive media —

Part 5:

Visual volumetric video-based coding (V3C) and video-based point cloud compression (V-PCC)

1 Scope

This document specifies the syntax, semantics, and decoding for visual volumetric media using video-based coding methods. Furthermore, this document specifies processes that can be needed for reconstruction of visual volumetric media, and can also include additional processes such as post-decoding, pre-reconstruction, post-reconstruction, and adaptation.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitute requirements 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/IEC 8825-1, *Information technology — ASN.1 encoding rules — Part 1: Specification of Basic Encoding Rules (BER), Canonical Encoding Rules (CER) and Distinguished Encoding Rules (DER)*

ISO/IEC 10646, *Information technology — Universal coded character set (UCS)*

ISO/IEC 14496-10, *Information technology — Coding of audio-visual objects — Part 10: Advanced video coding*

ISO/IEC 14496-12, *Information technology — Coding of audio-visual objects — Part 12: ISO base media file format*

ISO/IEC 14496-15, *Information technology — Coding of audio-visual objects — Part 15: Carriage of network abstraction layer (NAL) unit structured video in the ISO base media file format*

ISO/IEC 23002-7, *Information technology — MPEG video technologies — Part 7: Versatile supplemental enhancement information messages for coded video bitstreams*

ISO/IEC 23008-2, *Information technology — High efficiency coding and media delivery in heterogeneous environments — Part 2: High efficiency video coding*

ISO/IEC 23090-3, *Information technology — Coded representation of immersive media — Part 3: Versatile video coding*

ISO/IEC 23090-12, *Information technology — Coded representation of immersive media — Part 12: MPEG immersive video*

ISO/IEC 23090-29, *Information technology — Coded representation of immersive media — Part 29: Video-based dynamic mesh coding (V-DMC)*

ISO/IEC 23091-2, *Information technology — Coding-independent code points — Part 2: Video*

ISO/IEC 60559:2020, *Information technology — Microprocessor Systems — Floating-Point arithmetic*

Rec. ITU-T T.35, *Procedure for the allocation of ITU-T defined codes for non standard facilities*

Bibliography

- [1] ISO/IEC 13818-1, *Information technology — Generic coding of moving pictures and associated audio information — Part 1: Systems*
- [2] ISO/IEC 23090-10, *Information technology — Coded representation of immersive media — Part 10: Carriage of visual volumetric video-based coding data*
- [3] ISO/IEC 9834-1, *Information technology — Procedures for the operation of object identifier registration authorities — Part 1: General procedures and top arcs of the international object identifier tree*
- [4] ISO/IEC 9834-8, *Information technology — Procedures for the operation of object identifier registration authorities — Part 8: Generation of universally unique identifiers (UUIDs) and their use in object identifiers*
- [5] Rec. ITU-T H.222.0, *Information technology – Generic coding of moving pictures and associated audio information: Systems.*
- [6] Rec. ITU-T H.320, *Narrow-band visual telephone systems and terminal equipment.*
- [7] SMPTE ST 12-1:2014, *Time and Control Code*