
**Information technology — Generic
coding of moving pictures and
associated audio information —**

**Part 4:
Conformance testing**

*Technologies de l'information — Codage générique des images
animées et des informations sonores associées —*

Partie 4: Essais de conformité

Reference number
ISO/IEC 13818-4:2004(E)

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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. In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of the joint technical committee is to prepare International Standards. Draft International Standards adopted by the joint technical committee are circulated to national bodies for voting. Publication as an International Standard requires approval by at least 75 % of the national bodies casting a vote.

ISO/IEC 13818-4 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 29, *Coding of audio, picture, multimedia and hypermedia information*.

This second edition cancels and replaces the first edition, of which it constitutes a minor revision. It also incorporates the Amendments ISO 13818-4/Amd.1:1999, ISO 13818-4/Amd.2:2000 and ISO 13818-4/Amd.3:2000 and the Technical Corrigenda ISO 13818-4/Cor.2:1998, ISO 13818-4/Amd.1:1999/Cor.1:2003 and ISO 13818-4/Amd.3:2000/Cor.1:2003.

ISO/IEC 13818 consists of the following parts, under the general title *Information technology — Generic coding of moving pictures and associated audio information*:

- *Part 1: Systems*
- *Part 2: Video*
- *Part 3: Audio*
- *Part 4: Conformance testing*
- *Part 5: Software simulation* [Technical Report]
- *Part 6: Extensions for DSM-CC*
- *Part 7: Advanced Audio Coding (AAC)*
- *Part 9: Extension for real time interface for systems decoders*
- *Part 10: Conformance extensions for Digital Storage Media Command and Control (DSM-CC)*
- *Part 11: IPMP on MPEG-2 systems*

Introduction

Parts 1, 2, 3 and 7 of ISO/IEC 13818 specify a multiplex structure and coded representations of audio-visual information. Parts 1, 2, 3 and 7 of ISO/IEC 13818 allow for large flexibility, achieving suitability of ISO/IEC 13818 for many different applications. The flexibility is obtained by including parameters in the bitstream that define the characteristics of coded bitstreams. Examples are the audio sampling frequency, picture size, picture rate and bitrate parameters.

This part of ISO/IEC 13818 specifies how tests can be designed to verify whether bitstreams and decoders meet the requirements as specified in parts 1, 2, 3 and 7 of ISO/IEC 13818. These tests can be used for various purposes such as:

- Manufacturers of encoders, and their customers, can use the tests to verify whether the encoder produces valid bitstreams.
- Manufacturers of decoders and their customers can use the tests to verify whether the decoder meets the requirements specified in parts 1, 2, 3 and 7 of ISO/IEC 13818 for the claimed decoder capabilities.

The International Organization for Standardization and the International Electrotechnical Commission (IEC) draw attention to the fact that it is claimed that compliance with this part of ISO/IEC 13818 may involve the use of patents.

ISO and IEC take no position concerning the evidence, validity and scope of these patent rights.

The holders of these patent rights have assured the ISO and IEC that they are willing to negotiate licences under reasonable and non-discriminatory terms and conditions with applicants throughout the world. In this respect, the statements of the holders of these patents right are registered with ISO and IEC. Information may be obtained from the companies listed in Annex E.

Attention is drawn to the possibility that some of the elements of this part of ISO/IEC 13818 may be the subject of patent rights other than those identified in Annex E. ISO and IEC shall not be held responsible for identifying any or all such patent rights.

Information technology — Generic coding of moving pictures and associated audio information —

Part 4: Conformance testing

1 Scope

This part of ISO/IEC 13818 specifies how tests can be designed to verify whether bitstreams and decoders meet requirements specified in parts 1, 2, 3 and 7 of ISO/IEC 13818. In this part of ISO/IEC 13818, encoders are not addressed specifically. An encoder may be said to be an ISO/IEC 13818 encoder if it generates bitstreams compliant with the syntactic and semantic bitstream requirements specified in parts 1, 2, 3 and 7 of ISO/IEC 13818.

Characteristics of coded bitstreams and decoders are defined for parts 1, 2, 3 and 7 of ISO/IEC 13818. The characteristics of a bitstream define the subset of the standard that is exploited in the bitstream. Examples are the applied values or range of the picture size and bitrate parameters. Decoder characteristics define the properties and capabilities of the applied decoding process. An example of a property is the applied arithmetic accuracy. The capabilities of a decoder specify which coded bitstreams the decoder can decode and reconstruct, by defining the subset of the standard that may be exploited in decodable bitstreams. A bitstream can be decoded by a decoder if the characteristics of the coded bitstream are within the subset of the standard specified by the decoder capabilities.

Procedures are described for testing conformance of bitstreams and decoders to the requirements defined in parts 1, 2, 3 and 7 of ISO/IEC 13818. Given the set of characteristics claimed, the requirements that must be met are fully determined by parts 1, 2, 3 and 7 of ISO/IEC 13818. This part of ISO/IEC 13818 summarises the requirements, cross references them to characteristics, and defines how conformance with them can be tested. Guidelines are given on constructing tests to verify bitstream and decoder conformance. This document gives guidelines on how to construct bitstream test suites to check or verify decoder conformance. In addition, some test bitstreams implemented according to those guidelines are provided as an electronic annex to this document.

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 639 (all parts), *Codes for the representation of names of languages*

ISO 8859-1, *Information processing — 8-bit single-byte coded graphic character sets — Part 1: Latin alphabet No. 1*

ISO/IEC 11172-1, *Information technology — Coding of moving pictures and associated audio for digital storage media at up to about 1,5 Mbit/s — Part 1: Systems*

ISO/IEC 11172-2:1993, *Information technology — Coding of moving pictures and associated audio for digital storage media at up to about 1,5 Mbit/s — Part 2: Video*

ISO/IEC 11172-3:1993, *Information technology — Coding of moving pictures and associated audio for digital storage media at up to about 1,5 Mbit/s — Part 3: Audio*

ISO/IEC 11172-4, *Information technology — Coding of moving pictures and associated audio for digital storage media at up to about 1,5 Mbit/s — Part 4: Compliance testing*

ISO/IEC 13818-1:2000, *Information technology — Generic coding of moving pictures and associated audio information: Systems*

ISO/IEC 13818-2:2000, *Information technology — Generic coding of moving pictures and associated audio information: Video*

ISO/IEC 13818-3:1998, *Information technology — Generic coding of moving pictures and associated audio information — Part 3: Audio*

ISO/IEC 13818-7:2004, *Information technology — Generic coding of moving pictures and associated audio information — Part 7: Advanced Audio Coding (AAC)*

IEEE Std 1180-1990, *IEEE Standard Specifications for the Implementations of 8 by 8 Inverse Discrete Cosine Transform*, December 6, 1990

3 Terms and definitions

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

- 3.1 16x8 prediction [video]:** A prediction mode similar to field-based prediction but where the predicted block size is 16x8 luminance samples.
- 3.2 AC coefficient [video]:** Any DCT coefficient for which the frequency in one or both dimensions is non-zero.
- 3.3 access unit [systems]:** A coded representation of a presentation unit. In the case of audio, an access unit is the coded representation of an audio frame.
In the case of video, an access unit includes all the coded data for a picture, and any stuffing that follows it, up to but not including the start of the next access unit. If a picture is not preceded by a `group_start_code` or a `sequence_header_code`, the access unit begins with the picture start code. If a picture is preceded by a `group_start_code` and/or a `sequence_header_code`, the access unit begins with the first byte of the first of these start codes. If it is the last picture preceding a `sequence_end_code` in the bitstream all bytes between the last byte of the coded picture and the `sequence_end_code` (including the `sequence_end_code`) belong to the access unit.
- 3.4 adaptive bit allocation [audio]:** The assignment of bits to subbands in a time and frequency varying fashion according to a psychoacoustic model.
- 3.5 adaptive multichannel prediction [audio]:** A method of multichannel data reduction exploiting statistical inter-channel dependencies.
- 3.6 adaptive noise allocation [audio]:** The assignment of coding noise to frequency bands in a time and frequency varying fashion according to a psychoacoustic model.
- 3.7 adaptive segmentation [audio]:** A subdivision of the digital representation of an audio signal in variable segments of time.
- 3.8 alias [audio]:** Mirrored signal component resulting from sub-Nyquist sampling.
- 3.9 analysis filterbank [audio]:** Filterbank in the encoder that transforms a broadband PCM audio signal into a set of subsampled subband samples.
- 3.10 ancillary data [audio]:** part of the bitstream that might be used for transmission of ancillary data.
- 3.11 audio access unit [audio]:** For Layers I and II, an audio access unit is defined as the smallest part of the encoded bitstream which can be decoded by itself, where decoded means "fully reconstructed sound". For Layer III, an audio access unit is part of the bitstream that is decodable with the use of previously acquired main information.

- 3.12 audio buffer [audio]:** A buffer in the system target decoder for storage of compressed audio data.
- 3.13 audio sequence [audio]:** A non-interrupted series of audio frames (base frames plus optional extension frames) in which the following parameters are not changed:
- ID
 - Layer
 - Sampling Frequency
- For Layer I and II, a decoder is not required to support a continuously variable bitrate (change in the bitrate index) of the base stream. Such a relaxation of requirements does not apply to the extension stream.
- 3.14 B-field picture [video]:** A field structure B-Picture.
- 3.15 B-frame picture [video]:** A frame structure B-Picture.
- 3.16 B-picture; bidirectionally predictive-coded picture [video]:** A picture that is coded using motion compensated prediction from past and/or future reference fields or frames.
- 3.17 backward compatibility:** A newer coding standard is backward compatible with an older coding standard if decoders designed to operate with the older coding standard are able to continue to operate by decoding all or part of a bitstream produced according to the newer coding standard.
- 3.18 backward motion vector [video]:** A motion vector that is used for motion compensation from a reference frame or reference field at a later time in display order.
- 3.19 backward prediction [video]:** Prediction from the future reference frame (field).
- 3.20 Bark [audio]:** Unit of critical band rate. The Bark scale is a non-linear mapping of the frequency scale over the audio range closely corresponding with the frequency selectivity of the human ear across the band.
- 3.21 base layer [video]:** First, independently decodable layer of a scalable hierarchy.
- 3.22 big picture [video]:** A coded picture that would cause VBV buffer underflow as defined in C.7 of ISO/IEC 13818-2:2000. Big pictures can only occur in sequences where low_delay is equal to 1. "Skipped picture" is a term that is sometimes used to describe the same concept.
- 3.23 bitrate [audio]:** The rate at which the compressed bitstream is delivered to the input of a decoder.
- 3.24 bitstream; stream:** An ordered series of bits that forms the coded representation of the data.
- 3.25 bitstream verifier [video]:** A process by which it is possible to test and verify that all the requirements specified in ISO/IEC 13818-2 are met by the bitstream.
- 3.26 block [video]:** An 8-row by 8-column matrix of samples, or 64 DCT coefficients (source, quantised or dequantised).
- 3.27 block companding [audio]:** Normalising of the digital representation of an audio signal within a certain time period.
- 3.28 bottom field [video]:** One of two fields that comprise a frame. Each line of a bottom field is spatially located immediately below the corresponding line of the top field.
- 3.29 bound [audio]:** The lowest subband in which intensity stereo coding is used.
- 3.30 byte aligned:** A bit in a coded bitstream is byte-aligned if its position is a multiple of 8-bits from the first bit in the stream.
- 3.31 byte:** Sequence of 8-bits.
- 3.32 centre channel [audio]:** An audio presentation channel used to stabilise the central component of the frontal stereo image.
- 3.33 channel [audio]:** A sequence of data representing an audio signal being transported.
- 3.34 chroma simulcast [video]:** A type of scalability (which is a subset of SNR scalability) where the enhancement layer (s) contain only coded refinement data for the DC coefficients, and all the data for the AC coefficients, of the chrominance components.
- 3.35 chrominance format [video]:** Defines the number of chrominance blocks in a macroblock.

- 3.36 chrominance component [video]:** A matrix, block or single sample representing one of the two colour difference signals related to the primary colours in the manner defined in the bitstream. The symbols used for the chrominance signals are Cr and Cb.
- 3.37 coded audio bitstream [audio]:** A coded representation of an audio signal as specified in part 3 of ISO/IEC 13818.
- 3.38 coded B-frame [video]:** A B-frame picture or a pair of B-field pictures.
- 3.39 coded frame [video]:** A coded frame is a coded I-frame, a coded P-frame or a coded B-frame.
- 3.40 coded I-frame [video]:** An I-frame picture or a pair of field pictures, where the first field picture is an I-picture and the second field picture is an I-picture or a P-picture.
- 3.41 coded order [video]:** The order in which the pictures are transmitted and decoded. This order is not necessarily the same as the display order.
- 3.42 coded P-frame [video]:** A P-frame picture or a pair of P-field pictures.
- 3.43 coded picture [video]:** A coded picture is made of a picture header, the optional extensions immediately following it, and the following picture data. A coded picture may be a coded frame or a coded field.
- 3.44 coded representation:** A data element as represented in its encoded form.
- 3.45 coded video bitstream [video]:** A coded representation of a series of one or more pictures as defined in ISO/IEC 13818-2.
- 3.46 coding parameters [video]:** The set of user-definable parameters that characterise a coded bitstream. Bitstreams are characterised by coding parameters. Decoders are characterised by the bitstreams that they are capable of decoding.
- 3.47 component [video]:** A matrix, block or single sample from one of the three matrices (luminance and two chrominance) that make up a picture.
- 3.48 compression:** Reduction in the number of bits used to represent an item of data.
- 3.49 constant bitrate:** Operation where the bitrate is constant from start to finish of the coded bitstream.
- 3.50 constrained parameters [video]:** The values of the set of coding parameters defined in 2.4.3.2 of ISO/IEC 11172-2:1993.
- 3.51 constrained system parameter stream; CSPS [systems]:** A Program Stream for which the constraints defined in subclause 2.7.9 of ISO/IEC 13818-1:2000 apply.
- 3.52 CRC:** The Cyclic Redundancy Check to verify the correctness of data.
- 3.53 critical band [audio]:** Psychoacoustic measure in the spectral domain which corresponds to the frequency selectivity of the human ear. This selectivity is expressed in Bark.
- 3.54 critical band rate [audio]:** Psychoacoustic function of frequency. At a given audible frequency, it is proportional to the number of critical bands below that frequency. The units of the critical band rate scale are Barks.
- 3.55 data element:** An item of data as represented before encoding and after decoding.
- 3.56 data partitioning [video]:** A method for dividing a bitstream into two separate bitstreams for error resilience purposes. The two bitstreams have to be recombined before decoding.
- 3.57 DC coefficient [video]:** The DCT coefficient for which the frequency is zero in both dimensions.
- 3.58 DCT coefficient [video]:** The amplitude of a specific cosine basis function.
- 3.59 de-emphasis [audio]:** Filtering applied to an audio signal after storage or transmission to undo a linear distortion due to emphasis.
- 3.60 decoded stream:** The decoded reconstruction of a compressed bitstream.
- 3.61 decoder input buffer [video]:** The first-in first-out (FIFO) buffer specified in the video buffering verifier.
- 3.62 decoder:** An embodiment of a decoding process.

- 3.63 decoder sub-loop [video]:** Stages within encoder which produce numerically identical results to the decode process described in ISO/IEC 13818-2:2000, clause 7. Encoders capable of producing more than just I-pictures embed a decoder sub-loop to create temporal predictions and to model the behaviour of downstream decoders.
- 3.64 decoding (process):** The process defined in ISO/IEC 13818 parts 1, 2, 3 and 7 that reads an input coded bitstream and outputs decoded pictures or audio samples.
- 3.65 decoding time-stamp; DTS [systems]:** A field that may be present in a PES packet header that indicates the time that an access unit is decoded in the system target decoder.
- 3.66 dequantisation:** The process of rescaling the quantised DCT coefficients after their representation in the bitstream has been decoded and before they are presented to the inverse DCT.
- 3.67 digital storage media; DSM:** A digital storage or transmission device or system.
- 3.68 discrete cosine transform; DCT:** Either the forward discrete cosine transform or the inverse discrete cosine transform. The DCT is an invertible, discrete orthogonal transformation.
- 3.69 display aspect ratio [video]:** The ratio height/width (in SI units) of the intended display.
- 3.70 display order [video]:** The order in which the decoded pictures are displayed. Normally this is the same order in which they were presented at the input of the encoder.
- 3.71 display process [video]:** The (non-normative) process by which reconstructed frames are displayed.
- 3.72 downmix [audio]:** A matrixing of n channels to obtain less than n channels.
- 3.73 drift [video]:** Accumulation of mismatch between the reconstructed output produced by the hypothetical decoder sub-loop embedded within an encoder (see definition of "decoder sub-loop") and the reconstructed outputs produced by a (downstream) decoder.
- 3.74 DSM-CC:** digital storage media command and control.
- 3.75 dual channel mode [audio]:** A mode, where two audio channels with independent programme contents (e.g. bilingual) are encoded within one bitstream. The coding process is the same as for the stereo mode.
- 3.76 dual-prime prediction [video]:** A prediction mode in which two forward field-based predictions are averaged. The predicted block size is 16×16 luminance samples. Dual-prime prediction is only used in interlaced P-pictures.
- 3.77 dynamic crosstalk [audio]:** A method of multichannel data reduction in which stereo-irrelevant signal components are copied to another channel.
- 3.78 dynamic transmission channel switching [audio]:** A method of multichannel data reduction by allocating the most orthogonal signal components to the transmission channels.
- 3.79 editing:** The process by which one or more coded bitstreams are manipulated to produce a new coded bitstream. Conforming edited bitstreams must meet the requirements defined in parts 1, 2, and 3 of ISO/IEC 13818.
- 3.80 Elementary Stream Clock Reference; ESCR [systems]:** A time stamp in the PES Stream from which decoders of PES streams may derive timing.
- 3.81 elementary stream; ES [systems]:** A generic term for one of the coded video, coded audio or other coded bitstreams in PES packets. One elementary stream is carried in a sequence of PES packets with one and only one stream_id.
- 3.82 emphasis [audio]:** Filtering applied to an audio signal before storage or transmission to improve the signal-to-noise ratio at high frequencies.
- 3.83 encoder:** An embodiment of an encoding process.
- 3.84 encoding (process):** A process, not specified in ISO/IEC 13818, that reads a stream of input pictures or audio samples and produces a valid coded bitstream as defined in parts 1, 2, and 3 of ISO/IEC 13818.

- 3.85 enhancement layer [video]:** A relative reference to a layer (above the base layer) in a scalable hierarchy. For all forms of scalability, its decoding process can be described by reference to the lower layer decoding process and the appropriate additional decoding process for the enhancement layer itself.
- 3.86 entitlement control message; ECM [systems]:** Entitlement Control Messages are private conditional access information which specify control words and possibly other, typically stream-specific, scrambling and/or control parameters.
- 3.87 entitlement management message; EMM [systems]:** Entitlement Management Messages are private conditional access information which specify the authorisation levels or the services of specific decoders. They may be addressed to single decoders or groups of decoders.
- 3.88 entropy coding:** Variable length lossless coding of the digital representation of a signal to reduce redundancy.
- 3.89 event [systems]:** An event is defined as a collection of elementary streams with a common time base, an associated start time, and an associated end time.
- 3.90 evil bitstreams:** Bitstreams orthogonal to reality.
- 3.91 extension bitstream [audio]:** Information contained in an optional additional bit stream related to the audio base bit stream at the system level, to support bit rates beyond those defined in ISO/IEC 11172-3. The optional extension bit stream contains the remainder of the multichannel and multilingual data.
- 3.92 fast reverse playback [video]:** The process of displaying the picture sequence in the reverse of display order faster than real-time.
- 3.93 fast forward playback [video]:** The process of displaying a sequence, or parts of a sequence, of pictures in display-order faster than real-time.
- 3.94 FFT:** Fast Fourier Transformation. A fast algorithm for performing a discrete Fourier transform (an orthogonal transform).
- 3.95 field [video]:** For an interlaced video signal, a "field" is the assembly of alternate lines of a frame. Therefore an interlaced frame is composed of two fields, a top field and a bottom field.
- 3.96 field period [video]:** The reciprocal of twice the frame rate.
- 3.97 field picture; field structure picture [video]:** A field structure picture is a coded picture with picture_structure is equal to "Top field" or "Bottom field".
- 3.98 field-based prediction [video]:** A prediction mode using only one field of the reference frame. The predicted block size is 16x16 luminance samples. Field-based prediction is not used in progressive frames.
- 3.99 filterbank [audio]:** A set of band-pass filters covering the entire audio frequency range.
- 3.100 fixed segmentation [audio]:** A subdivision of the digital representation of an audio signal into fixed segments of time.
- 3.101 flag:** A variable which can take one of only the two values defined in this specification.
- 3.102 FLC:** Fixed Length Code.
- 3.103 forbidden:** The term "forbidden", when used in the clauses defining the coded bitstream, indicates that the value shall never be used. This is usually to avoid emulation of start codes.
- 3.104 forced updating [video]:** The process by which macroblocks are intra-coded from time-to-time to ensure that mismatch errors between the inverse DCT processes in encoders and decoders cannot build up excessively.
- 3.105 forward compatibility:** A newer coding standard is forward compatible with an older coding standard if decoders designed to operate with the newer coding standard are able to decode bitstreams of the older coding standard.
- 3.106 forward motion vector [video]:** A motion vector that is used for motion compensation from a reference frame or reference field at an earlier time in display order.
- 3.107 forward prediction [video]:** Prediction from the past reference frame (field).
- 3.108 frame [audio]:** A part of the audio bit stream that corresponds to audio PCM samples from an Audio Access Unit.

- 3.109 frame [video]:** A frame contains lines of spatial information of a video signal. For progressive video, these lines contain samples starting from one time instant and continuing through successive lines to the bottom of the frame. For interlaced video a frame consists of two fields, a top field and a bottom field. One of these fields may be temporally located one field period later than the other.
- 3.110 frame period [video]:** The reciprocal of the frame rate.
- 3.111 frame picture; frame structure picture [video]:** A frame structure picture is a coded picture with picture_structure is equal to "Frame".
- 3.112 frame rate [video]:** The rate at which frames are be output from the decoding process.
- 3.113 frame reordering [video]:** The process of reordering the reconstructed frames when the coded order is different from the display order. Frame reordering occurs when B-frames are present in a bitstream. There is no frame reordering when decoding low delay bitstreams.
- 3.114 frame-based prediction [video]:** A prediction mode using both fields of the reference frame.
- 3.115 free format [audio]:** Any bitrate other than the defined bitrates that is less than the maximum valid bitrate for each layer.
- 3.116 future reference frame (field) [video]:** A future reference frame(field) is a reference frame(field) that occurs at a later time than the current picture in display order.
- 3.117 granules [Layer II] [audio]:** The set of 3 consecutive subband samples from all 32 subbands that are considered together before quantisation. They correspond to 96 PCM samples.
- 3.118 granules [Layer III] [audio]:** 576 frequency lines that carry their own side information.
- 3.119 group of pictures [video]:** A notion defined only in ISO/IEC 11172-2 (MPEG-1 Video). In ISO/IEC 13818-2, a similar functionality can be achieved by the mean of inserting group of pictures headers.
- 3.120 Hann window [audio]:** A time function applied sample-by-sample to a block of audio samples before Fourier transformation.
- 3.121 header:** A block of data in the coded bitstream containing the coded representation of a number of data elements pertaining to the coded data that follow the header in the bitstream.
- 3.122 Huffman coding:** A specific method for entropy coding.
- 3.123 hybrid filterbank [audio]:** A serial combination of subband filterbank and MDCT.
- 3.124 hybrid scalability [video]:** Hybrid scalability is the combination of two (or more) types of scalability.
- 3.125 I-field picture [video]:** A field structure I-Picture.
- 3.126 I-frame picture [video]:** A frame structure I-Picture.
- 3.127 I-picture; intra-coded picture [video]:** A picture coded using information only from itself.
- 3.128 IDCT:** Inverse Discrete Cosine Transform.
- 3.129 IMDCT [audio]:** Inverse Modified Discrete Cosine Transform.
- 3.130 intensity stereo [audio]:** A method of exploiting stereo irrelevance or redundancy in stereophonic audio programmes based on retaining at high frequencies only the energy envelope of the right and left channels.
- 3.131 interlace [video]:** The property of conventional television frames where alternating lines of the frame represent different instances in time. In an interlaced frame, one of the field is meant to be displayed first. This field is called the first field. The first field can be the top field or the bottom field of the frame.
- 3.132 intra coding [video]:** Coding of a macroblock or picture that uses information only from that macroblock or picture.
- 3.133 ITU-T Rec. H.222.0 | ISO/IEC 13818 (multiplexed) stream [systems]:** A bitstream composed of 0 or more elementary streams combined in the manner defined in ITU-T Rec. H.222.0 | ISO/IEC 13818-1.
- 3.134 joint stereo coding [audio]:** Any method that exploits stereophonic irrelevance or stereophonic redundancy.
- 3.135 joint stereo mode [audio]:** A mode of the audio coding algorithm using joint stereo coding.

- 3.136 layer [audio]:** One of the levels in the coding hierarchy of the audio system defined in ISO/IEC 13818-3.
- 3.137 layer [systems]:** One of the levels in the data hierarchy of the video and system specifications defined in ISO/IEC 13818 parts 1 and 2.
- 3.138 layer [video]:** In a scalable hierarchy denotes one out of the ordered set of bitstreams and (the result of) its associated decoding process (implicitly including decoding of **all** layers below this layer).
- 3.139 layer bitstream [video]:** A single bitstream associated to a specific layer (always used in conjunction with layer qualifiers, e. g. "enhancement layer bitstream").
- 3.140 level [video]:** A defined set of constraints on the values which may be taken by the parameters of this specification within a particular profile. A profile may contain one or more levels. In a different context, level is the absolute value of a non-zero coefficient (see "run").
- 3.141 LFE [audio]:** Low Frequency Enhancement channel. A limited bandwidth channel for low frequency audio effects in a multichannel system.
- 3.142 low frequency enhancement (LFE) channel [audio]:** A limited bandwidth channel for low frequency audio effects in a multichannel system.
- 3.143 lower layer [video]:** A relative reference to the layer immediately below a given enhancement layer (implicitly including decoding of **all** layers below this enhancement layer).
- 3.144 luminance component [video]:** A matrix, block or single sample representing a monochrome representation of the signal and related to the primary colours in the manner defined in the bitstream. The symbol used for luminance is Y.
- 3.145 macroblock [video]:** The four 8 by 8 blocks of luminance data and the two (for 4:2:0 chrominance format), four (for 4:2:2 chrominance format) or eight (for 4:4:4 chrominance format) corresponding 8 by 8 blocks of chrominance data coming from a 16 by 16 section of the luminance component of the picture. Macroblock is sometimes used to refer to the sample data and sometimes to the coded representation of the sample values and other data elements defined in the macroblock header of the syntax defined in this part of this specification. The usage is clear from the context.
- 3.146 main audio channels:** All channels represented by either `single_channel_element()`'s or `channel_pair_element()`'s in one program.
- 3.147 mapping [audio]:** Conversion of an audio signal from time to frequency domain by subband filtering and/or by MDCT.
- 3.148 masking [audio]:** A property of the human auditory system by which an audio signal cannot be perceived in the presence of another audio signal.
- 3.149 masking threshold [audio]:** A function in frequency and time below which an audio signal cannot be perceived by the human auditory system.
- 3.150 Mbit [video]:** 1 000 000 bits.
- 3.151 MCP [video]:** Motion Compensated Predictor.
- 3.152 modified discrete cosin transform (MDCT) [audio]:** A transform which has the property of time domain aliasing cancellation.
- 3.153 mismatch [video]:** Numerical discrepancy between the data reconstructed from the same coded bitstream by two decoding processes. With the exception of IDCT, the specification of ISO/IEC 13818-2 defines the decoding process absolutely unambiguously. Therefore, if both decoding processes are implemented according the specifications ISO/IEC 13818-2, mismatch can only be caused by different implementations of IDCT.
- 3.154 motion compensation [video]:** The use of motion vectors to improve the efficiency of the prediction of sample values. The prediction uses motion vectors to provide offsets into the past and/or future reference frames or reference fields containing previously decoded sample values that are used to form the prediction error.
- 3.155 motion estimation [video]:** The process of estimating motion vectors during the encoding process.

- 3.156 motion vector [video]:** A two-dimensional vector used for motion compensation that provides an offset from the coordinate position in the current picture or field to the coordinates in a reference frame or reference field.
- 3.157 MS stereo [audio]:** A method of exploiting stereo irrelevance or redundancy in stereophonic audio programmes based on coding the sum and difference signal instead of the left and right channels.
- 3.158 multichannel [audio]:** A combination of audio channels used to create a spatial sound field.
- 3.159 multilingual [audio]:** A presentation of dialogue in more than one language.
- 3.160 NIT [systems]:** Network Information Table as defined in Table 2-23 of ISO/IEC 13818-1:2000.
- 3.161 non-intra coding [video]:** Coding of a macroblock or picture that uses information both from itself and from macroblocks and pictures occurring at other times.
- 3.162 non-tonal component [audio]:** A noise-like component of an audio signal.
- 3.163 Nyquist sampling:** Sampling at or above twice the maximum bandwidth of a signal.
- 3.164 opposite parity [video]:** The opposite parity of top is bottom, and vice versa.
- 3.165 P-field picture [video]:** A field structure P-Picture.
- 3.166 P-frame picture [video]:** A frame structure P-Picture.
- 3.167 P-picture; predictive-coded picture [video]:** A picture that is coded using motion compensated prediction from past reference fields or frame.
- 3.168 pack [systems]:** A pack consists of a pack header followed by zero or more packets. It is a layer in the system coding syntax described in 2.5.3.3 of ISO/IEC 13818-1:2000.
- 3.169 packet [systems]:** A packet consists of a header followed by a number of contiguous bytes from an elementary data stream. It is a layer in the system coding syntax described in 2.4.3 of ISO/IEC 13818-1:2000.
- 3.170 packet data [systems]:** Contiguous bytes of data from an elementary stream present in a packet.
- 3.171 packet identifier; PID [systems]:** A unique integer value used to associate elementary streams of a program in a single or multi-program Transport Stream as described in 2.4.3 of ISO/IEC 13818-1:2000.
- 3.172 padding [audio]:** A method to adjust the average length of an audio frame in time to the duration of the corresponding PCM samples, by conditionally adding a slot to the audio frame.
- 3.173 parameter:** A variable within the syntax of this specification which may take one of a range of values. A variable which can take one of only two values is a flag or indicator and not a parameter.
- 3.174 parity (of field) [video]:** The parity of a field can be top or bottom.
- 3.175 parser:** Functional stage of a decoder which extracts from a coded bitstream series of bits representing coded elements (FLC or VLC).
- 3.176 past reference frame (field) [video]:** A past reference frame(field) is a reference frame(field) that occurs at an earlier time than the current picture in display order.
- 3.177 PAT [systems]:** Program Association Table as defined in subclause 2.4.4.3 of ISO/IEC 13818-1:2000.
- 3.178 payload [systems]:** Payload refers to the bytes which follow the header bytes in a packet. For example, the payload of a Transport Stream packet includes the PES_packet_header and its PES_packet_data_bytes, or pointer_field and PSI sections, or private data; but a PES_packet_payload consists of only PES_packet_data_bytes. The Transport Stream packet header and adaptation fields are not payload.
- 3.179 PES [systems]:** An abbreviation for Packetized Elementary Stream.
- 3.180 PES packet [systems]:** The data structure used to carry elementary stream data. It consists of a PES packet header followed by PES packet payload and is described in 2.4.3.6 and 2.4.3.7 of ISO/IEC 13818-1:2000.
- 3.181 PES packet header[systems]:** The leading fields in a PES packet up to and not including the PES_packet_data_byte fields, where the stream is not a padding stream. In the case of a padding stream the PES packet header is similarly defined as the leading fields in a PES packet up to and not including padding_byte fields.

- 3.182 PES Stream [systems]:** A PES Stream consists of PES packets, all of whose payloads consist of data from a single elementary stream, and all of which have the same stream_id. Specific semantic constraints apply.
- 3.183 picture [video]:** Source, coded or reconstructed image data. A source or reconstructed picture consists of three rectangular matrices of 8-bit numbers representing the luminance and two chrominance signals. A "coded picture" is defined in ISO/IEC 13818-2. For progressive video, a picture is identical to a frame, while for interlaced video, a picture can refer to a frame, or the top field or the bottom field of the frame depending on the context.
- 3.184 picture data [video]:** In the VBV operations, picture data is defined as all the bits of the coded picture, all the header(s) and user data immediately preceding it if any (including any stuffing between them) and all the stuffing following it, up to (but not including) the next start code, except in the case where the next start code is an end of sequence code, in which case it is included in the picture data.
- 3.185 polyphase filterbank [audio]:** A set of equal bandwidth filters with special phase interrelationships, allowing for an efficient implementation of the filterbank.
- 3.186 prediction [audio]:** The use of a predictor to provide an estimate of the subband sample in one channel from the subband samples in other channels.
- 3.187 prediction error:** The difference between the actual value of a sample or data element and its predictor.
- 3.188 prediction:** The use of a predictor to provide an estimate of the sample value or data element currently being decoded.
- 3.189 predictor:** A linear combination of previously decoded sample values or data elements.
- 3.190 presentation channel [audio]:** audio channels at the output of the decoder corresponding to the loudspeaker positions left, centre, right, left surround and right surround.
- 3.191 presentation time-stamp; PTS [systems]:** A field that may be present in a PES packet header that indicates the time that a presentation unit is presented in the system target decoder.
- 3.192 presentation unit; PU [systems]:** A decoded Audio Access Unit or a decoded picture.
- 3.193 profile [video]:** A defined subset of the syntax of this specification.
- 3.194 profile-and-level combination [video]:** Point of conformance for video bitstreams and decoders. Defined profile-and-level combinations are defined in clause 8 of ISO/IEC 13818-2:2000. In the case of a bitstream, the profile-and-level combination is derived from the profile_and_level_indication. A decoder may comply with several profile-and level combinations.
- 3.195 program [AAC]:** A set of main audio channels, coupling_channel_element()'s, lfe_channel_element()'s, and associated data streams intended to be decoded and played back simultaneously. A program may be defined by default or specifically by a program_config_element(). A given single_channel_element(), channel_pair_element(), coupling_channel_element(), lfe_channel_element() or data channel may accompany one or more programs in any given bitstream.
- 3.196 program [systems]:** A program is a collection of program elements. Program elements may be elementary streams. Program elements need not have any defined time base; those that do, have a common time base and are intended for synchronised presentation.
- 3.197 Program Clock Reference; PCR [systems]:** A time stamp in the Transport Stream from which decoder timing is derived.
- 3.198 program element[systems]:** A generic term for one of the elementary streams or other data streams that may be included in a program.
- 3.199 Program Specific Information; PSI [systems]:** PSI consists of normative data which is necessary for the demultiplexing of Transport Streams and the successful regeneration of programs and is described in 2.4.4 of ISO/IEC 13818-1:2000. One case of PSI, the non-mandatory network information table, is privately defined.
- 3.200 progressive [video]:** The property of film frames where all the samples of the frame represent the same instances in time.

- 3.201 psychoacoustic model [audio]:** A mathematical model of the masking behaviour of the human auditory system.
- 3.202 quantisation matrix [video]:** A set of sixty-four 8-bit values used by the dequantiser.
- 3.203 quantised DCT coefficients [video]:** DCT coefficients before dequantisation. A variable length coded representation of quantised DCT coefficients is transmitted as part of the coded video bitstream.
- 3.204 quantiser scale [video]:** A scale factor coded in the bitstream and used by the decoding process to scale the dequantisation.
- 3.205 random access:** The process of beginning to read and decode the coded bitstream at an arbitrary point.
- 3.206 reconstructed frame [video]:** A reconstructed frame consists of three rectangular matrices of 8-bit numbers representing the luminance and two chrominance signals. A reconstructed frame is obtained by decoding a coded frame.
- 3.207 reconstructed picture [video]:** A reconstructed picture is obtained by decoding a coded picture. A reconstructed picture is either a reconstructed frame (when decoding a frame picture), or one field of a reconstructed frame (when decoding a field picture). If the coded picture is a field picture, then the reconstructed picture is the top field or the bottom field of the reconstructed frame.
- 3.208 reference decoder [video]:** A decoder that implements precisely the decoding process as specified in ISO/IEC 13818-2 and uses a reference IDCT. The reference decoder is capable of decoding compliant bitstreams of any defined profile-and-level.
- 3.209 reference IDCT [video]:** Embodiment of the saturated mathematical integer-number IDCT specified in Annex A of ISO/IEC 13818-2:2000.
- 3.210 reference field [video]:** A reference field is one field of a reconstructed frame. Reference fields are used for forward and backward prediction when P-pictures and B-pictures are decoded. Note that when field P-pictures are decoded, prediction of the second field P-picture of a coded frame uses the first reconstructed field of the same coded frame as a reference field.
- 3.211 reference frame [video]:** A reference frame is a reconstructed frame that was coded in the form of a coded I-frame or a coded P-frame. Reference frames are used for forward and backward prediction when P-pictures and B-pictures are decoded.
- 3.212 reordering delay [video]:** A delay in the decoding process that is caused by frame reordering.
- 3.213 requantisation [audio]:** Decoding of coded subband samples in order to recover the original quantised values.
- 3.214 reserved:** The term "reserved" when used in the clauses defining the coded bitstream indicates that the value may be used in the future for ISO/IEC defined extensions.
- 3.215 run [video]:** The number of zero coefficients preceding a non-zero coefficient, in the scan order. The absolute value of the non-zero coefficient is called "level".
- 3.216 sample aspect ratio [video]:** (abbreviated to **SAR**). This specifies the distance between samples. It is defined (for the purposes of this specification) as the vertical displacement of the lines of luminance samples in a frame divided by the horizontal displacement of the luminance samples. Thus its units are (metres per line) ÷ (metres per sample).
- 3.217 Sampling Frequency (Fs):** Defines the rate in Hertz that is used to digitize an audio signal during the sampling process.
- 3.218 saturation [video]:** Limiting a value that exceeds a defined range by setting its value to the maximum or minimum of the range as appropriate.
- 3.219 scalability [video]:** Scalability is the ability of a decoder to decode an ordered set of bitstreams to produce a reconstructed sequence. Moreover, useful video is output when subsets are decoded. The minimum subset that can thus be decoded is the first bitstream in the set which is called the base layer. Each of the other bitstreams in the set is called an enhancement layer. When addressing a specific enhancement layer, "lower layer" refer to the bitstream which precedes the enhancement layer.
- 3.220 scalable hierarchy [video]:** coded video data consisting of an ordered set of more than one video bitstream.
- 3.221 scalefactor [audio]:** Factor by which a set of values is scaled before quantisation.

- 3.222 scalefactor band [audio]:** A set of frequency lines in Layer III which are scaled by one scalefactor.
- 3.223 scalefactor index [audio]:** A numerical code for a scalefactor.
- 3.224 scrambling [systems]:** The alteration of the characteristics of a video, audio or coded data stream in order to prevent unauthorised reception of the information in a clear form. This alteration is a specified process under the control of a conditional access system.
- 3.225 side information:** Information in the bitstream necessary for controlling the decoder.
- 3.226 skipped macroblock [video]:** A macroblock for which no data is encoded.
- 3.227 slice [video]:** A series of consecutive macroblocks that start, in the coded bitstream, by a slice_start_code and that continue up to the next start code (or to the first stuffing bytes if the next start_code is preceded by stuffing bytes).
- 3.228 slot [audio]:** A slot is an elementary part in the audio bit stream. In Layer I a slot equals four bytes, in Layers II and III one byte.
- 3.229 SNR scalability [video]:** A type of scalability where the enhancement layer (s) contain only coded refinement data for the DCT coefficients of the lower layer.
- 3.230 source stream:** A single non-multiplexed stream of samples before compression coding.
- 3.231 source; input [video]:** Term used to describe the video material or some of its attributes before encoding.
- 3.232 spatial prediction [video]:** prediction derived from a decoded frame of the lower layer decoder used in spatial scalability.
- 3.233 spatial scalability [video]:** A type of scalability where an enhancement layer also uses predictions from sample data derived from a lower layer without using motion vectors. The layers can have different frame sizes, frame rates or chrominance formats.
- 3.234 spectral coefficients:** Discrete frequency domain data output from the analysis filterbank.
- 3.235 splicing[systems]:** The concatenation, performed on the system level, of two different elementary streams. The resulting system stream conforms totally to ISO/IEC 13818-1. The splice may result in discontinuities in timebase, continuity counter, PSI, and decoding.
- 3.236 spreading function [audio]:** A function that describes the frequency spread of masking effects.
- 3.237 start codes [systems]:** 32-bit codes embedded in the coded bitstream that are unique. They are used for several purposes including identifying some of the layers in the coding syntax.
- 3.238 STD input buffer [systems]:** A first-in first-out buffer at the input of a system target decoder for storage of compressed data from elementary streams before decoding.
- 3.239 stereo mode [audio]:** Mode, where two audio channels which form a stereo pair (left and right) are encoded within one bitstream. The coding process is the same as for the dual channel mode.
- 3.240 stereo-irrelevant [audio]:** a portion of a stereophonic audio signal which does not contribute to spatial perception.
- 3.241 still picture [systems]:** A coded still picture consists of a video sequence containing exactly one coded picture which is intra-coded. This picture has an associated PTS and the presentation time of succeeding pictures, if any, is later than that of the still picture by at least two picture periods.
- 3.242 stuffing (bits); stuffing (bytes):** Code-words that may be inserted at particular locations in the coded bitstream that are discarded in the decoding process. Their purpose is to increase the bitrate of the stream which would otherwise be lower than the desired bitrate.
- 3.243 subband [audio]:** Subdivision of the audio frequency band.
- 3.244 subband filterbank [audio]:** A set of band filters covering the entire audio frequency range. In ISO/IEC 13818-3, the subband filterbank is a polyphase filterbank.
- 3.245 subband samples [audio]:** The subband filterbank within the audio encoder creates a filtered and subsampled representation of the input audio samples. The filtered samples are called subband samples. From 32 time-consecutive input audio samples, one subband sample is generated within each of the 32 subbands.

- 3.246 surround channel [audio]:** An audio presentation channel added to the front channels (L and R or L, R, and C) to enhance the spatial perception.
- 3.247 syncword [audio]:** A 12-bit code embedded in the audio bit stream that identifies the start of a base frame or an extension frame.
- 3.248 synthesis filterbank [audio]:** Filterbank in the decoder that reconstructs a PCM audio signal from subband samples.
- 3.249 System Clock Reference; SCR [systems]:** A time stamp in the Program Stream from which decoder timing is derived.
- 3.250 system header [systems]:** The system header is a data structure defined in subclause 2.5.3.5 of ISO/IEC 13818-1:2000, that carries information summarising the system characteristics of the ITU-T Rec. H.222.0 | ISO/IEC 13818 multiplexed Program Stream.
- 3.251 system target decoder; STD [systems]:** A hypothetical reference model of a decoding process used to describe the semantics of an ITU-T Rec. H.222.0 | ISO/IEC 13818 multiplexed bitstream.
- 3.252 temporal prediction [video]:** prediction derived from reference frames or fields other than those defined as spatial prediction.
- 3.253 temporal scalability [video]:** A type of scalability where an enhancement layer also uses predictions from sample data derived from a lower layer using motion vectors. The layers have identical frame size, and chrominance formats, but can have different frame rates.
- 3.254 time-stamp [systems]:** A term that indicates the time of a specific action such as the arrival of a byte or the presentation of a Presentation Unit.
- 3.255 tonal component [audio]:** A sinusoid-like component of an audio signal.
- 3.256 top field [video]:** One of two fields that comprise a frame. Each line of a top field is spatially located immediately above the corresponding line of the bottom field.
- 3.257 top layer [video]:** the topmost layer (with the highest layer_id) of a scalable hierarchy.
- 3.258 Transport Stream packet header [systems]:** The leading fields in a Transport Stream packet, up to and including the continuity_counter field.
- 3.259 triplet [audio]:** A set of 3 consecutive subband samples from one subband. A triplet from each of the 32 subbands forms a granule.
- 3.260 variable bitrate:** Operation where the bitrate varies with time during the decoding of a coded bitstream.
- 3.261 variable length coding:** A reversible procedure for coding that assigns shorter code-words to frequent events and longer code-words to less frequent events.
- 3.262 variable length code (VLC):** A code word assigned by variable length encoder (see variable length coding).
- 3.263 variable length decoder (VLD):** A procedure to obtain the symbols encoded with a variable length coding technique.
- 3.264 variable length encoder:** A procedure to assign variable length codewords to symbols.
- 3.265 video buffering verifier; VBV [video]:** A hypothetical decoder that is conceptually connected to the output of the encoder. Its purpose is to provide a constraint on the variability of the data rate that an encoder or editing process may produce.
- 3.266 video sequence [video]:** The highest syntactic structure of coded video bitstreams. It contains a series of one or more coded frames.
- 3.267 xxx profile bitstream [video]:** a bitstream of a scalable hierarchy with a profile indication corresponding to xxx. Note that this bitstream is only decodable together with all its lower layer bitstreams (unless it is a base layer bitstream).

3.268 xxx profile decoder [video]: decoder able to decode one or a scalable hierarchy of bitstreams of which the top layer conforms to the specifications of the xxx profile (with xxx being any of the defined Profile names).

3.269 xxx profile scalable hierarchy [video]: set of bitstreams of which the top layer conforms to the specifications of the xxx profile.

3.270 zig-zag scanning order [video]: A specific sequential ordering of the DCT coefficients from (approximately) the lowest spatial frequency to the highest.

4 Symbols and abbreviated terms

NOTE The mathematical operators used to describe this part of ISO/IEC 13818 are similar to those used in the C programming language. However, integer divisions with truncation and rounding are specifically defined. Numbering and counting loops generally begin from zero.

4.1 Arithmetic operators

+	Addition.
-	Subtraction (as a binary operator) or negation (as a unary operator).
++	Increment.
--	Decrement.
×	Multiplication.
*	Multiplication.
^	Power.
/	Integer division with truncation of the result toward zero. For example, 7/4 and -7/-4 are truncated to 1 and -7/4 and 7/-4 are truncated to -1.
//	Integer division with rounding to the nearest integer. Half-integer values are rounded away from zero unless otherwise specified. For example 3//2 is rounded to 2, and -3//2 is rounded to -2.
DIV	Integer division with truncation of the result toward minus infinity. For example 3 DIV 2 is rounded to 1, and -3 DIV 2 is rounded to -2.
	Absolute value. $ x = x$ when $x > 0$ $ x = 0$ when $x == 0$ $ x = -x$ when $x < 0$
÷	Used to denote division in mathematical equations where no truncation or rounding is intended.
%	Modulus operator. Defined only for positive numbers.
Sign()	Sign(x) = 1 $x > 0$ 0 $x == 0$ -1 $x < 0$
NINT ()	Nearest integer operator. Returns the nearest integer value to the real-valued argument. Half-integer values are rounded away from 0.
sin	Sine.
cos	Cosine.

exp	Exponential.
$\sqrt{\quad}$	Square root.
$\log_{10}$	Logarithm to base ten.
$\log_e$	Logarithm to base e.
$\log_2$	Logarithm to base 2.
Abs()	Absolute value. $\text{Abs}(x) = x$ when $x > 0$ $\text{Abs}(x) = 0$ when $x == 0$ $\text{Abs}(x) = -x$ when $x < 0$
$\sum_{i=a}^{i=b} f(i)$	The summation of the $f(i)$ with i taking integral values from a up to, but not including b .
Sign(x) = -1	when $x < 0$
INT ()	Truncation to integer operator. Returns the integer part of the real-valued argument.

4.2 Logical operators

	Logical OR.
&&	Logical AND.
!	Logical NOT.

4.3 Relational operators

>	Greater than.
>=	Greater than or equal to.
$\geq$	Greater than or equal to.
<	Less than.
<=	Less than or equal to.
$\leq$	Less than or equal to.
==	Equal to.
!=	Not equal to.
max [,...]	the maximum value in the argument list.
min [,...]	the minimum value in the argument list.

4.4 Bitwise operators

&	AND
	OR
>>	Shift right with sign extension.
<<	Shift left with zero fill.

4.5 Assignment

=	Assignment operator.
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4.6 Mnemonics

The following mnemonics are defined to describe the different data types used in the coded bitstream.

bslbf	Bit string, left bit first, where "left" refers to the order in which bit strings are written in ISO/IEC 13818. Bit strings are written as a string of 1s and 0s within single quote marks, e.g. '1000 0001'. Bit strings are also written in hexadecimal notation, e.g. 0x4F. Blanks within a bit string are for ease of reading and have no significance.
center_chan	Index of center channel. (Audio)
center_limited	Variable which indicates whether a subband of the center is not transmitted. It is used in the case of phantom coding of center channel. (Audio)
ch	Channel. If ch has the value 0, the left channel of a stereo signal or the first of two independent signals is indicated. (Audio)
dyn_cross	dyn_cross means that dynamic crosstalk is used for a certain transmission channel and a certain subband. (Audio)
gr	Granule of 3 * 32 subband samples in audio Layer II, 18 * 32 subband samples in audio Layer III. (Audio)
Lo, Ro	Compatible stereo audio signals. (Audio)
L, C, R, LS, RS	Left, center, right, left surround and right surround audio signals. (audio)
L ^W , C ^W , R ^W , LS ^W , RS ^W	Weighted left, center, right, left surround and right surround audio signals. The weighting is necessary for two reasons: 1) All signals have to be attenuated prior to encoding to avoid overload when calculating the compatible stereo signal. 2) The weighted and processed signals are actually coded and transmitted, and denormalised in the decoder. (Audio)
left_sur_chan	Index of left surround channel. (Audio)
main_data	The main_data portion of the bitstream contains the scale factors, Huffman encoded data, and ancillary information. (Audio)
main_data_beg	This gives the location in the bitstream of the beginning of the main_data for the frame. The location is equal to the ending location of the previous frame's main_data plus 1 bit. It is calculated from the main_data_end value of the previous frame. (Audio)

mono_sur_chan	Index of the mono surround channel. This index is identical to the index of the left surround channel. (Audio)
msblimit	Maximum used subband. (Audio)
nch	Number of channels; equal to 1 for single_channel mode, 2 in other modes. (Audio)
nmch	Number of channels in the multichannel extension part. (Audio)
npred	Number of allowed predictors according to the tables in subclause 2.5.2.10 of ISO/IEC 13818-3:1998. (Audio)
npredcoeff	Number of prediction coefficients used. (Audio)
part2_length pci	The number of main_data bits used for scale factors. (Audio) index of predictor[0, 1, 2] (Audio)
px	index of predictor[0, 1, ..., npred-1] (Audio)
right_sur_chan	Index of right surround channel. (Audio)
rpchof	Remainder polynomial coefficients, highest order first. (Audio)
sb	Subband. (Audio)
sbgr	Groups of individual subband according to subbandgroup table in subclause 3.5.2.10. (Audio)
sblimit	The number of the lowest subband for which no bits are allocated. (Audio)
scfsi	Scalefactor selection information. (Audio)
simsbf	Signed integer, in two's complement format, most significant (sign) bit first. (Audio)
switch_point_l	Number of scalefactor band (long block scalefactor band) from which point on window switching is used. (Audio)
switch_point_s	Number of scalefactor band (short block scalefactor band) from which point on window switching is used. (Audio)
T0, T1, T2, T3, T4	Audio transmission channels. The assignment of audio signals to transmission channels is determined by the dematrixing procedure and the transmission channel allocation information. (Audio)
tc	Transmitted channel. (Audio)
tcimsbf	two's complement integer, msb (sign) bit first. (Systems)
uimsbf	Unsigned integer, most significant bit first.
vlcblf	Variable length code, left bit first, where "left" refers to the order in which the VLC codes are written.
window	Number of the actual time slot in case of block_type==2, 0 <= window <= 2. (Audio)
The byte order of multi-byte words is most significant byte first.	

4.7 Constants

π 3,14159265358...

e 2,71828182845...

5 Systems

5.1 System bitstream characteristics

5.1.1 General system bitstream characteristics

Transport Stream and Program Stream encoders may apply restrictions to the following parameters of Transport and Program Streams (see ITU-T Rec. H.222.0 | ISO/IEC 13818-1):

- constraints for STD Model
- use of smoothing buffer parameters
- delay caused by system target decoder input buffering
- length of PES packets
- presence of time stamps in PES packet headers (DTS, PTS)
- frequency of encoding time stamps in PES packet headers (DTS, PTS)
- use of private streams
- fixed or variable bitrate operation
- number of multiplexed audio streams in a program
- number of multiplexed video streams in a program
- decoding of trick modes
- use of PES Packet CRCs
- carriage of Program Stream data
- carriage of private data
- use of descriptors
- constraints for sending descriptors

5.1.2 Transport Stream specific characteristics

System encoders that produce Transport Streams may apply restrictions to the following parameters of Transport Streams (see ITU-T Rec. H.222.0 | ISO/IEC 13818-1) :

- use of transport priority indication
- application of scrambling
- frequency of opening an adaptation header field
- frequency of flagging random access points using the random_access_indicator
- use of elementary_stream_priority_indicator
- frequency of encoding PCRs
- use of option to encode OPCRs
- occurrence of splice points
- carriage of private data

- use of LTW concept
- support of seamless splicing
- encoding of a valid value in the PES_packet_length field in the case of a PES packet carrying MPEG-2 video data
- frequency of transmitting PSI tables
- use of Network Information Table
- use of Conditional Access Table
- use of private sections

5.1.3 Program Stream specific characteristics

Program Stream encoders may apply restrictions to the following parameters of Transport and Program Streams (see ITU-T Rec. H.222.0 | ISO/IEC 13818-1) :

- program mux_rate
- rate_bound
- P-STD_buffer_size
- P-STD_buffer_size_bound
- difference between two SCRs in successive packs
- length of a pack
- length of a PES packet
- number of PES packets in a pack
- presence of time stamps in packet headers (DTS, PTS)
- CSPS_flag
- use of private streams
- packet rate
- fixed or variable bitrate operation (fixed_flag parameter)
- number of multiplexed audio streams (audio_bound parameter)
- number of multiplexed video streams (video_bound parameter)
- locking of audio sampling frequency and frequency of system clock
- locking of video picture rate and frequency of system clock
- constraints for use of Program Stream Map Table
- constraints for use of Program Stream Directory Table

5.2 System bitstream tests

Each bitstream shall meet the syntactic and semantic requirements specified in ISO/IEC 13818-1. This subclause describes a set of semantic tests to be performed on bitstreams. To verify whether the syntax is correct is straight forward and therefore not defined in this subclause. In the description of the semantic tests it is assumed that the tested bitstream contains no errors due to transmission or other causes. For each test

the condition or conditions that must be satisfied are given, as well as the prerequisites or conditions in which the test can be applied. Note that the application of these tests requires parsing of the bitstream to the appropriate levels, which in some cases goes as far as the slice layer of video. Parsing and interpretation of PSI is also required. In some cases of scrambled data descrambling is required before the tests can be performed.

5.2.1 Tests of Transport Streams

5.2.1.1 Tests of transport packet header The following tests are applicable to Transport Stream packets in which the `transport_error_indicator` is set to '0'.

payload_unit_start_indicator: If the PID is 0x1FFF test that the `payload_unit_start_indicator` is '0'. If a PID is carrying PES packets or PSI sections, and `payload_unit_start_indicator` is set to 1, then test that `adaptation_field_control` is '01' or '11'.

PID: Test that the PID does not take any of the reserved values described in ISO/IEC 13818-1:2000, table 2-4.

transport_scrambling_control: If the PID is 0x0000 or 0x0001 or 0x1FFF, or if the Transport Stream Packet contains PMT sections, test that the `transport_scrambling_control` is '00'.

adaptation_field_control: If the PID is 0x1FFF, test that `adaptation_field_control` is '01', else test that `adaptation_field_control` is one of '01', '10', or '11'.

Transport Stream Continuity: Duplicate packets are packets which are identical except for the PCR field, if present. The following tests do not apply to null packets.

When (1) `adaptation_field_control` is '01' or '11',
and (2) `discontinuity_indicator` is '0',
and (3) the Transport Stream packet is not a duplicate packet,
then test that the continuity counter is one greater (modulo 16) than the continuity counter of the previous Transport Stream packet of the same PID.

When (1) `adaptation_field_control` is '00' or '10',
and (2) `discontinuity_indicator` is '0',
or when the Transport Stream packet is a duplicate packet,
then test that the continuity counter is equal to the continuity counter of the previous Transport Stream packet of the same PID.

duplicate_packet: If the previous Transport Stream packet is a duplicate, test that the present Transport Stream packet is not a duplicate packet.

If the Transport Stream packet is a duplicate, test that the `adaptation_field_control` is equal to '01' or '11'.

5.2.1.2 Tests of adaptation field

adaptation_field_length: If the `adaptation_field_control` is '10', then test that `adaptation_field_length` is 183. If the `adaptation_field_control` is '11', then test that `adaptation_field_length` is in the range 0 to 182, inclusive.

random_access_indicator: if the Transport Stream packet contains PES data and the `random_access_indicator` is set to '1' and the `payload_unit_start_indicator` is set to '1', then test that the PES packet starts in the Transport Stream packet.

random_access_PCR: If `random_access_indicator` is set to '1' and if the PID is a PCR_PID, then test that there is a PCR in the Transport Stream packet.

random_access_PTS: If `random_access_indicator` is set to '1', and if the corresponding video stream type is 1 or 2 or the corresponding audio stream type is 3 or 4, then test that there is a PTS for the next picture or audio frame.

elementary_stream_priority_indicator: If elementary_stream_priority_indicator is set to '1' and the Transport Stream packet carries video, then test that the Transport Packet payload contains one or more bytes from a slice that contains only an intra-coded macroblock.

PCR_OPCR_flags: If OPCR_flag is '1', then test that the PCR_flag is '1'.

transport_private_data: If transport_private_data_flag is '1' then test that transport_private_data_length is greater than 1 and less than the adaptation_field_length less all existing fields in the adaptation field as indicated by the various flags and by adaptation_field_extension_length.

legal time window: If the ltw_valid_flag is set to '1', the following test can be applied on one PID at a time.

It can start as soon as relevant values for the ltw_offset field and piecewise_rate field are defined.

The ltw_offset is expressed in units of (300/fs) seconds, where fs is the system clock frequency of the program that this PID belongs to. The piecewise_rate is expressed in bits/second.

The arrival times of each Transport Packet of the chosen PID are continuously plotted.

The arrival time of the Transport Packet enabling the validation of the two values of the ltw_offset field and of the piecewise_rate field is noted.

The legal_time_windows of the incoming Transport Packets of the same PID are, at that moment defined.

The delivery of the incoming Transport Packets at the end of their legal_time_windows shall satisfy the following conditions:

For video: At the time the first byte of the payload of this transport packet enters MB, MB contains less than 184 bytes and no buffer violation occurs in the T-STD. MB is the multiplex buffer as defined in subclause 2.4.2.3 of ISO/IEC 13818-1:2000.

For audio: At the time the first byte of the payload of this transport packet enters B, B contains less than BSdec + 1 bytes and no buffer violation occurs in the T-STD. B is the main buffer as defined in subclause 2.4.2.3 of ISO/IEC 13818-1:2000.

If the delivery of all the incoming transport packets satisfy the mentioned conditions, the legal_time_window mechanism is successfully implemented.

If the delivery of one transport packet does not satisfy the mentioned conditions, the legal_time_window mechanism is not well implemented.

OPCR: If it is known (outside of examination of the bitstream) that the Transport Stream is the original single program Transport Stream, then test that the OPCR is equal to the PCR.

splice_countdown: If the adaptation_field_control is '11' and the Transport Stream packet is not a duplicate packet and if the splicing_point_flag is '1', then for all consecutive packets with splicing_point_flag set to '1' test that the splice_countdown field decrements with each packet containing payload. At the Transport Stream packet at which the splice_countdown reaches or would reach -1, test that the packet payload starts with the first byte of a PES packet which starts with the first byte of an access point or a sequence end code followed by an access point as defined in the semantic description of splice_countdown in ISO/IEC 13818-1. If any Transport Stream packet contains a splice_countdown, then test that a Transport Stream packet at which the splice_countdown reaches or would reach zero contains the splice_countdown field.

5.2.1.3 Discontinuity tests

In order to validate that the discontinuity indicator is properly used in a Transport Stream, a number of factors need to be tested. These include the proper utilisation of the continuity counter, the proper sequence of packets containing discontinuity indicators, the occurrence of elementary stream access points corresponding to both timebase discontinuities and continuity counter discontinuities, the detection of the minimum number of PCRs between timebase discontinuities, and the proper redefinition of PSI information.

5.2.1.3.1 Discontinuity indicator test

if the discontinuity indicator is "1" and the PID of the received packet is the designated PCR_PID,

then designate the current state of this PID as the discontinuity_state and test for time base discontinuity (subclause 5.2.1.3.2).

else if the discontinuity indicator is '1' and the PID of the received packet is not the designated PCR_PID,
then test that the two previous Transport Stream packets of the same PID did not have discontinuity indicator set to '1', and designate the current state of this PID as the discontinuity_state and test for continuity counter discontinuity (subclause 5.2.1.3.3).

else if the discontinuity indicator is '0', and the current state of this PID is designated as the discontinuity state,
then clear the discontinuity state for the current PID and test for termination of the discontinuity state (subclause 5.2.1.3.4).

else if there is no adaptation field, and the current state of this PID is designated as the discontinuity state,
then clear the discontinuity state for the current PID and test for termination of the discontinuity state (subclause 5.2.1.3.4).

else if the discontinuity indicator is '1' and the PID of the received packet contains PSI information,
then designate the current state of this PID as the discontinuity_state and test for version_number discontinuity (subclause 5.2.1.3.5).

endif

5.2.1.3.2 Time base discontinuity test

— (Use for PCR_PID packets when the discontinuity indicator is '1'.)

if the adaptation_field_control is '11' and the continuity counter is not one greater (modulo 16) than the continuity counter of the previous Transport Stream packet of the same PID (continuity counter discontinuity), and this packet is not a duplicate packet,
then (1) test that the packet contains a PCR and, (2) test that at least two PCRs have been received from the previous timebase, and (3) test that the first byte of elementary stream data in this packet is the first byte of an elementary stream access point (or alternatively, for video, a sequence_end_code followed by an access point), or (4) if no elementary stream data occurs in this packet, test that the first byte of elementary stream data in a Transport Stream packet of the same PID shall be the first byte of an elementary stream access point (or alternatively, for video, a sequence_end_code followed by an access point).

else if the adaptation_field_control is '10' and the continuity counter is not equal to the continuity counter of the previous Transport Stream packet of the same PID (continuity counter discontinuity),
then (1) test that the packet contains a PCR and, (2) test that at least two PCRs have been received from the previous timebase, and (3) test that the first byte of elementary stream data in a Transport Stream packet of the same PID is the first byte of an elementary stream access point (or alternatively, for video, a sequence_end_code followed by an access point).

else if the adaptation_field_control is '11' and the continuity counter is one greater (modulo 16) than the continuity counter of the previous Transport Stream packet of the same PID,
then test that at least two PCRs have been received from the previous timebase.

else if the adaptation_field_control is '10' and the continuity counter is equal to the continuity counter of the previous Transport Stream packet of the same PID, and this packet is not a duplicate packet,
then test that at least two PCRs have been received from the previous timebase.

endif

5.2.1.3.3 Continuity counter discontinuity test

— (Use for non PCR_PID packets when the discontinuity indicator is '1'.)

if the adaptation_field_control is '11' and the continuity counter is not one greater (modulo 16) than the continuity counter of the previous Transport Stream packet of the same PID (continuity counter discontinuity) and this packet is not a duplicate packet,

then (1) test that a continuity counter discontinuity did not occur in the previous Transport Stream packet of the same PID, and
 (2) test that the first byte of elementary stream data in this packet is the first byte of an elementary stream access point (or alternatively, for video, a sequence_end_code followed by an access point),
 or
 (3) if no elementary stream data occurs in this packet, test that the first byte of elementary stream data in a Transport Stream packet of the same PID is the first byte of an elementary stream access point (or alternatively, for video, a sequence_end_code followed by an access point).

else if the adaptation_field_control is '10' and the continuity counter is not equal to the continuity counter of the previous Transport Stream packet of the same PID (continuity counter discontinuity),

then (1) test that a continuity counter discontinuity did not occur in the previous Transport Stream packet of the same PID, and
 (2) test that the first byte of elementary stream data in a Transport Stream packet of the same PID is the first byte of an elementary stream access point (or alternatively, for video, a sequence_end_code followed by an access point).

endif

5.2.1.3.4 Discontinuity state termination test

— (Use when the current state is designated as discontinuity state and the discontinuity indicator is '0' or when there is no adaptation field.)

if the PID of the received packet is the designated PCR_PID,
then test that the previous packet with the same PID contains a PCR.

endif

5.2.1.3.5 Version number discontinuity test

— (Use for PSI PIDs when the discontinuity indicator is '1'.)

if the section_length is "13" for the Transport Stream_program_map_sections,
then (1) test that the current_next_indicator is '1',
 (2) test that no program_descriptors exist in this packet,
 (3) test that no elementary streams are described in this packet,
 (4) test that following packet contain updated TS_program_map_sections for each affected program,
 (5) with the version_number incremented by one and with the value of current_next_indicator set at '1', test that these sections contain a complete program definition.

endif

5.2.1.4 Random access tests

5.2.1.4.1 Random access test

if the random access indicator is '1' and the PID of the received packet is the designated PCR_PID,
then test for the existence of a PCR field, and
 test for start of PES packet.

else if the random access indicator is '1',
then test for start of PES packet.

else if (1) the random access indicator is '0', and
 (2) the random access indicator was '1' in a previous Transport Stream packet of the same PID, and
 (3) the beginning of a PES packet has not been detected in a packet of the same PID since the occurrence of the packet of the same PID which contained the random access indicator set to '1',
then test for start of PES packet.

endif

5.2.1.4.2 Random access PES start test

if the start of a PES packet exists in the payload of the current Transport Stream Packet and the PES Stream type is '1' or '2',
then (1) test for the first byte of a video sequence header in the PES packet payload, or
 (2) if no PES packet payload data occurs in this packet, test that the first Transport Stream packet of the same PID which contains PES packet payload data contains the first byte of a video sequence header, and
 (3) test that a presentation time stamp is present in the first PES packet which contains the first picture following the sequence header.
else if the start of a PES packet exists in the payload of the current Transport Stream Packet and the PES Stream type is '3' or '4',
then (1) test for the first byte of an audio frame in the PES packet payload, or
 (2) if no PES packet payload data occurs in this packet, test that the first Transport Stream packet of the same PID which contains PES packet payload data contains the first byte of an audio frame, and
 (3) test that a presentation timestamp is present in the PES packet which contains the first byte of the audio frame.
endif

5.2.1.5 Tests of PES header

stream_id: Test that the stream_id is consistent with the stream_type of the PID as assigned in the PSI.

PES_packet_length: In a Transport Stream, test that the PES_packet_length is not zero in any PES packet that does not contain video. In a Program Stream, test that the value is not zero. If the value is not equal to zero, test that the length addresses the next PES packet startcode prefix.

data_alignment_indicator: If the data_alignment_indicator is set to 1 and if there is a data stream alignment descriptor for the elementary stream, test that the alignment is as indicated by the descriptor as described in ISO/IEC 13818-1:2000, table 2-47 for video streams or table 2-48 for audio streams. If there is no alignment descriptor, the alignment must be as indicated by the alignment_type '01' as given in ISO/IEC 13818-1:2000, table 2-47 for video or table 2-48 for audio.

PTS_DTS_flags: Test that the PTS_DTS_flags is not 01.

PES_header_data_length: Test that the PES_header_data_length value is consistent with the optional data fields of the PES header, such that the indicated length is greater than or equal to the total of the number of optional bytes as indicated by the flags preceding the length field, from PTS_DTS_flags to PES_extension_flag, and including the bytes in PES extensions, if present. Also test that the length is not more than 32 longer than the number of bytes indicated to be present in the optional fields.

Timestamps: For the timestamps that are present, as indicated by the PTS_DTS_flags, test for timestamp consistency within the context of the STD. Timestamp consistency means that the difference between any two timestamps (not necessarily consecutive) of the same elementary stream equals the time that corresponds to the interval between the access units referred to by the timestamps. This difference shall be exact when the interval between access units is an integer multiple of the 90 kHz clock (such as 29.97 Hz systems without 3:2 pulldown or 25 Hz systems). In all other cases where the time interval between access units is not an integer value or when 3:2 pulldown is used the difference shall be within +/- 1 count (PTS and DTS computation shall use the arithmetic accuracy as specified in equations 2-11 and 2-12 of ITU-T Rec. H.222.0 (2000)|ISO/IEC 13818-1:2000). In the case of video picture reordering, this reordering must be taken into account. Note that timestamps consistency cannot be tested across a discontinuity. For I and P pictures in non-low-delay sequences and in the case when there is no decoding discontinuity between access units k and k' and if the relevant PTS and DTS are present, test that the presentation time $tp_n(k)$ is equal to the decoding time $tp_n(k')$ of the next transmitted I or P picture. Test that there is a PTS at least every 700 msec for each ES.

intra_slice_refresh: If intra_slice_refresh is set to '0' and if the stream type is video, then test that there are no missing macroblocks between coded slices.

rep_cntrl: Test that rep_cntrl is not equal to 0.

previous_PES_packet_CRC: Test that the encoded value is correct.

pack_header_field_flag: If in a Program Stream, test that this bit is '0'.

program_packet_sequence_counter: If in a Program Stream, test that the program_packet_sequence_counter increments with each PES packet.

original_stuff_length: If MPEG1_MPEG2_identifier is 1, test that this value is not greater than 16. Otherwise test that this value is not greater than 32.

P-STD_buffer_scale: If in a Program Stream, then if audio test that the value is '0', else if video test that the value is '1'.

5.2.1.6 General tests for sections

section_length: Test that section_length is consistent with the pointer_fields.

version_number; current_next_indicator; section_number; last_section_number: These fields are analysed together. The same rules apply for this as for program_association_sections (subclause 5.2.1.7)

A section is denoted with the following attributes: S(v, c, s, l) where

v is the value of the version_number field,
c is the value of the current_next_indicator flag,
s is the value of the section_number field of the section, and
l is the value of the last_section_number field.

Test that for every section S(v, '1', s, l) that is currently valid, v+1 is the next version to have the current_next_indicator flag set to 1.

CRC_32: Test that this is correctly calculated such that the field value gives a zero output of the registers in the decoded defined in Annex B of part 1 of ISO/IEC 13818 after processing the entire section, excluding the CRC field itself.

Test that the first byte after the last byte of the CRC_32 field in any Transport Packet with this PID takes either the appropriate table_id value (in which case this is the start of the following section) or the start of the next Transport Stream packet (0x47) or the value 0xFF. If the value of 0xFF is found then test that all following bytes to the end of the Transport Packet are also 0xFF.

If the value 0xFF was present then test that the following Transport Packet of the same PID either

- (1) consists only of adaptation_field, or
- (2) has the payload_unit_start_indicator set to '1', has the pointer_field set to '0' and then starts a new section.

If no section started in the following Transport Packet, then the same test should be carried out until a Transport Packet is found in which a new section starts (above condition 2).

5.2.1.7 Program Association Table tests

PID0: Confirm that in the Transport Stream under test, there is at least one Transport Stream packet with PID set to 0x0000.

transport_scrambling_control: Test that it is set to '00' - i.e. not scrambled.

payload_unit_start_indicator: If this is set to a value of '1' then the first data byte of the Transport Packet shall be understood to be a pointer_field. If the payload_unit_start_indicator is set to '0' then no pointer_field shall be present in that Transport Stream packet and it is not compliant for a section to start in that Transport Stream packet.

table_id: Test that the byte pointed to by the pointer_field takes the value '0x00'.

section_syntax_indicator: Test that this bit is '1'.

section_length: Test that the first two bits are set to '00'.

$9 \leq \text{section_length} \leq 1021$

if section_length == n then byte n+1 == 0x00 or 0xFF (or 0x47 if start of next Transport Stream packet).

The nth byte of the section shall be tested to be the last byte of the CRC_32.

transport_stream_id: No test on the value but it should be same in all sections of that version number.

Test that all sections of the PAT that are currently valid have the same version_number.

program_number: Test that the program_number field does not take any single value more than once within all sections of any version of the program association table.

If program_number == 0x0000 then

network_PID: Test that this field does not take any value from 0x0000 - 0x000F, or 0x1FFF. Test also that it does not take any values identified as Transport Packets carrying video or audio data. Note that it is permitted for the network_PID to be the same as a program_map_PID. Test that if there are any Transport Stream packets with the PID denoted the network_PID then these packets contain private_sections.

If program_number != 0x0000 then

program_map_PID: Test that this field does not take any value from 0x0000 - 0x000F and also does not take the value 0x1FFF. Test also that it does not take any values identified as Transport Packets carrying video or audio data.

Then test that the PID pointed to contains a TS_program_map_section, with the program_number field coded the same as the program_number field in the PAT.

Test that there are no sections with table_id == 0x00 in any Transport Packet with a PID value other than 0x0000.

If there is a change in the program_number fields of the programs present in the tested Transport Stream then it should be tested that a new version of the PAT is present in the tested Transport Stream prior to the change, giving the new configuration. An example of such a change would be adding a new program, or deleting a program in order to be able to re-use the program_number.

Test that all the sections of the PAT for a given version_number contain a complete list of all the programs present within the tested Transport Stream. This is done by testing that every section in the tested Transport Stream with table_id set to 0x02 are listed through their program_numbers in the PAT. i.e. no sections with table_id set to 0x02 should be found in the tested Transport Stream unless their program number is listed in the PAT.

5.2.1.8 Program Map Table tests

Program Map Table PIDs The entries of the program_association_table should be used to obtain the values of PMT PIDs. Each separate PMT PID should then be tested with this procedure to ensure the PSI is compliant. Test that the payload of the packets indicated by the PMT PID consists of sections, including any private sections.

transport_scrambling_control_flags: If table_id == 0x02 then test that the transport_scrambling_control_flags are set to '00', i.e. not scrambled.

payload_unit_start_indicator: If set to a value of '1' in a Transport Stream packet of PMT_PID then the first data byte of the Transport Packet shall be assumed to be a pointer_field. If set to '0' then no pointer_field shall be present in that Transport Stream packet and it is not compliant for a section to start in that Transport Stream packet.

table_id: Test that this does not take a value 0x00, 0x01 or 0x03-0x3F. If table_id 0xFF appears then test that stuffing occurs to the end of the Transport Packet. Only sections with table_id value 0x02 are then to be subject to the following tests, as only they are TS_program_map_sections. (Other sections may be private sections).

section_syntax_indicator: Test that this is set to '1'.

'0': Test that this bit is '0'.

section_length: Test that the first two bits are coded '00'.

9 <= section_length <= 1021

if section_length == n then byte n+1 == next table_id value, (or 0x47 if new Transport Stream packet)

The nth byte of the section shall be tested to be the last byte of the CRC_32.

program_number: Test that this is coded to be the same as one of the values of program_number listed in the PAT as having the PMT_PID value which is the same as the PID value in which the section is found. Test that this field does not take the value 0x0000, which is reserved for the NIT.

PCR_PID: Test that in the adaptation_fields in the Transport Stream packets having a PID the same as the PCR_PID, a PCR occurs with the required regularity - see the part of this document which defines how to test for correct PCRs.

program_info_length: Test that the first two bits are coded '00'. Test that this length field is consistent with the immediately following descriptor length fields, and that the CRC_32 field is correct. This length only codes the length of the immediately following descriptors.

descriptor: To test each individual descriptor, see subclause 5.2.1.12, however, at this point test that only descriptors listed as being permitted at 'program level' are included here, or private descriptors (those with tags 64-255).

stream_type: Test that the stream_type field does not take the following values:

0x00, 0x10-0x7F.

- If the field takes the value 0x01, test that the Transport Stream packets of the PID listed in the next elementary_PID contain ISO/IEC 11172-2 data.
- If the field takes the value 0x02, test that the Transport Stream packets of the PID listed in the next elementary_PID contain ISO/IEC 13818-2 data.
- If the field takes the value 0x03, test that the Transport Stream packets of the PID listed in the next elementary_PID contain ISO/IEC 11172-3 data.
- If the field takes the value 0x04, test that the Transport Stream packets of the PID listed in the next elementary_PID contain ISO/IEC 13818-3 data.
- If the field takes the value 0x05, test that the Transport Stream packets of the PID listed in the next elementary_PID contain ISO/IEC 13818-1 data in private_sections.
- If the field takes the value 0x06, test that the Transport Stream packets of the PID listed in the next elementary_PID contain data in ISO/IEC 13818-1 PES packet form.
- If the field takes the value 0x07, test that the Transport Stream packets of the PID listed in the next elementary_PID contain ISO/IEC 13522 data.
- If the field takes the value 0x08, test that the Transport Stream packets of the PID listed in the next elementary_PID contain ISO/IEC 13818-1 DSM-CC data as defined in Annex A of ISO/IEC 13818-1:2000, or ISO/IEC 13818-6 DSM-CC data.
- If the field takes the value 0x0E, test that the Transport Stream packets of the PID listed in the next elementary_PID contain ISO/IEC 13818-1 auxiliary data.
- If the field takes the value 0x0F, test that the Transport Stream packets of the PID listed in the next elementary_PID contain ISO/IEC 13818-7 AAC(ADTS) audio data.

elementary_PID: Test that this field never takes the values 0x0000- 0x000F or 0x1FFF.

ES_info_length: Test that the first two bits are coded '00'. Test that this length field is consistent with the immediately following descriptor length fields, and that the CRC_32 field is correct.

descriptor: To test each individual descriptor, see subclause 5.2.1.12, however, at this point test that only descriptors listed as being permitted at 'ES level' are included here, or private descriptors (those with tags 64-255).

5.2.1.9 Conditional Access Table tests

PID1: Test that there are no sections with table_id set to 0x01 in any Transport Packet with a PID value other than 0x0001.

transport_scrambling_control: Test that transport_scrambling_control is set to '00', i.e. not scrambled.

payload_unit_start_indicator: If set to a value of '1' in a Transport Stream packet of PID set to 0x0001 then the first data byte of the Transport Packet shall be assumed to be a pointer_field. If the payload_unit_start_indicator is set to '0' then no pointer_field shall be present in that Transport Stream packet and it is not compliant for a section to start in that Transport Stream packet.

table_id: Test that the byte pointed to by the pointer_field takes the value '0x01' i.e. table_id set to 0x01.

section_syntax_indicator: Test that this bit is '1'.

'0': Test that this bit is '0'.

section_length: Test that the first two bits are set to '00'.

$9 \leq \text{section_length} \leq 1021$

if section_length == n then byte n+1 == 0x01 or 0xFF (or 0x47 in the case of this being the start of the next Transport Stream packet)

The nth byte of the section shall be tested to be the last byte of the CRC_32.

Test that all sections of the CA Table that are currently valid, all have the same version_number.

descriptor: To test each individual descriptor, see subclause 5.2.1.12, however, at this point test that only descriptors listed as being permitted here are included here, (or private descriptors (those with tags 64-255)).

There should be sufficient cases of the CA_descriptor to identify program related access control information for all scrambled streams. Since the content of the descriptor is primarily private, it is not possible to verify whether this private data is 'correct' or not.

If no section started in the following Transport Packet, then the same test should be carried out until a Transport Packet is found with the table_id set to 0x01.

5.2.1.10 Network Information Table tests

If in the PAT, a program_number set to 0x0000 occurs, then a test should be made for a network information table.

Test for any Transport Stream packets with a PID value of NIT as indicated in the PAT.

transport_scrambling_control: If the flags are set to a value other than '00' then no further tests are required. Otherwise, the assumption should be made that such packets are in section format.

payload_unit_start_indicator: When set to '1' then the first byte of the payload should be assumed to be a pointer field. This pointer should be used to identify the first byte of a section (table_id)

table_id: Test that it takes a value other than 0x00- 0x3F. If table_id is 0xFF then test that the rest of the Transport Stream packet is also filled with 0xFF bytes too. Otherwise the next test should be carried out on section_length field.

section_length: Assume this is correct. Using this information, skip over the full length of the section. The next byte should not take a value 0x00-0x3F. Continue to repeat the procedure of payload_unit_start_indicator and section_length tests until either a value of 0xFF is found as a first section byte (table_id), or until a section is found to end at the end of a Transport Stream packet.

Note : If it is known through means outside of the bitstream that the NIT consists only of long private_sections, then it can be tested that the private_sections that make up the NIT conform to the long private_section syntax. If it is not known that the NIT consists only of long private_sections, then only the first part of the private_section (which is common to both the short and long syntax) need be tested for conformance.

5.2.1.11 Private section

If Transport Stream packet PIDs are listed in a program definition as containing private data in section form, then the following test should be performed.

payload_unit_start_indicator: If set to '1' in such a Transport Stream packet, then assume that the first byte of the payload of that Transport Stream packet is a pointer field. Use this pointer field to find the first byte of a section.

transport_scrambling_control: If set to anything other than '00', then no further test is necessary. If these sections occur in Transport Stream packets which are listed in the PAT as being PMT_PIDs then the transport_scrambling_control flags shall be set to '00' to be compliant.

table_id: Test that this does not take one of the table_id values 0x00-0x3F. If coded to 0xFF then test that all other bytes to the end of the Transport Stream packet also take the value 0xFF.

Consistency Test: Assume the private_section_length field is correct, and use it to skip to the table_id of the next section. If this is in the following Transport Stream packet test that the payload_unit_start_indicator is set to '1' and that the pointer field in that Transport Stream packet also points to the start of the next section. Repeat procedure on next section.

5.2.1.12 Descriptor tests

5.2.1.12.1 General descriptor tests

Certain descriptors can only apply to certain stream types, and may be some only apply to either programs or elementary streams. Some descriptor tags are reserved.

Test that descriptors are not present in PID's defined as reserved in ISO/IEC 13818-1:2000, table 2-4.

descriptor_tag: Test that the descriptor's tag does not have any of the reserved values described in ISO/IEC 13818-1:2000, table 2-39.

descriptor_length: The test of descriptor's length is particular to each descriptor, i.e. that no additional byte (not described in the descriptor's syntax) can be added. The descriptor's length shall reflect only the fields described in the descriptor's syntax.

A global test has also to be performed, verifying that the total length of descriptors described in their associated PSI structures is equal to the sum of the lengths of all the included descriptors plus 2 times the number of descriptors.

Note : The fields which appear in the various descriptors and which are related to fields already present in the video and audio elementary streams structures shall be cross tested with these fields.

5.2.1.12.2 Video stream descriptor

This descriptor can be tested only if it applies to a video elementary stream.

The stream_id in the corresponding PES headers must be the stream_id of a video elementary stream (first 4 bits set to '1110', ISO/IEC 13818-1:2000 table 2-18).

In the PMT and PSM tables, this descriptor is allowed, at the elementary level and is not allowed at the program level.

Descriptor_length: Test that the length is 1 or 3.

Multiple_frame_rate_flag and frame_rate_code: When the value of the multiple_frame_rate_flag is zero, only a single frame rate may be assigned to the video elementary stream. That frame rate must correspond to the value indicated by the frame_rate_code following the multiple_frame_rate_flag flag (see first column of ISO/IEC 13818-1:2000, table 2-41).

When the value of the multiple_frame_rate_flag is one, different frame rates may be assigned to the video elementary stream, and these frame rates must correspond to the rates allowed by the value