

INTERNATIONAL STANDARD

Digital audio – interface for non-linear PCM encoded audio bitstreams applying IEC 60958 –

Part 10: Non-linear PCM bitstreams according to the MPEG-4 audio lossless coding (ALS) format

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**Digital audio – interface for non-linear PCM encoded audio bitstreams applying IEC 60958 –
Part 10: Non-linear PCM bitstreams according to the MPEG-4 audio lossless coding (ALS) format**

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**DIGITAL AUDIO – INTERFACE FOR NON-LINEAR PCM ENCODED
AUDIO BITSTREAMS APPLYING IEC 60958 –****Part 10: Non-linear PCM bitstreams according to the MPEG-4 audio
lossless coding (ALS) format**

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International Standard IEC 61937-10 has been prepared by technical area 4: Digital system interfaces and protocols, of IEC technical committee 100: Audio, video and multimedia systems and equipment.

This second edition cancels and replaces the first edition published in 2011. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- a) Addition of Levels 2, 3, 4 of MPEG-4 ALS Simple Profile;
- b) Addition of data-type bits 0-4 and data-type bits 5-6 for MPEG-4 ALS with LATM/LOAS header.

The text of this International Standard is based on the following documents:

CDV	Report on voting
100/2630/CDV	100/2930/RVC

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all the parts in the IEC 61937 series, published under the general title *Digital audio – Interface for non-linear PCM encoded audio bitstreams applying IEC 60958* can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "<http://webstore.iec.ch>" in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

A bilingual version of this publication may be issued at a later date.

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DIGITAL AUDIO – INTERFACE FOR NON-LINEAR PCM ENCODED AUDIO BITSTREAMS APPLYING IEC 60958 –

Part 10: Non-linear PCM bitstreams according to the MPEG-4 audio lossless coding (ALS) format

1 Scope

This part of IEC 61937 specifies the method for IEC 60958 to convey non-linear PCM bitstreams encoded in accordance with the MPEG-4 audio lossless coding (ALS) format.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60958-1, *Digital audio interface – Part 1: General*

IEC 60958-3, *Digital audio interface – Part 3: Consumer applications*

IEC 61937-1, *Digital audio – Interface for non-linear PCM encoded audio bitstreams applying IEC 60958 – Part 1: General*

IEC 61937-2, *Digital audio – Interface for non-linear PCM encoded audio bitstreams applying IEC 60958 – Part 2: Burst-Info*

ISO/IEC 14496-3:2009, *Information technology – Coding of audio-visual objects – Part 3: Audio*

ISO/IEC 14496-3:2009/AMD2:2010, *ALS simple profile and transport of SAOC*

ISO/IEC 14496-3:2009/AMD5:2015, *Support for Dynamic Range Control, New Levels for ALS Simple Profile, and Audio Synchronization*

3 Terms, definitions, abbreviated terms and conventions

3.1 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

3.1.1

als_id

ALS identifier in ALSSpecificConfig

3.1.2

ALS Simple Profile

MPEG-4 ALS Simple Profile defined by ISO/IEC 14496-3:2009/AMD2:2010 and ISO/IEC 14496-3:2009/AMD5:2015

3.1.3

aux_data

auxiliary data contained in the MPEG-4 ALS burst payload

Note 1 to entry: Not required for decoding audio samples.

3.1.4

aux_size

size of the auxiliary data field in bytes for MPEG-4 ALS

3.1.5

channels

number of channels-1, 'channels', contained in the MPEG-4 ALS burst payload

3.1.6

latency

delay time of an external audio decoder to decode a MPEG-4 ALS data-burst, defined as the sum of the receiving delay time and the decoding delay time

3.1.7

length code

code indicating the length of the data-burst-payload in 8-byte units according to this standard

3.1.8

low overhead audio stream

LOAS

synchronisation layer defined by ISO/IEC 14496-3

Note 1 to entry: Three different formats of LOAS are defined, each of which is designed to address the specific characteristics of the underlying transmission layer. AudioSyncStream shall be used.

3.1.9

low-overhead MPEG-4 audio transport multiplex

LATM

multiplexing layer defined by ISO/IEC 14496-3

Note 1 to entry: LATM is used for multiplexing of audio elementary streams. AudioMuxElement shall be used.

3.1.10

resolution

bit depth of the audio samples contained in the MPEG-4 ALS burst payload

3.1.11

samples

number of audio samples per channel contained in the MPEG-4 ALS burst payload

Note 1 to entry: In contrast to the ALS specification, each data-burst provides its own ALSSpecificConfig. Thus the 'samples' value refers to the total number of samples (per channel) of that data-burst.

3.1.12

samp_freq

sampling frequency of the audio samples contained in the MPEG-4 ALS burst payload

3.2 Abbreviated terms

ALS	audio lossless coding
PCM	pulse-code modulation

3.3 Presentation convention

01_2	Value "01" in binary format
--------	-----------------------------

4 Mapping of the audio bitstream onto IEC 61937

4.1 General

The coding of the bitstream and data-burst is in accordance with the IEC 61937 series of standards.

4.2 MPEG-4 ALS burst-info

The 16-bit burst-info contains information about the data that will be found in the data-burst in accordance with Table 1.

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Table 1 – Fields of burst-info
(data-type bits 0-4=23, data-type bits 5-6=0/ data-type bits 0-4=25, data-type bits 5-6=2)

Bits of Pc	Value	Contents	Reference point R	Repetition period of data-burst in IEC 60958 frames
0 to 4		data-type bits 0-4		
	0-22	In accordance with IEC 61937-2		
	23	MPEG-4 ALS or other applications according to IEC 61937-2, depending on data-type bits 5-6	Bit 0 of Pa	See 5.2.1
	24-24	In accordance with IEC 61937-2		
	25	MPEG-4 ALS or other applications according to IEC 61937-2, depending on data-type bits 5-6	Bit 0 of Pa	See 5.2.1
	26-31	In accordance with IEC 61937-2		
5, 6		data-type bits 5-6 for data-type bits 0-4 23		
	0	MPEG-4 ALS		See 5.2.1
	1-3	In accordance with IEC 61937-2		
		data-type bits 5-6 for data-type bits 0-4 25		
	0-1	In accordance with IEC 61937-2		See 5.2.1
	2	MPEG-4 ALS in LATM/LOAS		
7	3	In accordance with IEC 61937-2		
	0	Error-flag indicating a valid burst-payload		
	1	Burst may contain errors		
8 to 12		Data-type bits 0-4 and data-type bits 5-6 dependent information for MPEG-4 ALS		
8, 9		Multiplier		
	0	[IEC 60958 frame rate] = audio sampling frequency × 2		
	1	[IEC 60958 frame rate] = audio sampling frequency × 4		
	2	[IEC 60958 frame rate] = audio sampling frequency × 8		
	3	Reserved for future Multiplier		
10 to 12	0	No indication		
	1	ALS Simple Profile Level 1		
	2	ALS Simple Profile Level 2		
	3	ALS Simple Profile Level 3		
	4	ALS Simple Profile Level 4		
	5-7	Reserved for future Profile or Level		
13 to 15		In accordance with IEC 61937-1 and IEC 61937-2.		

5 Format of MPEG-4 ALS data-bursts

5.1 General

This clause specifies the audio data-burst MPEG-4 ALS. Specific properties, such as reference points, repetition period, the method of filling stream gaps, and decoding latency, are specified for each data-type bits 0-4.

The decoding latency (or delay), indicated for the data-type bits 0-4, should be used by the transmitter to schedule data-bursts, as necessary, to establish synchronisation between video and decoded audio.

MPEG-4 ALS has the Simple Profile in order to restrict the computational complexity. The several compression tools of ALS are prohibited to use under the Simple Profile of ALS. In addition, maximum values of number of channels, sampling frequency, word length, number of samples per frame, prediction order, block-switching stages, and multi-channel coding stages are limited by defined Levels. For the other levels and profiles or any other cases with no profile indication, Annex C provides some recommendations.

5.2 Audio data-bursts

5.2.1 Data-burst for MPEG-4 ALS

Figure 1 shows the detailed description of the MPEG-4 ALS data-burst. The stream of the data-bursts for MPEG-4 ALS consists of sequences of MPEG-4 ALS bitstreams. The data-type bits 0-4 of a MPEG-4 ALS data-burst is 23. The data-type bits 5-6 is 0. The data-burst is headed with a burst-preamble, followed by the burst-payload, and stuffed with stuffing bits. The burst-payload of each data-burst of MPEG-4 ALS data shall contain an ALSSpecificConfig header, and one or more ALS random access units. Each data-burst constitutes a self-contained ALS bitstream, whose number of samples (per channel) is given in the field 'samples' of (the corresponding) ALSSpecificConfig. The units of length-code (burst_length) shall be in 8-bytes. Note that if the actual data size of the data-burst is not a multiple of 8 bytes, 1 to 7 stuffing bytes are included in the burst_length. Some examples of the relationship between IEC 60958 frame rate and frame repetition of MPEG-4 ALS data-burst are shown in Annex A.

The number of samples for each encoded channel contained in the data-burst are indicated in the encoded ALS bitstream. The length of the MPEG-4 ALS data-burst depends on the encoded bit rate (which determines the MPEG-4 ALS frame length). For details, see Annex B.

The reference to the specification for the MPEG-4 ALS bitstream, representing the number of samples of encoded audio per frame, may be found in ISO/IEC 14496-3, subpart 11.

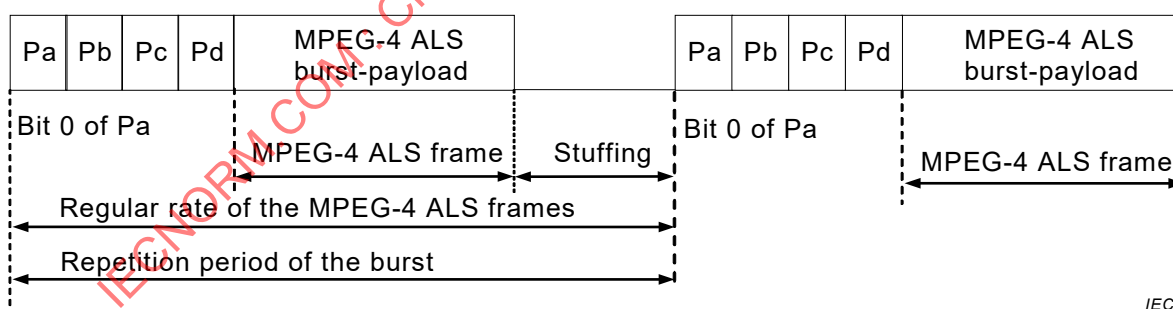


Figure 1 – MPEG-4 ALS data-burst

The regular rate of the MPEG-4 ALS frames and the repetition period of the data burst can be calculated as

'[samples] × [IEC 60958 frame rate]/[sampling frequency of the encoded audio samples (samp_freq)]'.

The value of the 'samples' field is stored in the 9th to 12th bytes of the MPEG-4 ALS burst-payload. The value represents the number of samples contained in the MPEG-4 ALS burst-payload. The IEC 60958 frame rate is defined by the audio sampling frequency and a value of the multiplier (see Table 2).

The reference point of a MPEG-4 ALS data-burst is bit 0 of Pa and occurs exactly once every predefined number of IEC 60958 frames. The data-burst containing MPEG-4 ALS frames shall occur at a regular rate, with the reference point of each MPEG-4 ALS data-burst beginning after the number of IEC 60958 frames in the previous MPEG-4 ALS data-burst from the reference point of the preceding MPEG-4 ALS data-burst (of the same bit-stream-number).

It is recommended that pause data-bursts be used to fill stream gaps in the MPEG-4 ALS bit stream as described in the IEC 61937-1, and that pause data-bursts be transmitted with a repetition period of 32 IEC 60958 frames, except when other repetition periods are necessary to fill the precise stream gap length (which may not be a multiple of 32 IEC 60958 frames), or to meet the requirement on burst spacing (see IEC 61937-1).

When a stream gap in an MPEG-4 ALS stream is filled by a sequence of pause data-bursts, the Pa of the first pause data-burst shall be located after a number of sampling periods represented by the 'samples' field of the ALSSpecificConfig header in the previous MPEG-4 ALS data-burst from the Pa of the previous MPEG-4 ALS frame. It is also recommended that the sequence(s) of pause data-bursts that fill the stream gap should continue from this point up to (as close as possible, considering the 32 IEC 60958 frame length of the pause data-burst) the Pa of the first MPEG-4 ALS data-burst that follows the stream gap. The MPEG-4 ALS decoder can detect the number of decoded PCM samples by using the value set in the 'samples' field of ALSSpecificConfig.

Table 2 shows the relation between the sampling frequency of MPEG-4 ALS encoded audio and the IEC 60958 frame rate used to deliver MPEG-4 ALS encoded audio via the IEC 61937-10 interface.

Table 2 – Sampling frequency, multiplier, and IEC 60958 frame rate

Audio sampling frequency kHz	Multiplier (Bits of Pc, 8 and 9)	IEC 60958 frame rate kHz
48	0 (×2)	96
	1 (×4)	192
	2 (×8)	384
96	0 (×2)	192
	1 (×4)	384
	2 (×8)	768
192	0 (×2)	384
	1 (×4)	768
	2 (×8)	1 536
44,1	0 (×2)	88,2
	1 (×4)	176,4
	2 (×8)	352,8

5.2.2 Latency of MPEG-4 ALS decoding

The latency of an external audio decoder to decode MPEG-4 ALS is defined as the sum of the receiving delay time and the decoding delay time as shown in Figure 2.

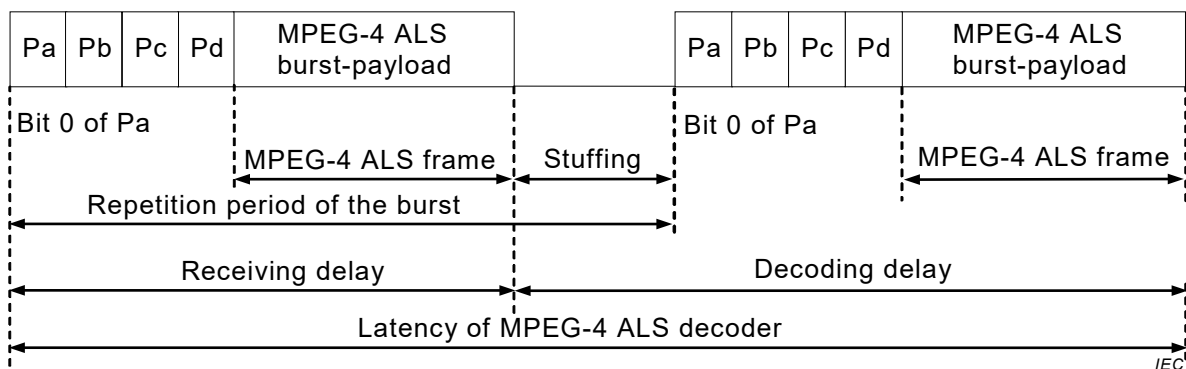


Figure 2 – Latency of MPEG-4 ALS decoding

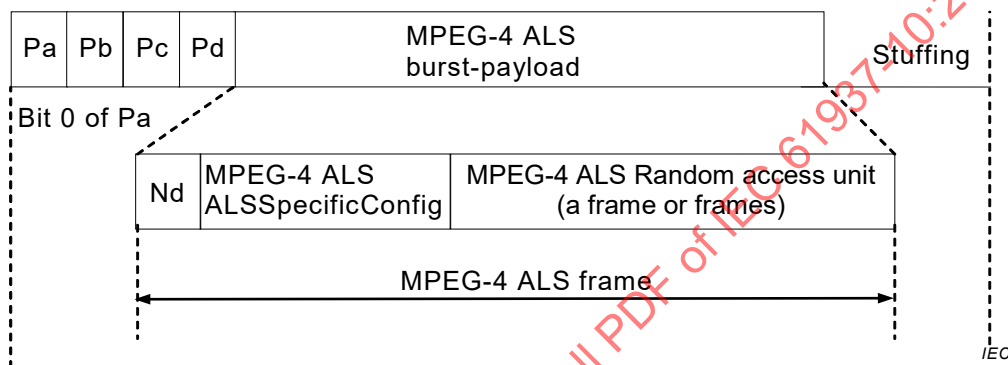


Figure 3 – The MPEG-4 ALS burst-payload

The receiving delay time to receive a whole data-burst is calculated by using the length of the burst-payload, N_d , which is shown in Figure 3. The length of preamble is 8 bytes. Since an IEC 60958 frame can contain 4 bytes, the receiving delay of an MPEG-4 ALS data-burst should be as follows:

$$\text{Receiving delay} = (N_d + 8 \text{ bytes}) / ([\text{IEC 60958 frame rate}] \times 4 \text{ bytes})$$

The maximum receiving delay time is related to the number of samples contained in the data-burst and the IEC 60958 frame rate. The number of samples, 'samples', is stored in the 9th to 12th bytes of the ALSSpecificConfig header of the MPEG-4 ALS burst-payload (13th to 16th bytes of the MPEG-4 ALS burst-payload) as shown in Figure 3. The maximum decoding delay time can be regarded as being the same as the maximum receiving delay time.

Note that the encoded size never exceeds the rate given by the IEC 60958 frame rate in theory except when the Aux data in burst is too large. The Aux size shall be small enough to ensure that the total size of the burst complies with following formula:

$$P_d \leq ((([\text{samples}]/[\text{samp_freq}]) \times [\text{IEC 60958 frame rate}] \times 4 \text{ bytes}) - 8 \text{ bytes})/8$$

EXAMPLE The maximum size of the MPEG-4 ALS burst-payload shall be equal to or less than the size calculated by the frame repetition period and the IEC 60958 frame rate. When the values of 'samp_freq', 'samples', 'channels', and 'resolution' are 48 000, 2 048, 1, and 1 respectively, the sampling frequency of the audio signal is 48 kHz, the number of samples contained in the MPEG-4 ALS burst-payload is 2 048 samples, the number of channels is 2 (= 'channels'+1), and the number of bits per an audio sample is 16 bit. With these values, the IEC 60958 frame rate is 96 kHz, as shown in Table 2. Though the receiving delay time varies depending on the compressed size of the MPEG-4 ALS burst-payload, the maximum receiving delay time can be calculated by using 'samples' and 'samp_freq'. In this example case, it should be 42,67 ms (2 048/48 000 = 0,042 67). The maximum decoding delay time should be

42,67 ms because it can be regarded as being the same as the maximum receiving delay time. The total latency of MPEG-4 ALS decoding is approximately 85,34 ms.

5.2.3 Data-burst for MPEG-4 ALS in LATM/LOAS

The MPEG-4 ALS burst-payload includes LATM/LOAS header and MPEG-4 ALS Random access unit as described in Figure 4. In this case, the length of the burst-payload, corresponding to N_d , is described in LOAS (AudioSyncStream). ALSSpecificConfig is included in LATM (AudioMuxElement). The example use case of frame repetition period is shown in Annex D.

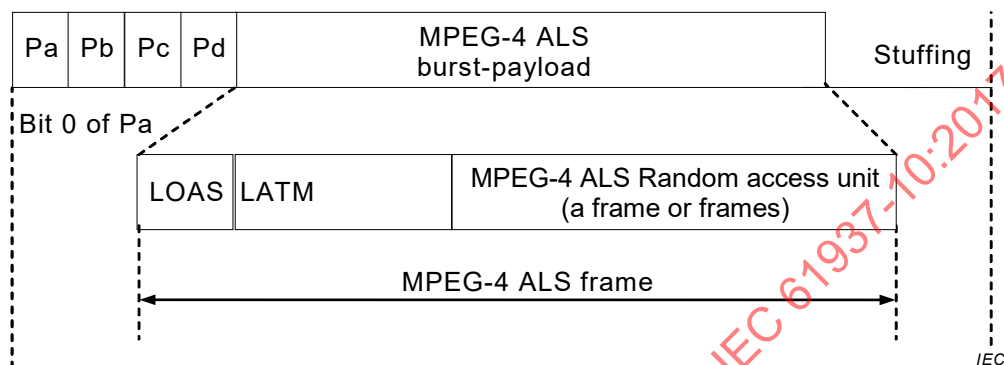


Figure 4 – MPEG-4 ALS burst-payload with LATM/LOAS header

Annex A

(informative)

Effect of repetition period of data-burst and IEC 60958 frame rate on frame period for the MPEG-4 ALS bitstreams

Table A.1 shows IEC 60958 frame rates, their repetition period and their frame period in milliseconds.

Table A.1 – MPEG-4 ALS payload and frame repetition: some examples

Sampling frequency	Frame repetition period	IEC 60958 frame rate Fs	Frame period ms
44,1 kHz	1 024	88,2 kHz for ×2	23,22
	2 048	176,4 kHz for ×4	46,44
	4 096	352,8 kHz for ×8	92,88
	8 192		185,76
48 kHz	1 024	96 kHz for ×2	21,33
	2 048	192 kHz for ×4	42,66
	4 096	384 kHz for ×8	85,32
	8 192		170,64
96 kHz	2 048	192 kHz for ×2	21,33
	4 096	384 kHz for ×4	42,66
	8 192	768 kHz for ×8	85,32
	16 384		170,64
192 kHz	4 096	384 kHz for ×2	21,33
	8 192	768 kHz for ×4	42,36
	16 384	1 536 kHz for ×8	85,32

× = multiplier

Annex B (normative)

Burst payload format for MPEG-4 ALS

Figure B.1 shows the detailed description of the MPEG-4 ALS burst-payload.

The MPEG-4 ALS burst-payload contains an ALSSpecificConfig and one or more random access units. The ALSSpecificConfig is defined in the specification of the ISO/IEC 14496-3.

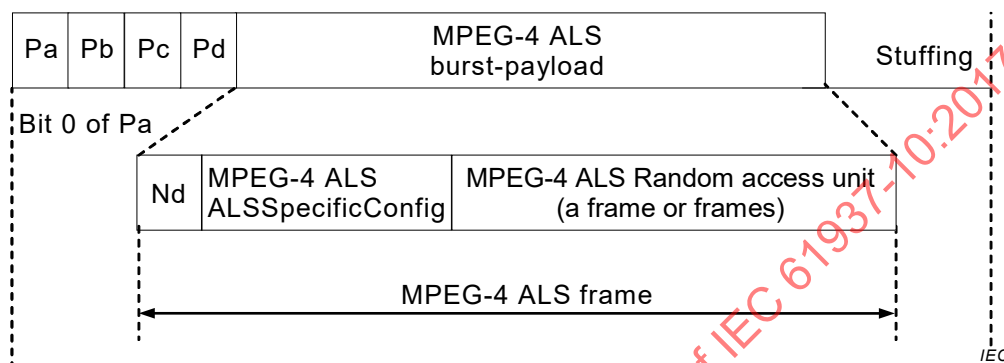


Figure B.1 – MPEG-4 ALS burst-payload

The first 4 bytes of the MPEG-4 ALS burst-payload should be the 'Nd'. The value indicates size of the MPEG-4 ALS burst-payload (including Nd) in bytes.

The following 4 bytes of the MPEG-4 ALS burst-payload should be the 'als_id'. The values of the first 3 bytes in the 'als_id' should be 'A', 'L', 'S'.

The sampling frequency of the samples, 'samp_freq', contained in the MPEG-4 ALS burst payload can be detected in the 4 bytes following 'als_id'.

The number of samples per channel, 'samples', contained in the MPEG-4 ALS burst payload can be detected in the following 4 bytes after the 'samp_freq'.

The number of channels, 'channels', contained in the MPEG-4 ALS burst payload can be detected in the 2 bytes following 'samples'.

The maximum size of the MPEG-4 ALS burst-payload shall be equal to or less than the size calculated by the frame repetition period and the IEC 60958 frame rate.

Repetition period of the data-burst = 'samples' × IEC 60958 frame rate/'samp_freq'.

IEC 60958 frame rate of the MPEG-4 ALS data-burst is defined by 'samp_freq' and 'channels'.

Annex C (normative)

Values for ALSSpecificConfig in the MPEG-4 ALS burst payload format

Table C.1 shows the recommended values for the ALSSpecificConfig in the MPEG-4 ALS burst-payload. The ALSSpecificConfig is defined in ISO/IEC 14496-3.

**Table C.1 – Recommended values for the ALSSpecificConfig
in the MPEG-4 ALS burst-payload**

Field	#Bits	Recommended values	Description
als_id	32	0x414C5300 (Hex)	"ALS\0"
samp_freq	32	Up to 192 kHz	For ALS simple profile level 1, 2, 3, and 4, samp_freq shall be 48 000 or less.
samples	32	Number of samples (per channel) The value 0xFFFFFFFF (HEX) is not allowed for samples in data-type bits 0-4 =23 and data-type bits 5-6=0. For LATM/LOAS case, the value 0xFFFFFFFF (HEX) is allowed for samples in data-type bits 0-4=25, data-type bits 5-6=2.	Number of samples contained in a MPEG-4 ALS burst-payload. Examples of preferred values: 1 024, 2 048, 4 096, 8 192, 10 240, 20 480, 30 720.
channels	16	0=mono 1=stereo 2 = 3 channels 3 = 4 channels 4 = 5 channels 5 = 6 channels 6 = 7 channels 7 = 8 channels (other values are reserved)	Up to 8 channels. The actual number of channels contained in the ALS bitstream can be calculated by 'channels+1'. For ALS simple profile level 1 and 2, channels value shall be 0=mono or 1=stereo. For ALS simple profile level 3 and 4, number of channels value shall be 6 or less (i.e., recommended value shall be 5 or less).
file_type	3	000 = unknown / raw file	The value of the file_type should be 0 (raw file).
resolution	3	000 = 8-bit 001 = 16-bit 010 = 24-bit (other values are reserved)	For ALS simple profile level 1 and 3, resolution value shall be 000=8-bit or 001=16-bit. For ALS simple profile level 2 and 4, resolution value shall be 000=8-bit, 001=16-bit or 010=24-bit.
floating	1	0 = integer	
msb_first	1	0 = least significant byte first 1 = most significant byte first	If resolution = 0 (8-bit data), msb_first = 0 indicates unsigned data (0...255), while msb_first = 1 indicates signed data (-128...127).
frame_length	16	Any	For ALS simple profile level 1, 2, 3, and 4, frame_length value shall be up to 4 096.
random_access	8	1 or larger value	To be set to at least every × samples defined in repetition period of data-burst in IEC 60958 frames.