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IEC 61937-7

Second edition
2004-11

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

Part 7:
Non-linear PCM bitstreams according to the ATRAC, ATRAC2/3 and ATRAC-X formats

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

Part 7: Non-linear PCM bitstreams according to the ATRAC, ATRAC2/3 and ATRAC-X formats

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International Standard IEC 61937-7 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 2002. This edition constitutes a technical revision.

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

a) In this edition, a new audio data-type of ATRAC-X is added to ATRAC and ATRAC2/3.
b) Specific properties such as reference points, repetition period, the method of filling stream gaps, and decoding latency are specified for data-type of ATRAC-X.

The text of this standard is based on the following documents:

CDV	Report on voting
100/752/CDV	100/834/RVC

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

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

IEC 61937 consists of the following parts, undert the general title *Digital audio – Interface for non-linear PCM encoded audio bitstreams applying IEC 60958*:

Part 1: General

Part 2: Burst-info

Part 3: Non-linear PCM bitstreams according to the AC-3 format

Part 4: Non-linear PCM bitstreams according to the MPEG audio formats

Part 5: Non-linear PCM bitstreams according to the DTS (Digital Theater Systems) format(s)

Part 6: Non-linear PCM bitstreams according to the MPEG-2 AAC format

Part 7: Non-linear PCM bitstreams according to the ATRAC, ATRAC2/3 and ATRAC-X formats (TA4)

Part 8: Non-linear PCM bitstreams according to the Windows Media Audio Professional (TA4)[1]

The committee has decided that the contents of this publication will remain unchanged until the maintenance result date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

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- withdrawn;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

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

[1] Under consideration.

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

Part 7: Non-linear PCM bitstreams according to the ATRAC, ATRAC2/3 and ATRAC-X formats

1 Scope

This part of IEC 61937 specifies the method for the digital audio interface specified in IEC 60958 to convey non-linear PCM bitstreams encoded in accordance with the ATRAC, ATRAC2/3 and ATRAC-X formats.

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.

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*

3 Terms, definitions and abbreviations

3.1 Definitions

For the purposes of this document, the definitions given in IEC 61937-1 and IEC 61937-2, as well as the following, apply.

3.1.1
latency
delay time of an external audio decoder to decode an ATRAC, ATRAC2/3 and ATRAC-X data-burst, defined as the sum of two values of the receiving delay time and the decoding delay time

3.2 Abbreviations

ATRAC	Adaptive TRansform Acoustic Coding
ATRAC2	Adaptive TRansform Acoustic Coding 2
ATRAC3	Adaptive TRansform Acoustic Coding 3
ATRAC2/3	ATRAC2 and/or ATRAC3
ATRAC-X	Adaptive TRansform Acoustic Coding-X

4 Mapping of the audio bitstream on to IEC 61937

4.1 General

The coding of the bitstream and data-burst shall be in accordance with IEC 61937-1 and IEC 61937-2.

4.2 ATRAC, ATRAC2/3 and ATRAC-X burst-info

This 16-bit burst-info shall contain data-burst information structured in accordance with Table 1.

Table 1 – Fields of burst-info

Bits of Pc	Value	Contents	Reference point R	Repetition period of data-burst in IEC 60958 frames
0-4		data-type		
	0-13	in accordance with IEC 61937-1 and IEC 61937-2		
	14	ATRAC	bit 0 of Pa	512
	15	ATRAC2/3	bit 0 of Pa	1 024
	16	ATRAC-X	Sub-data-type dependent	Sub-data-type dependent
	17-31	in accordance with IEC 61937-2		
5, 6	00_2	Reserved in ATRAC and ATRAC2/3 formats		
	00_2	Sub-data-type for ATRAC-X	bit 0 of Pa	2 048
	01_2, 10_2, 11_2	Reserved for sub-data-type in ATRAC-X		
7-15		in accordance with IEC 61937-1 and IEC 61937-2		

5 Format of ATRAC, ATRAC2/3 and ATRAC-X data-bursts

5.1 General

This clause specifies the audio data-bursts ATRAC, ATRAC2/3 and ATRAC-X. Specific properties such as reference points, repetition period, the method of filling stream gaps, and decoding latency are specified for each data-type of ATRAC, ATRAC2/3 and ATRAC-X.

The decoding latency (or delay), indicated for the data-types, shall be used by the transmitter to schedule data-bursts as necessary to establish synchronization between the picture and the decoded audio.

NOTE For ATRAC, ATRAC2/3 and ATRAC-X formats, the recommended repetition value period of pause data-bursts is 32 IEC 60958 frames.

5.2 Audio data-bursts

5.2.1 The data ATRAC

The ATRAC bitstream consists of sequences of ATRAC frames. The data-type of an ATRAC data-burst is 0Eh. The data-burst is headed with a burst-preamble, followed by the burst-payload, and is stuffed with stuffing bits (see Figure 1). The burst-payload of each data-burst of ATRAC data shall contain one complete ATRAC frame, and represents 512 samples for each encoded channel. The length of the ATRAC data-burst depends on the encoded bit rate (which determines the ATRAC-frame length).

NOTE The reference to the specification for the ATRAC bitstream, representing 512 samples of encoded audio per frame, may be found in the bibliography.

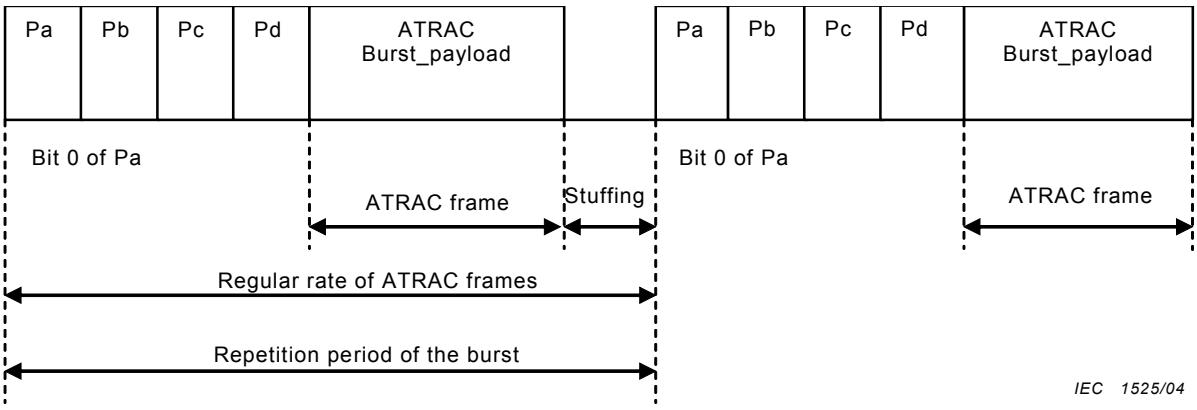

Figure 1 – ATRAC data-burst

The data-type-dependent information for ATRAC is given in Table 2.

Table 2 – Data-type-dependent information for data-type ATRAC

Bits of Pc LSB..MSB	Data type dependent, bit number LSB..MSB	Contents
8-12	00h – 1Fh	reserved, shall be set to '0'

The reference point of an ATRAC data-burst is bit 0 of Pa and shall occur exactly once every 512 sampling periods. The data-burst containing ATRAC frames shall occur at a regular rate, with the reference point of each ATRAC data-burst beginning 512 IEC 60958 frames after the reference point of the preceding ATRAC data-burst (of the same bit-stream-number).

NOTE 1 It is recommended that Pause data-bursts are used to fill stream gaps in the ATRAC bit stream as described in 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 ATRAC stream is filled by a sequence of Pause data-bursts, the Pa of the first Pause data-burst shall be located 512 sampling periods following the Pa of the previous ATRAC frame.

NOTE 2 It is recommended that the sequence(s) of Pause data-bursts which 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 ATRAC data-burst which follows the stream gap.

The gap-length parameter contained in the Pause data-burst is intended to be interpreted by the ATRAC decoder as an indication of the number of decoded PCM samples which are missing (due to the resulting audio gap).

5.2.2 Latency of ATRAC decoding

The latency of an external audio decoder to decode ATRAC is defined as the sum of the receiving delay time and the decoding delay time, as illustrated in Figure 2.

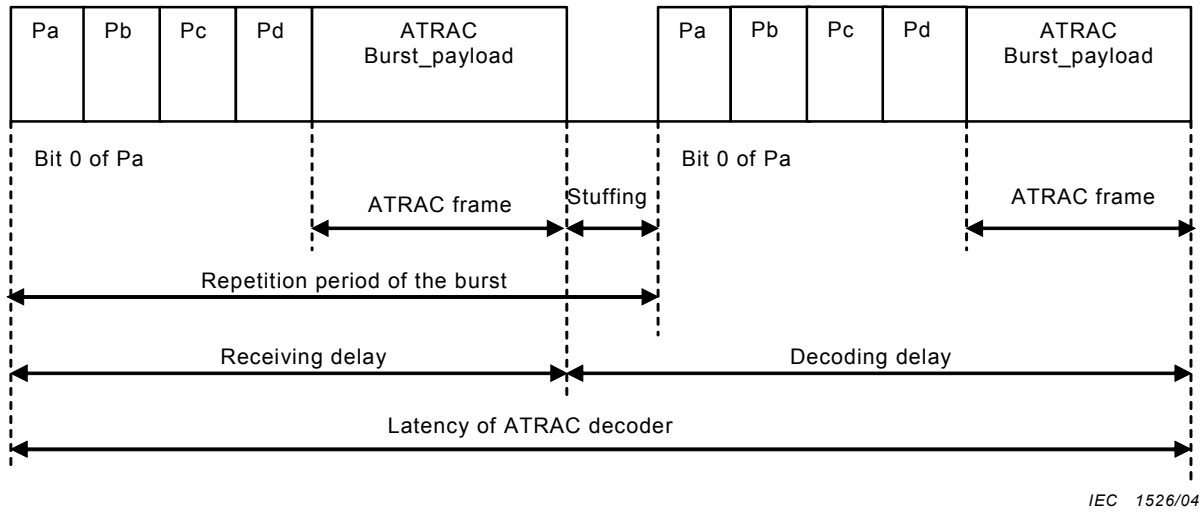

Figure 2 – Latency of ATRAC decoding

EXAMPLE The receiving delay time to receive a whole data-burst is calculated as follows. The length of preamble is 64 bits. If each ATRAC frame consists of 1 696 B (eight channels of 146,08 kbit/s per channel), the length of the whole data burst-payload is 13 568 bits. In this case, the whole length of the data burst is 13 632 bits. The receiving delay time is calculated as 9,66 ms with 44,1 kHz sampling frequency. The decoding delay time is calculated as 11,61 ms, and is equal to the decoding time for one ATRAC frame data. Hence, the latency of ATRAC decoding is approximately 21,27 ms in this case.

The absolute maximum decoding latency is taken when ATRAC burst-payload extends to just before the Pa of the next frame and is equal to 23,22 ms at 44,1 kHz sampling frequency.

5.2.3 The data ATRAC2/3

The ATRAC2/3 bitstream consists of sequences of ATRAC2/3 frames. The data-type of an ATRAC2/3 data-burst is 0Fh. The data-burst is headed with a burst-preamble, followed by the burst-payload, and stuffed with stuffing bits (see Figure 3). The burst-payload of each data-burst of ATRAC2/3 data shall contain one complete ATRAC2/3 frame, and represents 1 024 samples for each encoded channels. The length of the ATRAC2/3 data-burst depends on the encoded bit rate (which determines the ATRAC2/3-frame length).

NOTE The reference to the specification for the ATRAC2/3 bitstream, representing 1 024 samples of encoded audio per frame, may be found in the bibliography.

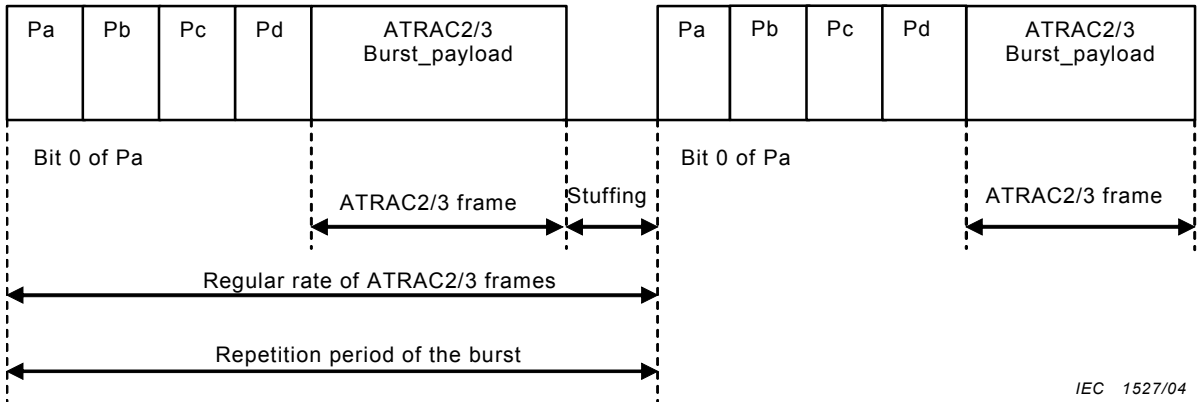

Figure 3 – ATRAC2/3 data-burst

The data-type-dependent information for ATRAC2/3 is given in Table 3.

Table 3 – Data-type-dependent information for data-type ATRAC2/3

Bits of Pc LSB..MSB	Data type dependent bit number LSB..MSB	Contents
8-12	00h	ATRAC2
	01h	ATRAC3
	02h-1Fh	reserved, shall be set to '0'

The reference point of an ATRAC2/3 data-burst is bit 0 of Pa and shall occur exactly once every 1 024 sampling periods. The data-burst containing ATRAC2/3 frames shall occur at a regular rate, with the reference point of each ATRAC2/3 data-burst beginning 1 024 IEC 60958 frames after the reference point of the preceding ATRAC2/3 data-burst (of the same bit-stream-number).

NOTE 1 It is recommended that Pause data-bursts are used to fill stream gaps in the ATRAC2/3 bit stream as described in 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 ATRAC2/3 stream is filled by a sequence of Pause data-bursts, the Pa of the first Pause data-burst shall be located 1 024 sampling periods following the Pa of the previous ATRAC2/3 frame.

NOTE 2 It is recommended that the sequence(s) of Pause data-bursts which 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 ATRAC2/3 data-burst which follows the stream gap.

The gap-length parameter contained in the Pause data-burst is intended to be interpreted by the ATRAC2/3 decoder as an indication of the number of decoded PCM samples which are missing (due to the resulting audio gap).

5.2.4 Latency of ATRAC2/3 decoding

The latency of an external audio decoder to decode ATRAC2/3 is defined as the sum of the receiving delay time and the decoding delay time (see Figure 4).

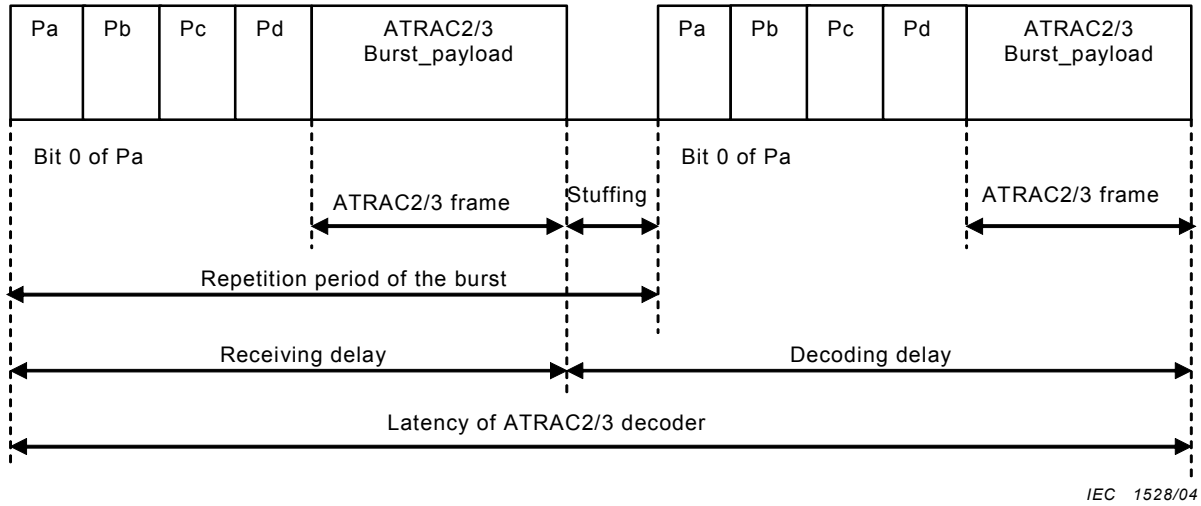

Figure 4 – Latency of ATRAC2/3 decoding

EXAMPLE The receiving delay time to receive a whole data-burst is calculated as follows. The length of preamble is 64 bits. If, for example, each ATRAC2/3 frame consists of 1 696 B (Eight channels of 73,04 kbit/s per channel), the length of the whole data burst-payload is 13 568 bits. In this case, the whole length of data burst is 13 632 bits. The receiving delay time is calculated as 9,66 ms with 44,1 kHz sampling frequency. The decoding delay time is calculated as 23,22 ms, and is equal to the decoding time for one ATRAC2/3 frame data. Hence, the latency of ATRAC2/3 decoding is approximately 32,88 ms in this case.

The absolute maximum decoding latency is taken when ATRAC2/3 burst-payload extends to just before the Pa of the next frame, and is equal to 46,44 ms at 44,1 kHz sampling frequency.

5.2.5 The data ATRAC-X

The ATRAC-X bitstream consists of sequences of ATRAC-X frames. The data-type of an ATRAC-X data-burst is 10 h. The data-burst is headed with a burst-preamble, followed by the burst-payload, and is stuffed with stuffing bits (see Figure 5). The burst-payload of each data-burst of ATRAC-X data shall contain one complete ATRAC-X frame, and represents 2 048 samples for each encoded channel. The length of the ATRAC-X data-burst depends on the encoded bit rate (which determines the ATRAC-X-frame length).

NOTE The reference to the specification for the ATRAC-X bitstream, representing 2 048 samples of encoded audio per frame, may be found in the bibliography.

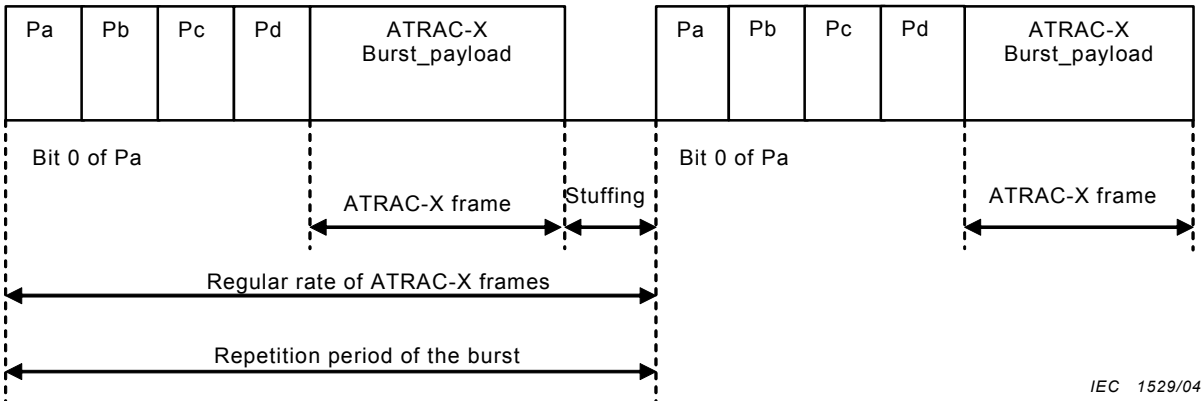

Figure 5 – ATRAC-X data-burst

The data-type-dependent information for ATRAC-X is given in Table 4.

Table 4 – Data-type-dependent information for data-type ATRAC-X

Bits of Pc LSB..MSB	Data type dependent, bit number LSB..MSB	Contents
8-12	00h – 1Fh	reserved, shall be set to '0'

The reference point of an ATRAC-X data-burst is bit 0 of Pa and shall occur exactly once every 2 048 sampling periods. The data-burst containing ATRAC-X frames shall occur at a regular rate, with the reference point of each ATRAC-X data-burst beginning 2 048 IEC 60958 frames after the reference point of the preceding ATRAC-X data-burst (of the same bit-stream-number).

NOTE 1 It is recommended that Pause data-bursts are used to fill stream gaps in the ATRAC-X bit stream as described in 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 ATRAC-X stream is filled by a sequence of Pause data-bursts, the Pa of the first Pause data-burst shall be located 2 048 sampling periods following the Pa of the previous ATRAC-X frame.

NOTE 2 It is recommended that the sequence(s) of Pause data-bursts which 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 ATRAC-X data-burst which follows the stream gap.

The gap-length parameter contained in the Pause data-burst is intended to be interpreted by the ATRAC-X decoder as an indication of the number of decoded PCM samples which are missing (due to the resulting audio gap).

5.2.6 Latency of ATRAC-X decoding

The latency of an external audio decoder to decode ATRAC-X is defined as the sum of the receiving delay time and the decoding delay time (see Figure 6).

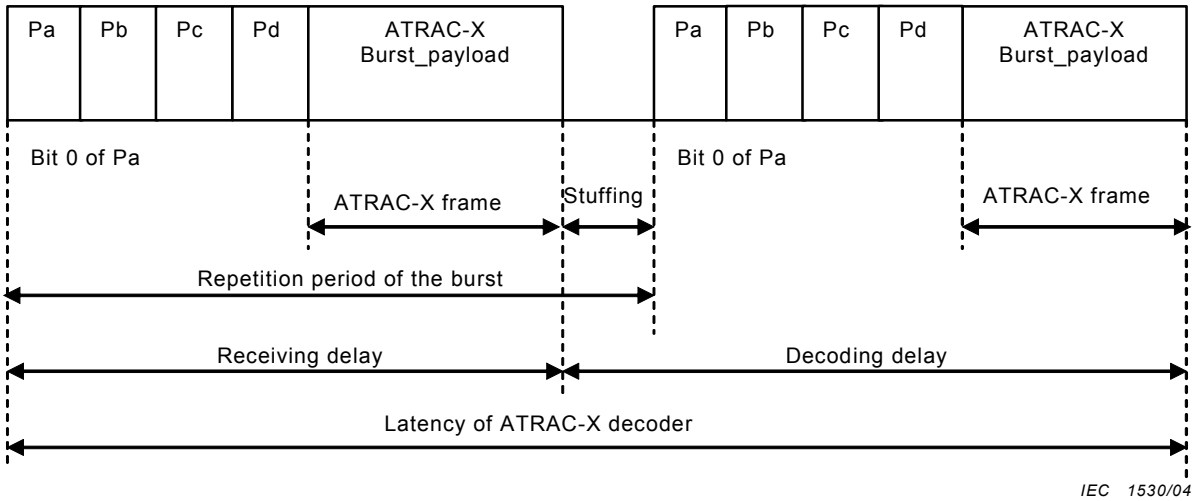

Figure 6 – Latency of ATRAC-X decoding

EXAMPLE The receiving delay time to receive a whole data-burst is calculated as follows. The length of preamble is 64 bits. If each ATRAC-X frame consists of maximum bit rate of 352,8 kbit/s, the maximum length of the whole data burst-payload is 16 384 bits. In this case, the whole length of the data burst is 16 448 bits. The receiving delay time is calculated as 11,66 ms with 44,1 kHz sampling frequency. The decoding delay time is calculated as 46,44 ms, and is equal to the decoding time for one ATRAC-X frame data. Hence, the latency of ATRAC-X decoding is approximately 58,10 ms in this case.

The absolute maximum decoding latency is taken when ATRAC-X burst-payload extends to just before the Pa of the next frame and is equal to 92,88 ms at 44,1 kHz sampling frequency.

Bibliography

The following documents have served as references for the specification of the related data-type and other parts of IEC 61937.

Data-type	Reference
ATRAC	IEC 61909, A*udio recording – Minidisc system*
ATRAC2	*MD Data System Description*, January 1995, Sony Corporation
ATRAC3	*Memory Stick Standard Audio File Format Specifications*, ver. 1.0, Chap. 6 ATRAC3, September 1999, Sony Corporation
ATRAC-X	*Memory Stick Standard Audio File Format Specifications*, ver. 2.1, Chap. 7 ATRAC-X, 2001, 2002, Sony Corporation

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