BS EN 61937-3:2009

BSI Standards Publication

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

Part 3: Non-linear PCM bitstreams according to the AC-3 and enhanced AC-3 formats

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National foreword

This British Standard is the UK implementation of EN 61937-3:2009. It is identical to IEC 61937-3:2007. It supersedes BS EN 61937-3:2003, which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee EPL/100, Audio, video and multimedia systems and equipment.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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English version

Digital audio - Interface for non-linear PCM encoded audio bitstreams applying IEC 60958 - Part 3: Non-linear PCM bitstreams according to the AC-3 and enhanced AC-3 formats

(IEC 61937-3:2007)

Audionumérique -
Interface pour les flux de bits audio
à codage MIC non linéaire
conformément à la CEI 60958 -
Partie 3: Flux de bits MIC non linéaire
conformément aux formats AC-3
et AC-3 amélioré
(CEI 61937-3:2007)

Digitalton -
Schnittstelle für nichtlinear-PCM-codierte
Audio-Bitströme unter Verwendung
von IEC 60958 -
Teil 3: Nichtlineare PCM-Bitströme
nach dem AC-3- und dem erweiterten
AC-3-Format
(IEC 61937-3:2007)

CENELEC

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Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

Central Secretariat: Avenue Marnix 17, B - 1000 Brussels

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Foreword

The text of document 100/1207/CDV, future edition 2 of IEC 61937-3, prepared by technical area 4, Digital system interfaces, of IEC TC 100, Audio, video and multimedia systems and equipment, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 61937-3 on 2009-07-01.

This European Standard supersedes EN 61937-3:2003.

EN 61937-3:2009 contains the following significant technical changes with respect to EN 61937-3:2003.

– the definition of the audio data-burst required to deliver enhanced AC-3 bitstreams has been added;

– the definition of the latency of an enhanced AC-3 decoder has been added;

– the use of pause data-bursts when delivering enhanced AC-3 bitstreams has been added.

The following dates were fixed:

– latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2010-04-01
– latest date by which the national standards conflicting with the EN have to be withdrawn	(dow)	2012-07-01

Annex ZA has been added by CENELEC.

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Endorsement notice

The text of the International Standard IEC 61937-3:2007 was approved by CENELEC as a European Standard without any modification.

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Annex ZA
(normative)

Normative references to international publications with their corresponding European publications

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.

NOTE When an international publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

Publication	Year	Title	EN/HD	Year
IEC 60958	Series	Digital audio interface	EN 60958	Series
IEC 61937-1	2007	Digital audio - Interface for non-linear PCM encoded audio bitstreams applying IEC 60958 - Part 1: General	EN 61937-1	2007
IEC 61937-2	2007	Digital audio - Interface for non-linear PCM encoded audio bitstreams applying IEC 60958 - Part 2: Burst-info	EN 61937-2	2007
ETSI TS 102 366	- [1)]	Digital Audio Compression (AC-3, Enhanced AC-3)	-	-
ATSC A/52B	- [1)]	Digital Audio Compression (AC-3, E-AC-3), Rev. B	-	-

[1)] Undated reference.

CONTENTS

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

Part 3: Non-linear PCM bitstreams according to the AC-3 and enhanced AC-3 formats

1 Scope

This part of IEC 61937 describes the method used to convey non-linear PCM bitstreams encoded according to the AC-3 and enhanced AC-3 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 (all parts), *Digital audio interface*

IEC 61937-1:2007, *Digital audio interface for non-linear PCM encoded audio bitstreams applying IEC 60958 – Part 1: General*

IEC 61937-2:2007, *Digital audio interface for non-linear PCM encoded audio bitstreams applying IEC 60958 – Part 2: Burst-info*

ATSC Standard A/52B, *Digital Audio Compression (AC-3, E-AC-3), Rev. B*

ETSI TS 102 366, *Digital Audio Compression (AC-3, Enhanced AC-3)*

3 Terms and definitions

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

3.1 Terms and definitions

3.1.1
latency
delay time of an external audio decoder to decode an AC-3 or enhanced AC-3 data burst, defined as the sum of two values of the receiving delay time and the decoding delay time.

3.1.2
stream type
an enhanced AC-3 bitstream is constructed from one or more substreams, with each substream being constructed from a sequence of frames. The stream type parameter of an enhanced AC-3 frame identifies the type of substream of which the frame is a part

3.1.3
substream identification
substream identification parameter of an enhanced AC-3 frame which, in conjunction with the stream type parameter, identifies the substream in the bitstream of which the enhanced AC-3 frame is a part

3.1.4
converter synchronization flag
flag used for synchronization by a device that converts an enhanced AC-3 bitstream to a bitstream compliant with an AC-3 decoder and indicates that the first block in this enhanced AC-3 frame will form the first block of the AC-3 frame output by the conversion process

3.1.5
block identification flag
if the stream type value of an enhanced AC-3 substream is two, indicating that the bitstream has been converted from an AC-3 bitstream, this bit is set to 1 to indicate that the first block in this enhanced AC-3 frame was the first block in the original standard AC-3 frame

3.2 Abbreviations

ATSC	Advanced Television Standards Committee
ETSI	European Telecommunication Standards Institute
IEC	International Electrotechnical Commission
ISO/IEC MPEG	Moving Pictures Expert Group, a joint committee of ISO and IEC

4 Mapping of the audio bitstream on to IEC 61937-1

4.1 General

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

4.2 AC-3 and enhanced AC-3 burst-info

The 16-bit burst-info contains information about the data which will be found in the data-burst (see Table 1).

Table 1 – Fields of burst-info

Data-type Value of Pc bits 0-4	Sub-data-type Value of Pc bits 5-6	Contents	Reference point R	Repetition period of data-burst measured in IEC 60958 frames
1	0	AC-3	R-AC-3	1 536
21	0	Enhanced AC-3	Bit 0 of Pa	6 144
	1-3	Reserved	Reserved	Reserved

5 Format of AC-3 and enhanced AC-3 data-bursts

5.1 General

This clause specifies the audio data-bursts AC-3 and enhanced AC-3. Specific properties such as reference points, repetition periods, the method of filling stream gaps, and decoding latency are specified.

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

5.2 Pause data-burst

Pause data-bursts for AC-3 and enhanced AC-3 are given in Table 2.

Table 2 – Repetition period of the pause data-bursts

Data-type of audio data-burst	Repetition period of pause data-burst	
	Mandatory	Recommended
AC-3	-	3 IEC 60958 frames
Enhanced AC-3	-	4 IEC 60958 frames

5.3 Audio data-bursts

5.3.1 AC-3 data

The AC-3 bitstream consists of a sequence of AC-3 frames. The data-type of an AC-3 data-burst is 1. An AC-3 frame represents 1 536 samples of each encoded audio channel (left, centre, etc.). The data-burst is headed with a burst-preamble followed by the burst-payload. The burst-payload of each data burst of AC-3 data shall contain one complete AC-3 frame. Figure 1 shows the structure of the AC-3 data-burst.

The length of the AC-3 data-burst will depend on the encoded bit rate (which determines the AC-3 frame length). The specification for the AC-3 bitstream may be found in ATSC Standard A52/B or in ETSI TS 102 366.

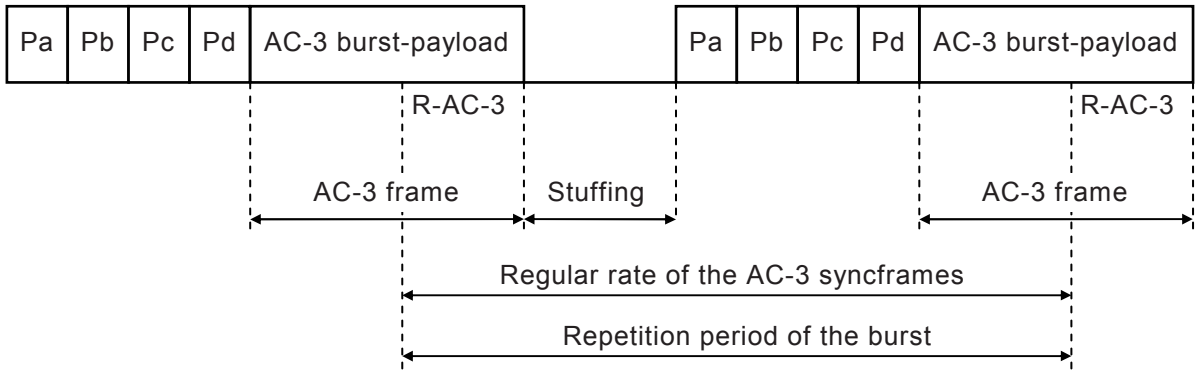

Figure 1 – AC-3 data-burst, with reference point R

The data-type-dependent info for AC-3 is given in Table 3.

Table 3 – Data-type-dependent information when data-type = 1

Bits of Pc LSB..MSB	Data type dependent, bit number LSB...MSB	Contents
8-10	0-2	Value of ‘bsmod’ parameter in AC-3 elementary stream
11, 12	3-4	Reserved

The data-bursts containing AC-3 frames shall occur at a regular rate, with the reference point of each AC-3 data-burst beginning (except in the case of a gap) 1 536 sampling periods of the audio after the reference point of the preceding AC-3 data burst (of the same bitstream number).

The reference point of an AC-3 data-burst (R-AC-3) is the IEC 60958 frame that occurs two-thirds of the way through the AC-3 payload. The definition of the two-thirds value is the closest integer to the value of the AC-3 frame size measured in 32-bit words multiplied by the value 2/3, or

$$2/3 \text{ frame size} = \text{int}\,(0{,}5 + (2/3) \times (\text{frame size in 32-bit words}))$$

5.3.2 Latency of AC-3 decoding

The latency of an AC-3 decoder which receives this signal is specified, with respect to the reference point of the AC-3 burst, to be equal to one AC-3 block time, which is equal to the time occupied by 256 PCM samples at the encoded sampling frequency (5,33 ms for 48 kHz sampling frequency; see Figure 2).

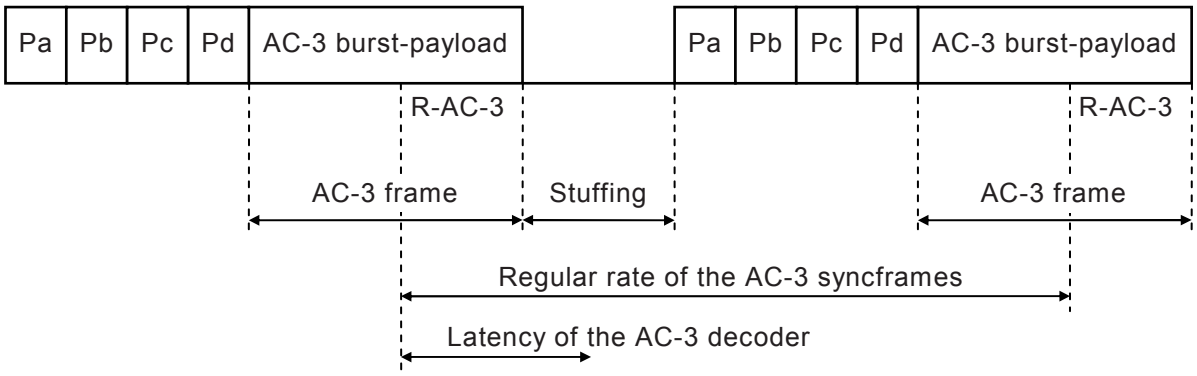

Figure 2 – Latency of AC-3 decoding

It is recommended that pause data-bursts be used to fill stream gaps in the AC-3 bitstream, as described in IEC 61937-1, and that pause data-bursts be transmitted with a repetition period of three IEC 60958 frames, except when other repetition periods are necessary to fill the precise stream gap length (which may not be a multiple of three IEC 60958 frames), or to meet the requirement on burst spacing (see IEC 61937-1, 6.3.3).

When a stream gap in an AC-3 stream is filled by a sequence of pause data-bursts, the Pa of the first pause data-burst shall be located one frame repetition period following the Pa of the previous AC-3 frame. 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 three IEC 60958 frame length of the pause data-burst) the Pa of the first AC-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 AC-3 decoder as an indication of the number of decoded PCM samples which are missing (due to the resulting audio gap). If the sizes of the AC-3 frames before and after the stream gap are not equal (due to a bitrate change in the interrupted AC-3 bitstream), this value may differ from the actual number of sampling periods of the audio contained in the stream gap due to the definition of the AC-3 burst reference points.

Some AC-3 decoders may be capable of “concealing” audio gaps. The indication of the audio gap length (gap-length) which may be included in the payload of the pause data-burst allows the decoder to know how long an audio gap will need to be concealed, and thus allow the decoder to optimize the concealment process for the actual audio gap length. AC-3 decoders will most easily conceal audio gaps that have a length equal to an integral multiple of 256

samples. Thus, audio gaps of lengths 256, 512, 768, etc. sampling periods of the audio are strongly preferred, and transmitters should provide stream gaps that represent audio gaps with this granularity.

It is possible that an audio gap in an AC-3 stream is carried over this interface without there also being a stream gap. This can happen when the audio gap length is small and there is a bit rate change in the interrupted AC-3 bit stream, and the bit rate following the gap is larger than the bit rate prior to the gap. Because of the definition of the reference point of the AC-3 data burst, it is possible for the Pa of the first burst following a bitstream interruption to be less than frame repetition period of the audio following the Pa of the burst preceding the gap, while the reference point of the first burst following the bit stream interruption is more than one frame repetition period of the audio after the reference point of the burst preceding the gap. When this case occurs, since there is no stream gap to fill with pause bursts, there is no need to send any pause bursts. The audio decoder will never be starved for data and can calculate the length of the audio gap based on the reference points of the received AC-3 bursts.

5.3.3 Enhanced AC-3 data

An enhanced AC-3 bitstream is constructed from one or more substreams, with each substream being constructed from a sequence of enhanced AC-3 frames. An enhanced AC-3 frame is constructed from blocks of audio data, each block representing 256 samples of audio of each encoded audio channel (left, centre, etc.). An enhanced AC-3 frame can consist of one, two, three, or six blocks of audio data. The number of blocks per enhanced AC-3 frame is the same for all substreams present in the bitstream and is constant for the duration of the bitstream.

The data-burst is headed with a burst-preamble, followed by the burst-payload. The data-type of an enhanced AC-3 data-burst is 21, and the sub-data-type is 0. When enhanced AC-3 data is being transmitted, the transmission device shall ensure that both the data-type and sub-data-type values are set correctly. Additionally, the receiving device shall utilize both the data-type and sub-data-type values to ensure that the content of the data-burst is correctly identified as enhanced AC-3. The structure of the enhanced AC-3 data-burst is shown in Figure 3.

The enhanced AC-3 burst-payload shall always contain six blocks of coded audio data, representing 1 536 samples of PCM audio, from each of the substreams present in the bitstream. The transmission device shall ensure that the enhanced AC-3 burst-payload is constructed only from complete enhanced AC-3 frames. It is prohibited to transmit a single enhanced AC-3 frame using multiple data-bursts.

The transmission device shall ensure that the first enhanced AC-3 frame in the burst-payload is the frame that has a stream type value of zero or two, and a substream identification value of zero. When the enhanced AC-3 bitstream is constructed from frames that consist of six blocks of audio data, one frame from each substream present in the bitstream shall be included in the burst-payload.

When the enhanced AC-3 bitstream is constructed from frames that consist of less than six blocks of audio, the transmission device shall ensure that the burst-payload contains the number of enhanced AC-3 frames required to deliver six blocks of audio data from each substream in the bitstream. For example, when the bitstream is constructed from frames that consist of two blocks of audio data, the burst-payload shall contain three enhanced AC-3 frames from each substream in the bitstream. Additionally, when the number of blocks per frame is less than six, the transmission device shall ensure that when the first substream in the bitstream has a stream type value of zero, the first frame in the burst-payload shall be the frame where the converter synchronization flag is set to one. When the first substream in the bitstream has a stream type value of two, the first frame in the burst-payload shall be the frame where the block identification flag is set to one.

The length of the enhanced AC-3 data-burst will depend on the encoded bit rate (which determines the enhanced AC-3 frame length). The specification for the enhanced AC-3 bitstream may be found in ATSC Standard A/52B or in ETSI TS 102 366.

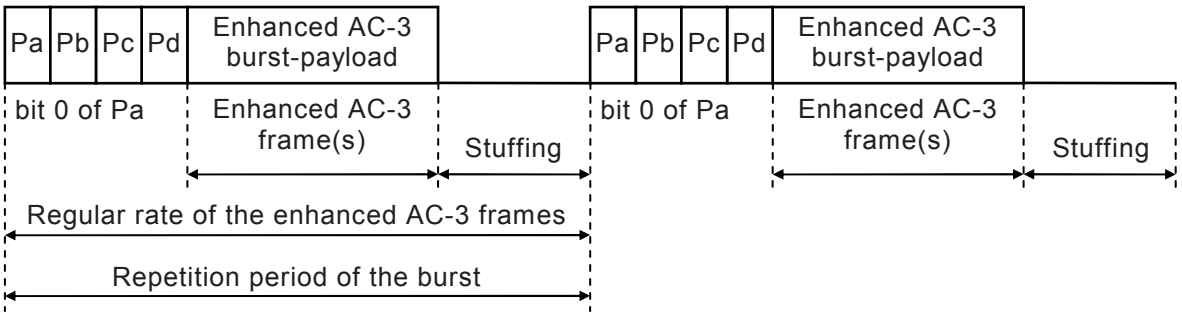

Figure 3 – Enhanced AC-3 data-burst

The units of **burst-length** shall be in bytes. The maximum size of an enhanced AC-3 burst-payload is 24 560 bytes.

The data-type-dependent information for enhanced AC-3 is given in Table 4.

Table 4 – Data-type-dependent information when data-type = 21

Bits of Pc LSB..MSB	Data type dependent, bit number LSB...MSB	Contents
8-10	0-2	Value of 'bsmod' parameter in independent substream 0 of the enhanced AC-3 elementary stream. If the 'bsmod' parameter is not present in the enhanced AC-3 elementary stream, these bits shall be set to '0'
11, 12	3-4	Reserved

The reference point of an enhanced AC-3 data-burst is bit 0 of Pa. The data-bursts containing enhanced AC-3 frames shall occur at a regular rate. When enhanced AC-3 streams are conveyed via the IEC 61937 interface, the IEC 60958 frame rate shall always be four times the sample rate of the enhanced AC-3 bitstream, and the repetition period of the enhanced AC-3 data-burst shall be 6 144 sample periods. Table 5 shows the relationship between the frame repetition period, the IEC 60958 frame rate, and the maximum available data rate for the enhanced AC-3 bitstream.

Table 5 – Frame repetition period and maximum data rate for enhanced AC-3 bitstreams

Frame repetition period	Encoded sample rate kHz	IEC 60958 frame rate kHz	Burst duration ms	Maximum data rate kbit/s
6 144	32	128	48	4 093
6 144	44,1	176,4	34,83	5 641
6 144	48	192	32	6 140

The maximum data rates in this table assume a provision for two IEC 60958 frames for padding between bursts.

5.3.4 Latency of the enhanced AC-3 decoder

The latency of an enhanced AC-3 decoder is defined as the sum of the receiving delay time and decoding delay time.

The receiving delay time is the time taken to receive the complete enhanced AC-3 burst-payload and is dependent on the encoded bitrate of the enhanced AC-3 bitstream. For the purposes of maintaining synchronization (for example, with video), it is recommended that a constant value of receiving delay time be assumed. This value is calculated on the basis of the maximum possible size of an enhanced AC-3 burst-payload and is equal to the time occupied by six 142 IEC 60958 frames at the IEC 60958 frame rate.

The decoding delay time is equal to the time occupied by one 792 PCM samples at the encoded sampling frequency or seven 168 IEC 60958 frames at the IEC 60958 frame rate. See Figure 4.

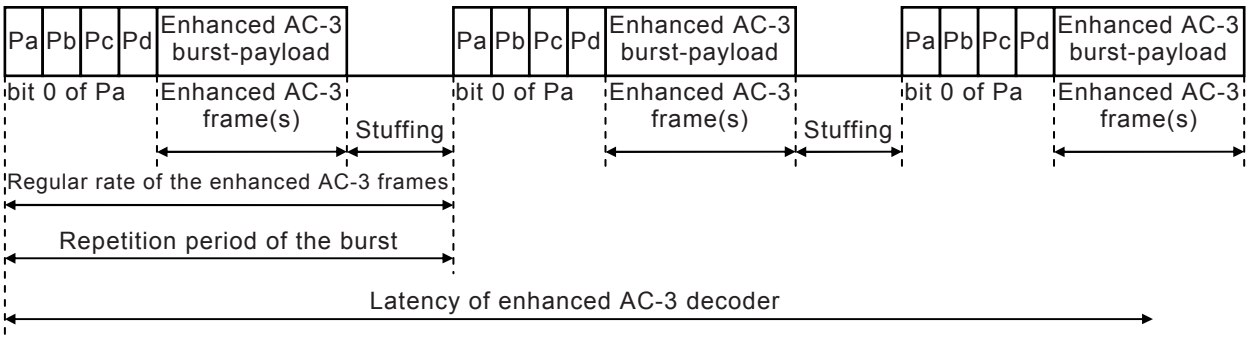

Figure 4 – Latency of enhanced AC-3 decoding

It is recommended that pause data-bursts be used to fill stream gaps in the enhanced AC-3 bitstream, as described in IEC 61937-1, and that pause data-bursts be transmitted with a repetition period of four IEC 60958 frames, except when other repetition periods are necessary to fill the precise stream gap length (which may not be a multiple of four IEC 60958 frames) or to meet the requirement on burst spacing (see IEC 61937-1, 6.3.3).

When a stream gap in an enhanced AC-3 stream is filled by a sequence of pause data-bursts, the Pa of the first pause data-burst shall be located one frame repetition period following the Pa of the previous enhanced AC-3 frame. 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 four IEC 60958 frame lengths of the pause data-burst) the Pa of the first enhanced AC-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 enhanced AC-3 decoder as an indication of the number of decoded PCM samples which are missing (due to the resulting audio gap). The gap length parameter indicates the gap length measured in IEC 60958 frames at the IEC 60958 clock rate. As the clock rate of the IEC 60958 interface is always four times the sampling rate of the coded audio stream when delivering enhanced AC-3 data, the value of the gap-length parameter is four times the number of PCM audio samples which would be missing in the decoded output signal.

If the sizes of the enhanced AC-3 frames before and after the stream gap are not equal (due to a bitrate change in the interrupted enhanced AC-3 bitstream), the number of audio sampling periods indicated by the gap-length parameter may differ from the actual number of sampling periods of the audio contained in the stream gap due to the definition of the enhanced AC-3 burst reference points.

Some enhanced AC-3 decoders may be capable of “concealing” audio gaps. The indication of the audio gap length (gap-length) which may be included in the payload of the pause data-burst allows the decoder to know how long an audio gap will need to be concealed and, thus, to optimize the concealment process for the actual audio gap length. Enhanced AC-3 decoders will most easily conceal audio gaps that have a length equal to an integral multiple of 256 decoded output samples. Thus, audio gap-length values of 1 024, 2 048, 3 072, etc. IEC 60958

frames are strongly preferred, and transmitters should provide stream gaps that represent audio gaps with this granularity.

It is possible that an audio gap in an enhanced AC-3 stream is carried over this interface without there also being a stream gap. This can happen when the audio gap length is small and there is a bit rate change in the interrupted enhanced AC-3 bit stream, and the bit rate following the gap is larger than the bit rate prior to the gap. Because of the definition of the reference point of the enhanced AC-3 data burst, it is possible for the Pa of the first burst following a bitstream interruption to be less than frame repetition period of the audio following the Pa of the burst preceding the gap, while the reference point of the first burst following the bitstream interruption is more than one frame repetition period of the audio after the reference point of the burst preceding the gap. When this case occurs, since there is no stream gap to fill with pause bursts, there is no need to send any pause bursts. The audio decoder will never be starved for data and can calculate the length of the audio gap based on the reference points of the received enhanced AC-3 bursts.

Bibliography

Technical Bulletin – Dolby® Digital Plus Transmission over the HDMI™ Interface has served as a reference for the specification of the related data-type and other parts of IEC 61937.

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