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INTERNATIONAL STANDARD

Digital audio – Interface for non-linear PCM encoded audio bitstreams applying IEC 60958 –
Part 9: Non-linear PCM bitstreams according to the MAT format

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IEC 61937-9

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International Standard IEC 61937-9 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 2007. This edition constitutes a technical revision.

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

a) addition of new frame rates.

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

CDV	Report on voting
100/2721/CDV	100/2933/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 parts in the IEC 61973 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- withdrawn,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.

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

Part 9: Non-linear PCM bitstreams according to the MAT format

1   Scope

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

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

IEC 61937-1:2007/AMD1:2011, *Digital audio interface for non-linear PCM encoded audio bit streams applying IEC 60958 – Part 1: General*

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

3   Terms, definitions and abbreviated terms

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
audio frame rate
number of MAT audio frames per second

3.2
fractional frame rates
fractional audio frame rates supported by MAT

Note 1 to entry: These frame rates are written in shorthand notation, as specified in Table 1.

**Table 1 – Shorthand notation for
fractional frame rates**

Fractional MAT audio frame rate (fps)	Shorthand version
$48 \times {}^{1\,000}/_{1\,001}$	47,952
$60 \times {}^{1\,000}/_{1\,001}$	59,94
$120 \times {}^{1\,000}/_{1\,001}$	119,88

**3.3
latency**
delay time of an external audio decoder to decode a MAT data-burst, defined as the sum of two values: the receiving delay time and the decoding delay time

3.4 Abbreviated terms

MAT   Metadata-enhanced Audio Transmission

fps   frames per second

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, IEC 61937-1:2007/AMD1:2011 and IEC 61937-2, including field names such as "Pc", "Pa" and "R".

4.2 MAT burst-info

The 16-bit burst-info contains information about the data that will be found in the data-burst (see Table 2).

Table 2 – Fields of burst-info

Bits of Pc	Data-type bits 0-4	Data-type bits 5-6	Contents	Reference point R	Repetition period of data-burst in IEC 60958 frames
0 – 6	1 – 21	According to IEC 61937			
	22	0	MAT	R-MAT	See Table 4
		1 – 3	According to IEC 61937		
	23 – 31	According to IEC 61937			
7 – 15	According to IEC 61937				

5 Format of MAT data-bursts

5.1 General

This clause specifies the audio data-burst MAT. Specific properties such as reference points, repetition period, the method of filling stream gaps, and decoding latency are specified.

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 synchronization between the picture and the decoded audio.

5.2 Pause data-burst

Pause data-burst for MAT is given in Table 3.

Table 3 – Repetition period of the pause data-bursts

Data-type bits 0-4 of audio data-burst	Repetition period of pause data-burst	
	Mandatory	Recommended
MAT	-	4 IEC 60958 frames

5.3 Audio data-bursts

5.3.1 The MAT data

The MAT bitstream consists of a sequence of MAT frames. The data-type bits 0-4 of a MAT data-burst is 22, and the data-type bits 5-6 is 0. When MAT data is being transmitted, the transmission device shall ensure that both the data-type bits 0-4 and data-type bits 5-6 values are set correctly. Additionally, the receiving device shall utilize both the data-type bits 0-4 and data-type bits 5-6 values to ensure that the content of the data-burst is correctly identified as MAT. The MAT data-burst is headed with a burst-preamble, followed by the burst-payload. The structure of the MAT data-burst is shown in Figure 1.
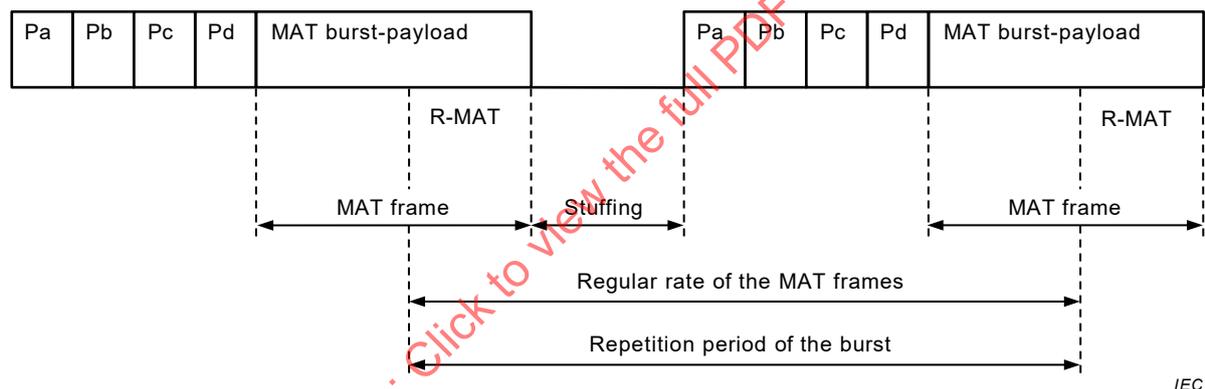

Figure 1 – MAT data-burst

The data-type-dependent information of bits 8-12 for MAT is given in Table 4.

Table 4 – Data-type-dependent information for MAT

Bits of Pc LSB..MSB	Bit 12 value	Bits 8 to 11 value	Repetition period of the data-burst
8 to 12	0	0	15 360 IEC 60958 frames
	1	See Table 8	As specified in Table 8

The MAT burst-payload shall always contain a single MAT frame. The transmission device shall ensure that the MAT burst-payload is constructed only from a single complete MAT frame. It is prohibited to transmit a single MAT frame using multiple data-bursts. The length of the MAT data-burst will depend on the encoded bit rate (which determines the MAT frame length).

Table 5 shows the relation between the sampling frequency of MAT-encoded audio and the IEC 60958 frame rate used to deliver MAT data via the IEC 61937 interface. The repetition

period of the MAT data-burst shall be defined by the sampling frequency and frame rate of the MAT bit stream.

Table 5 – Sampling frequency of MAT-encoded audio and IEC 60958 frame rate

MAT sampling frequency	IEC 60958 frame rate
48 kHz	768 kHz
96 kHz	
192 kHz	
44,1 kHz	705,6 kHz
88,2 kHz	
176,4 kHz	

At sampling frequencies of 48, 96 and 192 kHz, a MAT bitstream may be encoded at an audio frame rate that is aligned with one or more commonly-used video frame rates. Consequently, the transmission device shall ensure that the selected MAT data-burst repetition rate is equal to the duration of the MAT frame, as specified in Table 6.

Table 6 – MAT audio frame rate and corresponding data-burst repetition period for video-frame-aligned MAT bitstreams

MAT audio frame rate (fps)	MAT data-burst repetition period in IEC 60958 frames
47,952	16 016
48	16 000
50	15 360
59,94	12 800 / 12 816 (see Table 7)
60	12 800
100	7 680
119,88	6 400 / 6 416 (see Table 7)
120	6 400
187,5	4 096

For MAT audio frame rates of 59,94 and 119,88 fps, the duration of MAT audio frames in the bitstream is varied to ensure that, over a five frame sequence, precise time alignment is maintained with the accompanying video frames. Consequently, the repetition period of each MAT Data-burst$_{0..4}$ shall also vary to match the duration of each MAT frame in the five frame sequence, as specified in Table 7.

Table 7 – MAT data-burst sequence and repetition period variance to ensure MAT audio frame alignment at 59,94 and 119,88 fps

MAT audio frame rate (fps)	Repetition periods for MAT data-burst sequence in IEC 60958 frames				
	Data-burst$_0$	Data-burst$_1$	Data-burst$_2$	Data-burst$_3$	Data-burst$_4$
59,94	12 816	12 816	12 800	12 816	12 816
119,88	6 400	6 416	6 400	6 416	6 400

When transmitting a video-frame-aligned MAT bitstream, bit 12 of Pc shall be set to 1, and the value of bits 8 to 11 Pc shall indicate the repetition period of the MAT data-burst, as specified in Table 8.

**Table 8 – MAT data-burst: meaning of Pc bits 8 to 11
when bit 12 of Pc = 1**

Value (Pc bits 8 to 11)	Repetition period of the MAT data-burst in IEC 60958 frames	MAT audio frame rate (fps)
0 – 4	Reserved	
5	16 016	47,952
6	16 000	48
7	15 360	50
8	12 800 / 12 816 (see Table 7)	59,94
9	12 800	60
10	7 680	100
11	6 400 / 6 416 (see Table 7)	119,88
12	6 400	120
13	Reserved	
14	4 096	187,5
15	Reserved	

The reference point of a MAT data-burst (R-MAT) is the IEC 60958 frame that occurs half-way through the MAT burst-payload.

The units of burst-length shall be in bytes. The maximum size of a MAT burst payload is dependent on the repetition rate of the data-burst, and is specified in Table 9. The maximum burst-length values shown in Table 9 assume a provision for two IEC 60958 frames for padding between bursts.

**Table 9 – Maximum burst-length values per MAT data-burst
repetition period**

MAT sampling frequency	IEC 60958 frame rate	Repetition period of the MAT data-burst in IEC 60958 frames	Maximum burst-length of the MAT data-burst in bytes
48 / 96 / 192 kHz	768 kHz	16 016	64048
		16 000	63984
		15 360	61424
		12 800 / 12 816	51184 / 51248
		12 800	51184
		7 680	30704
		6 400 / 6 416	25584 / 25648
		6 400	25584
		32 768	16368
44.1 / 88.2 / 176.4 kHz	705,6 kHz	15 360	61424

5.3.2 Latency of the MAT decoder

The latency of a MAT decoder which receives this signal is specified, with respect to the reference point of the MAT data-burst, to be equal to the time occupied by 1/12 of a MAT frame (see Figure 2).
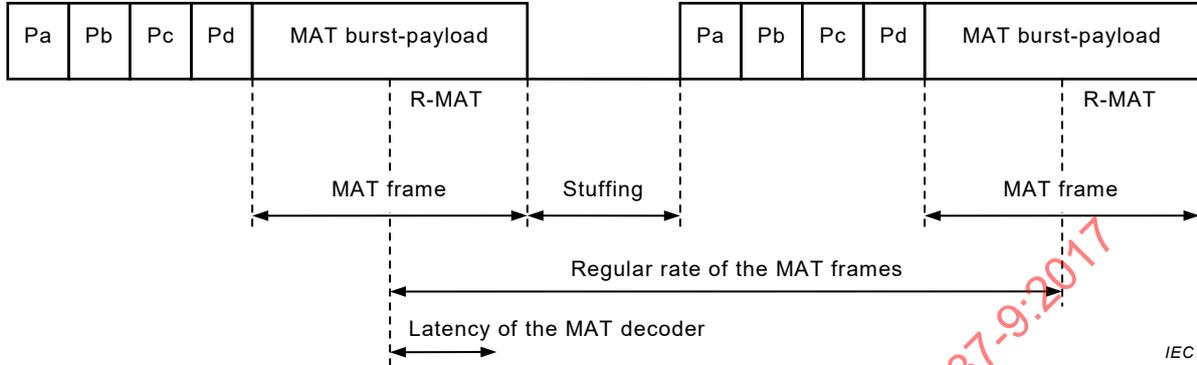

Figure 2 – Latency of MAT decoding

It is recommended that pause data-bursts be used to fill stream gaps in the MAT bitstream as described in IEC 61937-1, and that pause data-bursts be transmitted with a repetition period of 4 IEC 60958 frames, except when other repetition periods are necessary to fill the precise stream gap length (which may not be a multiple of 4 IEC 60958 frames), or to meet the requirement on burst spacing (refer to IEC 61937-1:2007, 6.3.3).

When a stream gap in a MAT 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 MAT frame. It is 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 4 IEC 60958 frame length of the pause data-burst) the Pa of the first MAT data-burst that follows the stream gap.

The gap length parameter contained in the pause data-burst is intended to be interpreted by the MAT 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 MAT frames before and after the stream gap are not equal (due to a bit rate change in the interrupted MAT 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 MAT data-burst reference points.