SMPTE ST 337:2015
Revision of
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SMPTE STANDARD

Format for Non-PCM Audio and Data in an AES3 Serial Digital Audio Interface

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Foreword

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SMPTE ST 337 was prepared by Technology Committee 32NF.

Intellectual Property

At the time of publication no notice had been received by SMPTE claiming patent rights essential to the implementation of this Engineering Document. However, attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. SMPTE shall not be held responsible for identifying any or all such patent rights.

Introduction

This section is entirely informative and does not form an integral part of this Engineering Document.

The AES3 standard is widely used in industry to convey linear PCM audio between digital audio devices. However the AES3 standard is limited to two channels of audio. Significant issues arise when multiple AES3 channels are used to convey greater than two channels of associated audio. This standard defines a method in which the existing AES3 format is modified to convey non-PCM data, including non-PCM audio bit streams which are typically, but not necessarily, bit-rate reduced. This allows a single audio program of more than 2 channels or multiple audio programs, each potentially consisting of more than 2 channels, to be carried over a single AES3 interface.

This standard specifies a modification to the logical portion of the AES3 standard and is compatible with the existing AES3 standard for transport of linear PCM audio. Therefore, this standard can facilitate the interconnection of equipment which may be capable of working with either linear PCM or non-PCM audio and data. This method may allow some existing equipment which is capable of recording linear PCM to also record non-PCM data. Independent use of the AES3 channels is also supported by this standard to allow both one channel of linear PCM audio and non-PCM data to be carried within a single AES3 signal.

This standard accommodates methods of synchronization both for reconstruction of the original source audio signals coded within non-PCM audio streams and for time alignment with other information streams such as an associated video stream. Synchronization methods for specific non-PCM bitstreams are dependent on the data type carried within the bitstream and are beyond the scope of this standard. However, other standards and recommended practices may contain important and necessary information regarding synchronization requirements for specific data types. In general, it is required to refer to such information in order to properly transmit and receive non-PCM streams using this standard. References to documents containing synchronization requirements for specific data types can be found in SMPTE ST 338.

Note: Because of the wide variety of data types that may potentially be conveyed according to this standard, no global synchronization requirements are specified in this standard. However, synchronization of non-PCM data content, both in terms of the relationship of the coded audio sampling rate to the AES3 frame frequency (when conveying non-PCM audio) and in terms of time synchronization to other information streams, is very important to the proper use of this standard. Additionally, synchronization requirements for specific data types may impose buffering requirements on devices that support these data types. Therefore, it is required that additional documents containing synchronization requirements for specific data types be referenced in order to maintain compatibility with these data types.

A dedicated data type, the time stamp data type, is included to support synchronization methods. Many data types may make use of information contained in the time stamp data bursts, which can include SMPTE ST 12-1 time code information, to maintain time synchronization with other information streams. References for documents describing the time stamp data type can be found in SMPTE ST 338.

This standard is applicable to professional audio equipment only. Existing standards (IEC 61937 family) cover transport of non-PCM data in the consumer environment. Some interoperability between professional and consumer equipment is accommodated by this standard, and specific compatibility requirements are described.

1 Scope

This standard specifies an interface format for the transport of non-PCM audio and data in professional applications using the AES3 serial digital audio interface. This standard includes both physical and logical specifications, based on the existing AES3 format, to allow exchange of non-PCM data between different devices. The standard accommodates multiple non-PCM audio and data formats and allows carriage of multiple data streams within a single interface. This standard provides means for carrying time code or time alignment information so that the information conveyed over this interface may be synchronized with information content delivered over other interfaces.

2 Conformance Notation

Normative text is text that describes elements of the design that are indispensable or contains the conformance language keywords: "shall", "should", or "may". Informative text is text that is potentially helpful to the user, but not indispensable, and can be removed, changed, or added editorially without affecting interoperability. Informative text does not contain any conformance keywords.

All text in this document is, by default, normative, except: the Introduction, any section explicitly labeled as "Informative" or individual paragraphs that start with "Note:"

The keywords "shall" and "shall not" indicate requirements strictly to be followed in order to conform to the document and from which no deviation is permitted.

The keywords, "should" and "should not" indicate that, among several possibilities, one is recommended as particularly suitable, without mentioning or excluding others; or that a certain course of action is preferred but not necessarily required; or that (in the negative form) a certain possibility or course of action is deprecated but not prohibited.

The keywords "may" and "need not" indicate courses of action permissible within the limits of the document.

The keyword “reserved” indicates a provision that is not defined at this time, shall not be used, and may be defined in the future. The keyword “forbidden” indicates “reserved” and in addition indicates that the provision will never be defined in the future.

Unless otherwise specified, the order of precedence of the types of normative information in this document shall be as follows: Normative prose shall be the authoritative definition; Tables shall be next; then formal languages; then figures; and then any other language forms.

3 Normative References

The following standards contain provisions which, through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent edition of the standards indicated below.

Note: In some parts of this standard, reference is made generically to “AES3”, rather than to a specific Part of the four-part AES Standard (AES3-1, AES3-2, AES3-3 and AES3-4). See the Normative References and Annex C Bibliography.

AES3-1-2009, AES Standard for Digital Audio — Digital Input-Output Interfacing — Serial Transmission Format for Two-Channel Linearly Represented Digital Audio Data — Part 1: Audio Content

AES3-2-2009, AES Standard for Digital Audio — Digital Input-Output Interfacing — Serial Transmission Format for Two-Channel Linearly Represented Digital Audio Data — Part 2: Metadata and Subcode

AES3-3-2009, AES Standard for Digital Audio — Digital Input-Output Interfacing — Serial Transmission Format for Two-Channel Linearly Represented Digital Audio Data — Part 3: Transport

SMPTE ST 338:2015, Format for Non-PCM Audio and Data in AES3 — Data Types

4 Definitions

This document defines certain bit-field values. When they are expressed in binary representation they are enclosed in single quote marks (thus: ‘ ’) and are stated with most-significant bit first (leftmost). e.g. ‘100’ represents decimal 4.

4.1 Frame Frequency

The frequency at which AES3 frames occur. When linear PCM audio is carried within the AES3 interface, the frame frequency is equivalent to the sampling rate of the linear PCM audio.

5 Overview

SMPTE ST 337 defines a method for transporting non-PCM audio (such as compressed formats) using the AES3 interface standard.

The logical format of the AES3 interface consists of a sequence of subframes. Each subframe is intended to convey one linear PCM sample, and contains 32 time slots, each of which (excluding the four time slots used for synchronization purposes) can carry a single bit of information. A pair of subframes, each containing the PCM word of one audio channel, make up an AES3 frame containing two PCM words, one from channel 1 and one from channel 2. A sequence of 192 frames makes up a block. The 192 channel status bits for each channel during a block make up the 192-bit (24-byte) channel status word for that channel. SMPTE ST 337 adapts the standard usage of the 32 AES3-3 subframe time slots when conveying non-PCM data. This usage shall be as shown in Table 1.

Table 1 – AES3-3 subframe bit field usage for non-PCM data

Bit locations	AES3-3 field designations	Non-PCM data usage
0 – 3	AES Sync preamble	As per AES3-3
4 – 7	Aux data field or 4 LSBs of audio sample word	Non-PCM data in 24-bit mode — see Section 7.2
8 – 27	Audio sample word	Non-PCM data
28	Validity (V) bit	As per AES3-1 and AES3-3
29	User data (U) bit	As per AES3-2 and AES3-3
30	Channel status (C) bit	Bytes 0, 1, 2, 23 defined; other bytes undefined — see Section 6.2
31	Parity (P) bit	As per AES3-3

The non-PCM data streams to be conveyed are formed into data bursts, each consisting of a preamble containing information about the burst followed by a data payload. The data bursts are placed in the audio sample word/aux data fields of AES3-3 subframes in one of two modes. In the frame mode, the data space from each subframe within an AES3-3 frame is combined to allow up to 48 bits of data to be placed in each frame. In the subframe mode, each channel is treated independently and data are not shared across subframes within a frame. In this mode, each subframe may contain either linear PCM audio or non-PCM data. This allows the AES3 interface to simultaneously convey two linear PCM channels, or one linear PCM channel and one set of non-PCM data bit streams, or two sets of non-PCM data bit streams.

Data bursts are tagged with a number indicating to which data stream they belong. Up to seven different non-PCM data streams, along with an additional stream type dedicated for time stamp data bursts, may be time multiplexed together to form a set of data bit streams. In the subframe mode, this allows up to 14 independent non-PCM data streams to be multiplexed within a single AES3 interface.

Data bursts are placed in the audio sample word/aux data fields of AES3-3 subframes using 16, 20, or 24 bits of the available space within each subframe. While the 24-bit mode allows more efficient use of the AES3 data capacity, the 16- and 20-bit modes might need to be used when interfacing with existing equipment that is limited to 16- or 20-bit operation. Annex B contains additional comments regarding the use of 20- and 24-bit data modes.

6 Interface Format

6.1 Detailed Specifications

The logical interface format shall be as defined in AES3-1, AES3-2, AES3-3 except as noted in this standard.

When in the subframe mode and one channel is used to convey linear PCM, the channel conveying linear PCM shall be used in accordance with AES3.

Non-PCM data shall be placed in the available AES3-3 data space in bursts as described in this standard. The non-PCM data shall occupy some or all of bit locations 4-27 of the AES3-3 subframe. Unused bit locations within a sub-frame or in subframes between bursts shall be set to ‘0’.

6.2 Channel Status Word

The Channel Status Word structure shall be as defined in AES3-2. For AES3 channels that convey non-PCM data, Channel Status byte 0, byte 1, byte 2, and byte 23 of the channel status word shall be used as described in this standard. The usage of the remaining bytes of the channel status word is undefined for channels that convey non-PCM data. It is recommended that each bit of the undefined channel status bytes be set to ‘0’.

Byte 0 bit 0 of the channel status word shall be set to ‘1’, indicating professional use of the channel status block. Consumer use of the AES3 bit stream is not considered in this standard.

Byte 0 bit 1 shall be set to ‘1’, indicating non-audio mode.

Byte 0 bits 2-4 shall be set to ‘000’.

Byte 0 bit 5 shall be set according to AES3-2, but shall indicate the source frame frequency lock status. The source frame frequency shall be interpreted as the source rate from which the AES3 interface frame rate is derived. This bit shall not necessarily be used to indicate that the source sampling rates of audio signals encoded within non-PCM audio streams in the AES3 signal are locked to the AES3 frame rate, although such use may be specified by certain data stream types.

Byte 0 bits 6-7 shall be set according to AES3-2, but shall indicate the frame frequency of the AES3 interface. These bits shall not necessarily be used to indicate the source sampling rate of audio signals encoded within non-PCM audio streams in the AES3 signal, although such use may be specified by certain data stream types. State '00' (interpreted as frame frequency not indicated) shall be allowed by this standard, but it is recommended that the actual frame frequency be indicated.

Table 2 provides a summary of the setting of byte 0 of the channel status word when conveying non-PCM data.

Table 2 – Channel status bits in byte 0

Bit(s)	Value	Comments
Bit 0	'1'	Professional use of channel status block
Bit 1	'1'	Non-audio mode
Bits 2-4	'000'	Emphasis not indicated
Bit 5	—	Frame frequency lock status
Bits 6, 7	—	Indicates frame frequency per AES3

Byte 1 bits 0-3 shall be set to '0000'. Byte 1 bits 4-7 shall be set according to AES3-2.

Table 3 summarizes the setting of byte 1 of the channel status word when conveying non-PCM data.

Table 3 – Channel status bits in byte 1

Bit(s)	Value	Comments
Bits 0-3	'0000'	Encoded channel mode not indicated
Bits 4-7	—	Encoded user bits management per AES3

Byte 2 bits 0-2 shall be set according to AES3-2 to indicate the auxiliary sample bit usage. In this context, audio sample word length shall refer to the non-PCM data word length (the number of bits used to convey non-PCM data) as defined by the data_mode parameter (see Section 7.2.4.3). When multiple non-PCM data streams are carried within the AES3 interface and multiple data_mode words exist, the data mode corresponding to the greatest non-PCM data word length shall be used.

Byte 2 bits 3-5 shall be set according to AES3-2, but shall indicate the non-PCM data word length (the number of bits used to convey non-PCM data) as defined by the data_mode parameter (see Section 7.2.4.3). In the case that multiple non-PCM data streams are carried within the AES3 interface and multiple data_mode words exist, the data mode corresponding to the largest non-PCM data word length shall be used. State 000 (interpreted as non-PCM data word length not indicated) shall be allowed by this standard, but it is recommended that the actual non-PCM data word length be indicated. Annex B contains additional comments regarding the use of these bits for the 20- and 24-bit data modes.

Byte 2 bits 6-7 shall be set to '00'.

Table 4 provides a summary of the setting of byte 2 of the channel status word when conveying non-PCM data.

Table 4 – Channel status bits in byte 2

Bit(s)	Value	Comments
Bits 0-2	—	Auxiliary sample bit usage per AES3-2
Bits 3-5	—	Non-PCM data word length per AES3-2
Bits 6, 7	‘00’	Reserved

Byte 23 bits 0-7 shall contain a valid CRCC value for the channel status block calculated according to AES3-2, the default state of 0x0 shall not be allowed.

This usage is summarized in Table 5.

Table 5 – Channel status bits in byte 23

Bit(s)	Value	Comments
Bits 0-7	—	CRCC word per AES3

6.3 Sample Rate Synchronization

This standard places no requirement on synchronization between the AES3 interface rate (frame frequency) and sample rates of the audio coded within non-PCM data streams. However, other standards or recommended practices may specify a fixed relationship between the AES3 interface and the coded audio sample rate for certain data types.

References to documents containing sample rate synchronization requirements for specific data types can be found in SMPTE ST 338 (see for instance Time Stamp data type).

7 Data Burst Format

7.1 General

The non-PCM data streams to be conveyed shall be formed into data bursts consisting of data words in a continuous sequence of AES3 frames. Each data burst shall consist of a burst_preamble followed by a burst_payload. When multiple streams are present, bursts from each stream shall be placed in the AES3 stream in a time-division multiplexed fashion.

7.2 burst_preamble

7.2.1 General

The burst_preamble shall occur at the beginning of each data burst and shall be followed by the burst_payload.

There are two forms of the burst_preamble:

A four subframe version which shall consist of words designated Pa to Pd in Table 6.

or

A six subframe version which shall consist of words designated Pa to Pf in Table 6.

The four subframe version only has a 5-bit capacity for defining the data_type of the payload (see Section 7.2.4.2) and the six subframe version was introduced to provide extended code points for additional data_type definitions. The six subframe version shall be used when data_type has the value 31; otherwise, the four subframe version shall be used.

The burst_preamble shall occupy 16, 20, or 24 bits in each of consecutive subframes in one of two modes — frame mode (see Section 7.2.2) or subframe mode (see Section 7.2.3). When placed into an AES3-3 subframe, the MSB of a preamble word shall be placed into time slot 27 of that subframe. The LSB of each preamble word shall be placed into time slot 12, 8, or 4 depending on the data mode. In the 16-bit mode, time slots 11 to 8 shall be set to 0 for each subframe containing a preamble word.

It is recommended that time slots 4 to 7 also be set to 0 when in the 16 bit mode. It is also recommended that time slots 4 to 7 of each subframe containing a preamble word be set to 0 in the 20 bit mode.

Table 6 – Preamble Words

Preamble word	Contents	
Pa	Sync word 1	= 0xF872 (16-bit mode) = 0x6F872 (20-bit mode) = 0x96F872 (24-bit mode)
Pb	Sync word 1	= 0x4E1F (16-bit mode) = 0x54E1F (20-bit mode) = 0xA54E1F (24-bit mode)
Pc	burst_info value	
Pd	length_code (unsigned integer), equal to the number of data bits in the burst_payload. When using a six subframe preamble, Pe and Pf shall be counted as payload bytes. This ensures compatibility with equipment that does not support six subframe operation.	
Pe	extended_data_type Values registered in SMPTE ST 338	Range is 0x0000 to 0xFFFF. In 20 bit and 24 bit modes, the higher-significance bits shall be set to zero.
Pf	Reserved	

7.2.2 Frame mode

Four subframe version:

The 4 preamble words shall be contained in 2 sequential frames. The frame beginning the data burst shall contain preamble word Pa in the Ch1 subframe, and Pb in the Ch2 subframe. The next frame shall contain Pc in Ch1 and Pd in Ch2.

Six subframe version:

The 6 preamble words shall be contained in 3 sequential frames. The frame beginning the data burst shall contain preamble word Pa in the Ch1 subframe, and Pb in the Ch2 subframe. The next frame shall contain Pc in Ch1 and Pd in Ch2. The next frame shall contain Pe in Ch1 and Pf in Ch2.

When using the six subframe version, preamble words Pe and Pf shall be counted as payload bytes. This ensures compatibility with equipment that does not support six subframe operation.

7.2.3 Subframe mode

Four subframe version:

The 4 preamble words shall be contained in 4 sequential subframes of the individual channel (Ch1 or Ch 2) being employed to convey the non-PCM data. The subframe of the channel being used at the beginning the data burst shall contain preamble word Pa, the next subframe of the channel being used for the burst shall contain Pb, etc.

Six subframe version:

The 6 preamble words shall be contained in 6 sequential subframes of the individual channel (Ch1 or Ch 2) being employed to convey the non-PCM data. The subframe of the channel being used at the beginning the data burst shall contain preamble word Pa, the next subframe of the channel being used for the burst shall contain Pb, etc.

When using the six subframe version, preamble words Pe and Pf shall be counted as payload bytes. This ensures compatibility with equipment that does not support six subframe operation.

7.2.4 burst_info

7.2.4.1 General

The burst_info value shall contain information about the contents of the burst_payload as specified in Table 7. See Annex B for additional information regarding the use of the 20- and 24-bit data modes. Bit 15, bit 19, or bit 23 of the burst_info word shall be considered the MSB depending on the data mode (16, 20, or 24 bit). The burst_info MSB shall be located in time slot 27 of an AES3-3 subframe.

Table 7 – burst_info

Bit(s)			Value
24-bit mode	20-bit mode	16-bit mode	
0-3	—	—	Reserved
4-7	0-3	—	Reserved
8-12	4-8	0-4	data_type (5-bit unsigned integer = 0 to 31)
13-14	9-10	5-6	data_mode
15	11	7	error_flag 1 indicates data burst may contain errors 0 indicates data may be valid.
16-20	12-16	8-12	data_type_dependent
21-23	17-19	13-15	data_stream_number

7.2.4.2 data_type

The 5-bit data_type field shall indicate the type of data contained in the burst_payload. The MSB of the data_type field shall be placed in bit 4, 8, or 12 of the burst_info word depending on the data mode. The data_type MSB shall be located in time slot 16 of an AES3-3 subframe.

Data_type values shall apply to individual data bursts only. The data type may vary between differing stream numbers when multiple data streams are carried within the AES3 interface.

Supported data types and the mapping of data_type values to specific data types shall be as defined in SMPTE ST 338. Additional standards may contain specific data type dependent formatting requirements. References to documents containing formatting requirements for specific data types can be found in SMPTE ST 338.

7.2.4.3 data_mode

The 2-bit data_mode field shall indicate the mode in which the data for the burst_payload is placed in AES3-3 subframes as specified in Table 8. The MSB of the data_mode field shall be placed in bit 6, 10, or 14 of the burst_info word depending on the data mode. The data_mode MSB shall be located in time slot 18 of an AES3-3 subframe.

In each data mode, the burst_payload data words shall occupy the subframe time slots as indicated in Table 8. See Annex B for additional information regarding the use of the 20- and 24-bit data modes. In the 16- and 20-bit modes, unused time slots shall contain the value 0.

Data-mode values shall apply to individual data bursts only. The data mode may vary between consecutive data bursts of a given data_stream_number, or between data bursts of differing stream numbers when multiple data streams are carried within the AES3 interface.

Table 8 data_mode

Value	Data mode	burst_payload position
0	16-bit mode	Subframe time slots 27-12
1	20-bit mode	Subframe time slots 27-8
2	24-bit mode	Subframe time slots 27-4
3	Reserved	N/A

7.2.4.4 error_flag

The error_ flag bit shall provide an error indication for the data in the burst_payload. If the data in the burst_payload is known to be error free or if it is unknown whether the data contains errors, then the value of this bit shall be set to a ‘0’. If the data in the burst_payload is known to contain errors, this bit may be set to a ‘1’. The error_flag bit shall be located in time slot 19 of an AES3-3 subframe.

7.2.4.5 data_type_dependent

The data_type_dependent field shall contain 5 bits whose meaning is dependent on the value of data_type. Specific coding for this field may be found in other standards or recommended practices applying to specific data types. References to documents containing descriptions of this field for specific data types can be found in SMPTE ST 338.

7.2.4.6 data_stream_number

The 3-bit data_stream_number shall indicate the number of the data stream to which the burst belongs. The MSB of the 3-bit data_stream_number shall be placed in bit 15, 19, or 23 of the burst_info word depending on the data mode. The data_stream_number MSB shall be located in time slot 27 of an AES3-3 subframe.

At least one bit stream having data_stream_number = 0 shall be present. This bit stream shall contain coded audio information considered to be a main audio service.

Each independent data stream shall use a unique value for data_stream_number. Eight data stream numbers (0-7) are available. Data stream number 7 is reserved for the time stamp data type. All time stamp data bursts shall be encoded with a data_stream_number set to 7. Data stream numbers 0-6 are available for all data types except the time stamp data type. Therefore, up to 7 independent data streams may be time multiplexed in the AES3 interface when in the frame mode. In the subframe mode, each AES3 channel shall be treated independently and the requirement for unique data stream numbers for each data stream shall apply only within a given AES3 channel. In this mode, up to 14 independent data streams (7 in each channel) may be time multiplexed in the AES3 interface.

Individual time stamp data bursts apply to specific data bursts of other data types. Although all time stamp data bursts are identified as data stream number 7, they should not be considered as a single stream of related time stamp values. When time code information is carried within time code data bursts, multiple time code streams may be conveyed within data bursts identified as data stream number 7. References to documents containing information about the time stamp data type can be found in SMPTE ST 338.

7.2.5 length_code

The length_code shall indicate the length of the burst_payload in bits. The length_code shall occupy 16, 20, or 24 bits of an AES3-3 subframe depending on the data mode. The length_code MSB shall always be located in time slot 27 of an AES3-3 subframe.

The burst_ payload field is limited in size based on the data mode: from 0 to 65,535 bits in the 16-bit mode, from 0 to 1,048,575 bits in the 20-bit mode, and from 0 to 16,777,215 bits in the 24-bit mode. The size of the burst_preamble words Pa - Pd shall not be counted in the value of length_code.

7.3 burst_payload

The burst_payload shall be segmented into data words and placed in a continuous sequence of AES3-3 frames in one of two modes:

7.3.1 Frame mode

In the frame mode, both AES3 channels shall be utilized to carry one set of non-PCM data streams. The available data space from each subframe within an AES3-3 frame shall be combined when packing data bursts into a continuous sequence of frames. This mode will allow up to 32, 40, or 48 data bits to be placed in a single AES3-3 frame depending on the data_mode setting in the burst_preamble.

Considering the burst_payload as a serial stream of bits, the first bit of the first data word of the payload in a burst shall occupy the MSB bit position of subframe 1 (time slot 27) and the last bit of the first data word shall occupy the LSB bit position (according to the data_mode setting) of subframe 2. The last data bits of the burst_payload may occupy only a fraction of the last frame. Any unused bits in the last frame shall be set to 0.

7.3.2 Subframe mode

In the subframe mode, each AES3 channel shall be utilized independently to carry either one set of non-PCM data streams or linear PCM audio. The subframe from each AES3 channel within a frame shall be considered independently when packing data bursts into a continuous sequence of frames. This mode will allow up to 16, 20, or 24 data bits per channel to be placed in a single AES3-3 frame depending on the data_mode setting in the burst_preamble.

Considering the burst_payload as a serial stream of bits, the first bit of the first data word of the payload in a burst shall occupy the MSB bit position of the subframe (time slot 27) and the last bit of the first data word shall occupy the LSB bit position (according to the data_mode setting) of the subframe. The last data bits of the burst_payload may occupy only a fraction of the last frame. Any unused bits in the last frame shall be set to '0'.

The channel status words for each channel shall be treated independently when in the subframe mode. Any channel conveying non-PCM data shall set the channel status bits according to this standard. Any channels conveying linear PCM audio shall set the channel status bits according to AES3-2.

7.4 Burst Spacing

There shall not be a sequence of 4096 or more AES3 frames (in frame mode) or subframes (in subframe mode) which contain at least one data burst, without the beginning of at least one of the data bursts preceded by four AES3-3 subframes which have subframe contents in time slots 8-27 of all 0s. This requirement ensures that there are occurrences of an extended sync code of 0, 0, 0, 0, Pa, Pb (in the case of 16-bit mode this is 0x0000, 0x0000, 0x0000, 0x0000, 0xF872, 0x4E1F).

Data bursts from a given non-PCM data stream shall be placed in the AES3 interface in consecutive order. If multiple non-PCM data streams are placed in the AES3 interface (or in an individual channel in the subframe mode), the data bursts from each stream shall be interleaved in a time multiplexed manner. This standard places no other requirements on the multiplexing method as long as the above requirements are met for each stream. Other standards or recommended practices may define specific multiplexing techniques which may be data type dependent.

This standard makes no requirement for placing data bursts at fixed intervals or locations within the AES3 stream, although such features may be made use of for conveying synchronization information. Other standards or recommended practices may specify data type dependent fixed reference locations and repetition rates for such purposes. References to documents containing burst spacing requirements for specific data types can be found in SMPTE ST 338. The time_stamp data type may also be used for conveying specific synchronization information for some data types. These synchronization methods may place requirements on burst spacing.

7.5 Data Type Dependent Fields

The format of data contained within the data_type_specific and burst_payload fields is dependent on the data_type field and is beyond the scope of this standard. Specific coding for these fields may be found in other standards or recommended practices applying to specific data types. References to documents containing formatting information on these fields for specific data types can be found in SMPTE ST 338.

8 Consumer Format Compatibility (Informative)

8.1 General

This standard applies to professional equipment. Some users in a professional environment might wish to have compatibility with consumer devices. For explicit compatibility with consumer devices, professional equipment can implement interfaces or specific interface modes conforming to the consumer format specification IEC 61937. However, it might be desired for some professional equipment to be compatible at the level of bit stream formatting while still utilizing the AES3 interface in the professional mode. This section lists specific compatibility issues to consider in terms of bit stream formatting.

8.2 Receiving Devices

The consumer bit stream format can, in general, be considered a subset of the professional bit stream format defined by this standard. Professional devices implementing this standard are expected to be capable of reading consumer burst preambles and properly extracting consumer data bursts carried in the AES3 interface. This does not guarantee professional receivers can properly receive and decode all data types. Some consumer data types may be undefined by this standard. In practice, professional receivers discard any data bursts containing undefined data types. Refer to Section 7.4 for additional data type dependent compatibility issues.

8.3 Source Devices

In order for professional devices to produce AES3 output bit streams compatible with the consumer format, data bursts are formatted in the following manner:

When consumer format compatibility is required, all data bursts are restricted to the 16-bit frame mode (data_mode=0, both AES3-3 subframes used).

Consumer devices might not be capable of receiving bit streams with data stream numbers greater than 0.

Some professional data types defined by this standard might be undefined in the consumer format. Consumer devices can be anticipated, but not guaranteed, to ignore these data types.

Consumer devices might be capable of reading burst preambles and properly extracting data bursts formatted according to the above. This does not guarantee consumer receivers can properly receive and decode all data types. Professional devices need to also take into account consumer synchronization requirements for certain data types which might affect the ability of consumer devices to receive and decode the encoded data. Refer to Section 7.4 for data type dependent compatibility issues. In addition, many consumer receivers rely on channel status information for detection of non-PCM coded data. Consumer receivers might not be capable of detecting bit streams in AES3 signals where the channel status is set according to this standard.

8.4 Data Type Dependent Issues

For data types that are common to both professional and consumer specifications, specific data type dependent issues might still affect bit stream compatibility between professional and consumer devices. For some data types, the data_type_dependent field might differ between professional and consumer specifications. Such differences might prohibit proper exchange of coded data and/or synchronization information. The coding of the burst_payload might also differ for some data types. In addition, synchronization methods required by the consumer format for some data types might place restrictions on data burst spacing which, in some cases, might differ from the allowed professional formats. Data type specific formatting issues are not addressed in this standard. Compatibility with specific data types might be addressed by other standards and recommended practices. References to documents containing formatting requirements for specific data types can be found in SMPTE ST 338.

Annex A Auto-Detection of Audio / Data Mode (Informative)

The AES3 interface can convey PCM audio, non-PCM data, or both in separate channels. Receiving devices capable of receiving AES3 streams containing PCM and non-PCM data may wish to know whether the AES3 information is to be considered PCM audio, non-PCM data, or both. This information is best conveyed by setting bit 1 of the channel status word to indicate data. In some applications, it may be useful for receivers to be able to determine whether the AES3 contents are PCM audio or non-PCM data, without referring to bit 1 of the channel status word. This can be done quite reliably by recognizing that the sync code formed by the first two words of the preamble (Pa, Pb) are unlikely to occur very often in natural PCM audio. By looking for an extended sync code consisting of six words (4 zeros followed by Pa, Pb which, in the case of the 16-bit mode is 0x0000, 0x0000, 0x0000, 0x0000, 0xF872, 0x4E1F), the probability of a false occurrence of sync will be vanishingly small. The decision process which can be followed is shown in Figure A.1. In this diagram, the mode of the receiver can be switched between PCM and DATA. The SYNC function is meant to indicate whether, in a span of 4096 AES3 frames, the extended sync code is found. Note that if the AES3 stream goes idle (all zeros), the auto-detector will go into PCM mode, and only switch back to DATA mode when a data burst appears. If this behavior is undesirable, it can be prevented by inserting null data bursts at least once every 4096 AES3 frames.

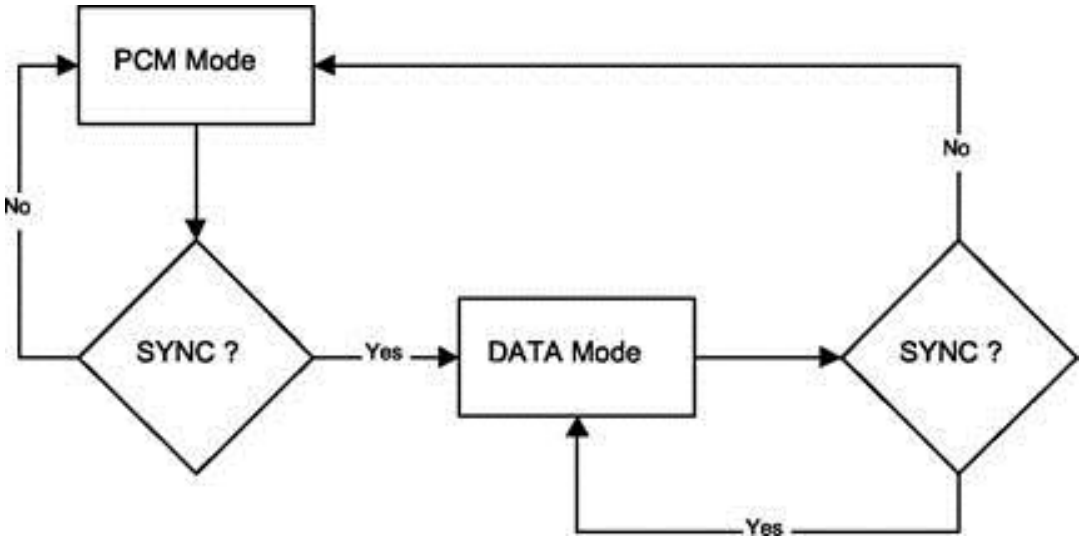

Figure A.1 – PCM-DATA auto-detection

Annex B Equipment Compatibility Issues (Informative)

B.1 Data Mode

This standard defines 20- and 24-bit data modes so that efficient use can be made of the available data space in the AES3 interface, as these are commonly supported modes in professional equipment. Some digital audio devices restrict their operation to 16 bit mode only. Such devices may truncate 20- or 24-bit data words to 16 bits. Other devices may accommodate 20-bit data words, but not 24 bits. It is recommended that users consider whether such devices may be possible receivers of non-PCM data signals when determining data modes. In general, it is recommended that the 16-bit data mode be used in cases where the extra data bandwidth of the 20- and 24-bit modes is not needed. Data generators might wish to provide user control of the data modes used.

Users should also be aware that some existing devices make use of the channel status bits for encoded audio word length to determine stored/transmitted data word sizes. If the 20- or 24-bit modes are used, it is recommended to set the encoded audio word length channel status bits according to the data mode as described in Section 6.2. Use of the default audio word length setting may result in improper truncation of the non-PCM data words. Receiving devices, when receiving non-PCM data, should determine the data mode directly from the data_mode field in the data burst preamble rather than from the encoded audio word length channel status bits.

B.2 Channel Status Usage

Some existing digital audio devices do not store or transmit the channel status information that is present on received digital audio inputs. Other existing devices might only store a limited amount of channel status information. Such devices, while not strictly compatible with this standard, still may be useful for conveying non-PCM information formatted according to this standard. For this reason, it is recommended that receiving devices not rely on channel status fields as the sole source of information as to whether non-PCM data are present and for determining non-PCM format information such as data mode. For example, the non-audio channel status bit (bit 1) may be used as the primary means of determining the presence of non-PCM data, but an auto-detection technique, such as that described in Annex A, might also be used to confirm the channel status indication. This may allow proper reception of non-PCM data output from non-compliant devices.

B.3 Non-PCM Data Modification

Whenever possible, receiving devices should take into account the fact that non-PCM data words present in input signals may have become modified or corrupted in several ways, especially if devices not strictly compliant with this standard are involved in the storage and/or transmission of the signal. Possible modifications include truncation of 20 and 24-bit non-PCM data words to 16 or 20 bits, momentary disruptions in the bit stream due to signal switching or synchronization devices, errors propagated from storage devices or transmission links, and other forms of PCM type processing performed by equipment not compliant with this standard (dithering, gain changes, sample rate conversion, effects processing, etc.). No specific capability for detection of these kinds of bit stream modifications is provided by this standard; however, certain encoded data types may provide such capability (CRC, checksums, parity, etc.). It is recommended that receiving devices make use of these detection features to provide operator feedback.

Annex C Bibliography (Informative)

SMPTE ST 12-1:2014, Time and Control Code

AES3-4-2009, AES Standard for Digital Audio — Digital Input-Output Interfacing — Serial Transmission Format for Two-Channel Linearly Represented Digital Audio Data — Part 4: Physical and Electrical

IEC 61937-1 Edition 2.1 2011-12, Digital Audio — Interface for Non-Linear PCM Encoded Audio Bitstreams Applying IEC 60958 — Part 1: General

IEC 61937-2 Edition 2.1 2011-12, Digital Audio — Interface for Non-Linear PCM Encoded Audio Bitstreams Applying IEC 60958 — Part 2: Burst-nfo

Additional Parts of IEC 61937 define characteristics of specific data types.