IEC 60958-1

Edition 4.0 2021-09
REDLINE VERSION

INTERNATIONAL STANDARD

colour inside

Digital audio interface –
Part 1: General

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DIGITAL AUDIO INTERFACE –

Part 1: General

FOREWORD

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This redline version of the official IEC Standard allows the user to identify the changes made to the previous edition IEC 60958-1:2008+AMD1:2014 CSV. A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text.

IEC 60958-1 has been prepared by technical area 20: Analogue and digital audio, of IEC technical committee 100: Audio, video and multimedia systems and equipment. It is an International Standard.

This fourth edition cancels and replaces the third edition published in 2008, and Amendment 1:2014. This edition constitutes a technical revision.

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

a) The relevant part of IEC 60958-5 is supported.

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

Draft	Report on voting
100/3544/CDV	100/3593/RVC

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

The language used for the development of this International Standard is English.

A list of all parts of the IEC 60958 series, under the general title *Digital audio interface*, can be found on the IEC website.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under 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- withdrawn,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.

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~~INTRODUCTION to Amendment 1~~

~~The revision of IEC 60958-1:2008 has become necessary in order to revise Annexes B and C, and the Bibliography. Additional information for the use of the IEC 60958 conformant data format has also been included.~~

DIGITAL AUDIO INTERFACE –

Part 1: General

1 Scope

This part of IEC 60958 describes a serial, uni-directional, self-clocking interface for the interconnection of digital audio equipment for consumer and professional applications.

It provides the basic structure of the interface. Separate documents define items specific to particular applications.

The interface is primarily intended to carry monophonic or stereophonic programmes, encoded using linear PCM and with a resolution of up to 24 bits per sample.

When used for other purposes, the interface is able to carry audio data coded other than as linear PCM coded audio samples. Provision is also made to allow the interface to carry data related to computer software, multimedia technologies, or signals coded using non-linear PCM. The format specification for these applications is not part of this document.

The interface is intended for operation at audio sampling frequencies of 32 kHz and above. Auxiliary information is transmitted along with the programme.

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 60268-11:1987, *Sound system equipment – Part 11: Application of connectors for the interconnection of sound system components*

~~IEC 60874-17, *Connectors for optical fibres and cables – Part 17: Sectional specification for fibre optic connector – Type F-05 (friction lock)*~~

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

IEC 60958-4 (all parts), *Digital audio interface – Part 4: Professional applications*

IEC 60958-5, *Digital audio interface – Part 5: Consumer application enhancement*

3 Terms and definitions

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

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

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

3.1
sampling frequency
frequency of the samples representing an audio signal

Note 1 to entry: When more than one signal is transmitted through the same interface, the sampling frequencies are identical.

3.2
audio sample word
value of a digital audio sample; representation is linear in 2's complement binary form

Note 1 to entry: Positive numbers correspond to positive analogue voltages at the input of the analogue-to-digital converter (ADC).

3.3
auxiliary sample bit
four least significant bits (LSBs) which can be assigned as auxiliary sample bits and used for auxiliary information when the number of audio sample bits in the main data field is less than or equal to 20

3.4
validity bit
bit indicating whether the main data field bits in the sub-frame (time slots 4 to 27 or 8 to 27, depending on the audio word length as described in 4.1.1) are reliable or not

3.5
channel status
~~the channel status carries~~ data carrying, in a fixed format, information associated with each main data field channel which is decodable by any interface user

Note 1 to entry: Examples of information to be carried in the channel status are: length of audio sample words, pre-emphasis, sampling frequency, time codes, alphanumeric source and destination codes.

3.6
user data
~~the user~~ data ~~channel is~~ provided to carry any other information

3.7
parity bit
bit provided to permit the detection of an odd number of errors resulting from malfunctions in the interface

3.8
preamble
specific patterns used for synchronization

Note 1 to entry: There are three different preambles (see 4.3).

3.9
sub-frame
fixed structure used to carry information (see 4.1.1 and 4.1.2)

3.10
frame
sequence of two successive and associated sub-frames

3.11
block
group of 192 consecutive frames

Note 1 to entry: The start of a block is designated by a special sub-frame preamble (see 4.3).

3.12
channel coding
coding method by which the binary digits are represented for transmission through the interface

3.13
unit interval (UI)
shortest nominal time interval in the coding scheme

Note 1 to entry: There are 128 UI in a sample frame.

3.14
interface jitter
deviation in the timing of interface data transitions (zero crossings) when compared with an ideal clock

3.15
intrinsic jitter
output interface jitter of a device that is either free-running or is synchronized to a jitter-free reference

3.16
jitter gain
ratio of the amplitude of jitter components at the output to their amplitude at the synchronization input to the device under test

4 Interface format

4.1 Structure of format

4.1.1 Sub-frame format

Each sub-frame is divided into 32 time slots, numbered from 0 to 31 (see Figure 1).

Time slots 0 to 3 (preambles) carry one of the three permitted preambles (see 4.1.2 and 4.3; also see Figure 2).

Time slots 4 to 27 (main data field) carry the audio sample word in linear 2's complement representation. The most significant bit (MSB) is carried by time slot 27.

When a 24-bit coding range is used, the LSB is in time slot 4 (see Figure 1).

When a 20-bit coding range is used, time slots 8 to 27 carry the audio sample word with the LSB in time slot 8. Time slots 4 to 7 may be used for other applications. Under these circumstances, the bits in the time slots 4 to 7 are designated auxiliary sample bits (see Figure 1).

If the source provides fewer bits than the interface allows (either 20 or 24), the unused LSBs are set to a logical "0".

For a non-linear PCM audio application or a data application the main data field may carry any other information.

Time slot 28 (validity bit) carries the validity bit associated with the main data field (see 4.4).

Time slot 29 (user data bit) carries 1 bit of the user data channel associated with the main data field channel transmitted in the same sub-frame. For the applications, refer to the other parts of IEC 60958.

Time slot 30 (channel status bit) carries 1 bit of the channel status information associated with the main data field channel transmitted in the same sub-frame. For details refer to the other parts of IEC 60958.

Time slot 31 (parity bit) carries a parity bit such that time slots 4 to 31 inclusive carry an even number of ones and an even number of zeroes (even parity).

NOTE The preambles have even parity as an explicit property.

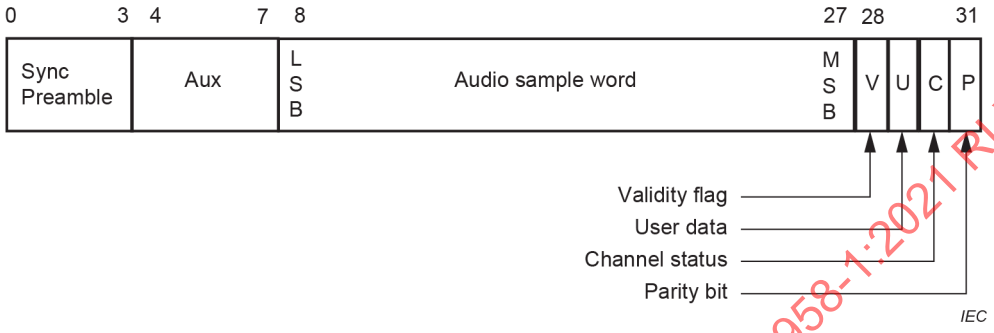


Figure 1 – Sub-frame format (linear PCM application)

Annex E describes the IEC 60958 series conformant data format that utilises the sub-frame format.

4.1.2 Frame format

A frame is uniquely composed of two sub-frames (see Figure 2). For linear coded audio applications, the rate of transmission of frames normally corresponds exactly to the source sampling frequency.

In 2-channel operation mode, the samples taken from both channels are transmitted by time multiplexing in consecutive sub-frames. The first sub-frame (left or "A" channel in stereophonic operation and primary channel in monophonic operation) normally starts with preamble "M". However, the preamble changes to preamble "B" once every 192 frames to identify the start of the block structure used to organize the channel status information. The second sub-frame (right or "B" channel in stereophonic operation and secondary channel in monophonic operation) always starts with preamble "W".

In single channel operation mode in a professional application, the frame format is the same as in the 2-channel mode. Data is carried in the first sub-frame and may be duplicated in the second sub-frame. If the second sub-frame is not carrying duplicate data, then time slot 28, (validity flag) shall be set to logical "1".

NOTE For historical reasons preambles "B", "M" and "W" are, for use in professional applications, referred to as "Z", "X" and "Y", respectively.

Annex C describes the relation of the IEC 60958 series families based on the frame format.

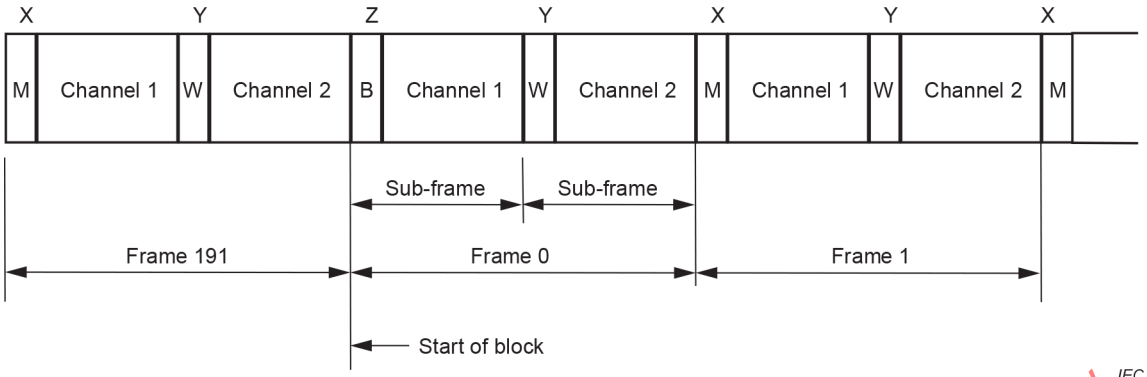


Figure 2 – Frame format

4.2 Channel coding

To minimize the direct current (d.c.) component on the transmission line, to facilitate clock recovery from the data stream and to make the interface insensitive to the polarity of connections, time slots 4 to 31 are encoded in biphase-mark.

Each bit to be transmitted is represented by a symbol comprising two consecutive binary states. The first state of a symbol is always different from the second state of the previous symbol. The second state of the symbol is identical to the first if the bit to be transmitted is logical "0". However, it is different if the bit is logical "1" (see Figure 3).

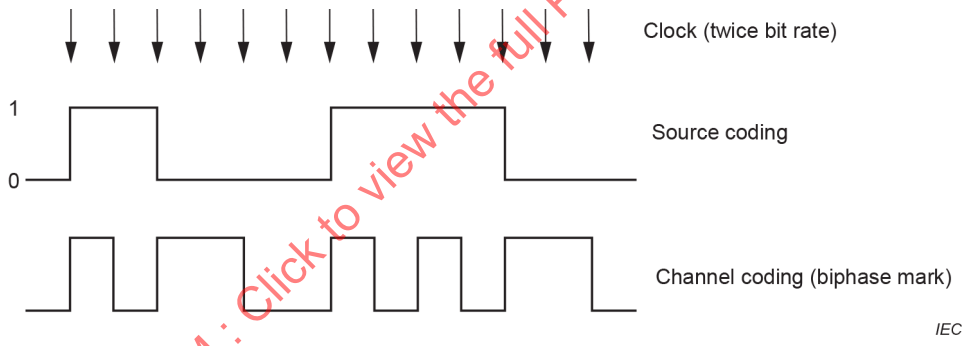


Figure 3 – Channel coding

4.3 Preambles

Preambles are specific patterns providing synchronization and identification of the sub-frames and blocks.

To achieve synchronization within one sampling period and to make this process completely reliable, these patterns violate the biphase-mark code rules, thereby avoiding the possibility of data imitating the preambles.

A set of three preambles is used. These preambles are transmitted in the time allocated to four time slots at the start of each sub-frame (time slots 0 to 3), and are represented by eight successive states. The first state of the preamble is always different from the second state of the previous symbol (representing the parity bit). Depending on this state, the preambles are as shown in Table 1.

Table 1 – Preamble coding

Preceding state	0	1	
Preamble code	**Channel coding**		
"B" or "Z" (see note to 4.1.2)	11101000	00010111	Sub-frame 1 and the start of the block
"M" or "X"	11100010	00011101	Sub-frame 1
"W" or "Y"	11100100	00011011	Sub-frame 2

Like biphase code, these preambles are d.c. free and provide clock recovery. They differ in at least two states from any valid biphase sequence.

Figure 4 represents preamble "M".

NOTE Owing to the even-parity bit in time slot 31, all preambles start with a transition in the same direction (see 4.1.1). Thus, only one of these sets of preambles is, in practice, transmitted through the interface. However, it is necessary for both sets to be decodable because either polarity is possible in a connection.

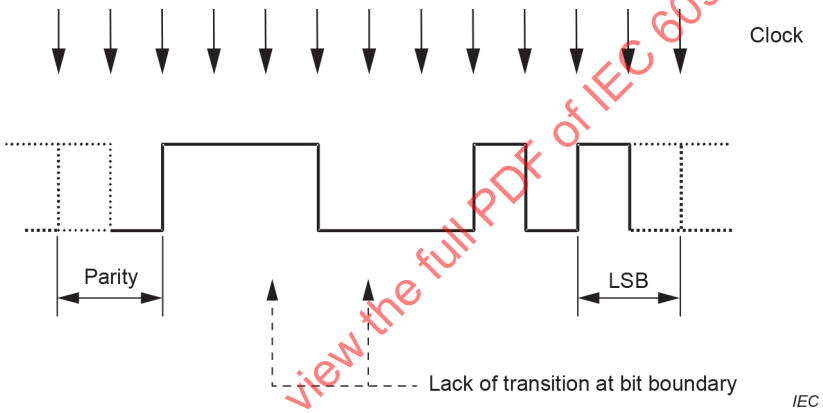


Figure 4 – Preamble M (shown as 11100010)

4.4 Validity bit

The validity bit is logical "0" if the information in the main data field is reliable, and it is logical "1" if it is not. There is no default state for the validity bit.

NOTE For transmissions not using a linear PCM coding, this bit ~~may~~ can be set. This is intended to prevent accidental decoding of non-audio data to analogue before a complete channel status block is received. See Annex A.

5 Channel status

5.1 General

For every sub-frame, the channel status provides information related to the data carried in the main data field of that same sub-frame.

Channel status information is organised in a 192-bit block, subdivided into 24 bytes. The first bit of each block is carried in the frame with preamble "B". The channel status data format is defined in Table 2.

The specific organisation depends on the application. In the descriptions, the suffix "0" designates the first byte or bit. Where channel status bits are combined to form non-binary values, the least significant bit should be transmitted first, unless otherwise indicated.

5.2 Applications

The primary application is indicated by the first channel status bit (bit 0) of a block as defined in 5.3.

For professional applications, refer to IEC 60958-4.

For consumer applications, refer to IEC 60958-3 and IEC 60958-5.

Secondary applications may be defined within the framework of these primary applications.

Application documents or specifications are listed in Annex B.

5.3 General assignment of the first and second channel status bits

The first and second channel status bits (bit 0 and bit 1) are specified as follows.

Byte 0		
Bit 0	"0"	Consumer use of channel status block.
	"1"	Professional use of channel status block.
Bit 1	"0"	Main data field represents linear PCM samples.
	"1"	Main data field used for other purposes.

Annex D describes an exception case of bit 1 status. Annex F describes a receiver's behaviour when bit 1 is being altered.

5.4 Category code

Channel status including category code is defined in IEC 60958-3 for consumer applications; these category codes are used for other variations of IEC 60958 for consumer use, such as IEC 61937.

Also, channel status is defined in IEC 60958-4 for professional applications; these channel statuses are used for other variations for professional use such as SMPTE ~~337M~~ ST 337 and others.

Table 2 – Channel status data format

Byte									
0		a	b						
	bit	0	1	2	3	4	5	6	7
1									
	bit	8	9	10	11	12	13	14	15
2									
	bit	16	17	18	19	20	21	22	23
3									
	bit	24	25	26	27	28	29	30	31
4									
	bit	32	33	34	35	36	37	38	39
5									
	bit	40	41	42	43	44	45	46	47
6									
	bit	48	49	50	51	52	53	54	55
7									
	bit	56	57	58	59	60	61	62	63
8									
	bit	64	65	66	67	68	69	70	71
9									
	bit	72	73	74	75	76	77	78	79
10									
	bit	80	81	82	83	84	85	86	87
11									
	bit	88	89	90	91	92	93	94	95
12									
	bit	96	97	98	99	100	101	102	103
13									
	bit	104	105	106	107	108	109	110	111
14									
	bit	112	113	114	115	116	117	118	119
15									
	bit	120	121	122	123	124	125	126	127
16									
	bit	128	129	130	131	132	133	134	135
17									
	bit	136	137	138	139	140	141	142	143
18									
	bit	144	145	146	147	148	149	150	151
19									
	bit	152	153	154	155	156	157	158	159
20									
	bit	160	161	162	163	164	165	166	167
21									
	bit	168	169	170	171	172	173	174	175
22									
	bit	176	177	178	179	180	181	182	183
23									
	bit	184	185	186	187	188	189	190	191
		a: use of channel status block.							
		b: linear PCM identification.							

6 User data

6.1 General

The default value of the user bits is logical "0".

6.2 Applications

6.2.1 Professional use

User data may be used in any way required by the user. Application details are described in IEC 60958-4.

6.2.2 Consumer use

The application of the user data in digital audio equipment for consumer use is according to rules described in IEC 60958-3 and IEC 60958-5.

7 Electrical requirement

7.1 Consumer application

7.1.1 General

Two types of transmission lines are defined: unbalanced line and optical fibre.

7.1.2 Timing accuracy

7.1.2.1 Accuracy of sampling frequency (clock accuracy)

7.1.2.1.1 General

Three levels of sampling frequency accuracy are defined to meet various requirements of the frequency accuracy. These levels shall be indicated in the channel status data.

7.1.2.1.2 Level I: high-accuracy mode

The transmitted sampling frequency shall be within a tolerance of $\pm 50 \times 10^{-6}$.

7.1.2.1.3 Level II: normal-accuracy mode

The transmitted sampling frequency shall be within a tolerance of $\pm 1\,000 \times 10^{-6}$.

7.1.2.1.4 Level III: variable pitch shifted clock mode

The signal in this mode can be received by specially designed receivers.

NOTE The frequency range is under consideration. A range of ±12,5 % is envisaged.

7.1.2.1.5 Interface frame rate not matched to sampling frequency

This state is used to indicate high speed and other transfers where the interface does not carry an embedded sampling frequency clock.

7.1.2.2 Receiver locking range

By default, receivers should be able to lock to signals of level II accuracy with respect to the supported standard sampling frequencies.

If a receiver is only capable of normal operation with a narrower locking range, then this range should exceed the sample frequency tolerance of level I and it shall be specified as a level I receiver.

If a receiver is capable of normal operation at sample rate variations corresponding to level III, then this shall be specified as a level III receiver.

~~NOTE~~ Until the range for level III has been defined, the frequency range supported by a level III receiver should be at least ±12,5 %. For clarity, the actual value should be specified.

7.1.2.3 Receiver sampling frequency support

The product specification or application standard may define the sampling frequencies that shall be supported by a receiver. In the absence of such a definition, the receiver shall support 32 kHz, 44,1 kHz and 48 kHz operation.

7.1.3 Unbalanced line

7.1.3.1 General characteristics

The interconnecting cable shall be unbalanced and screened (shielded) with a nominal characteristic impedance of (75 ± 26,25) Ω at frequencies from 0,1 MHz to 128 times the maximum frame rate.

The transmission circuit configuration shown in Figure 5 may be used.

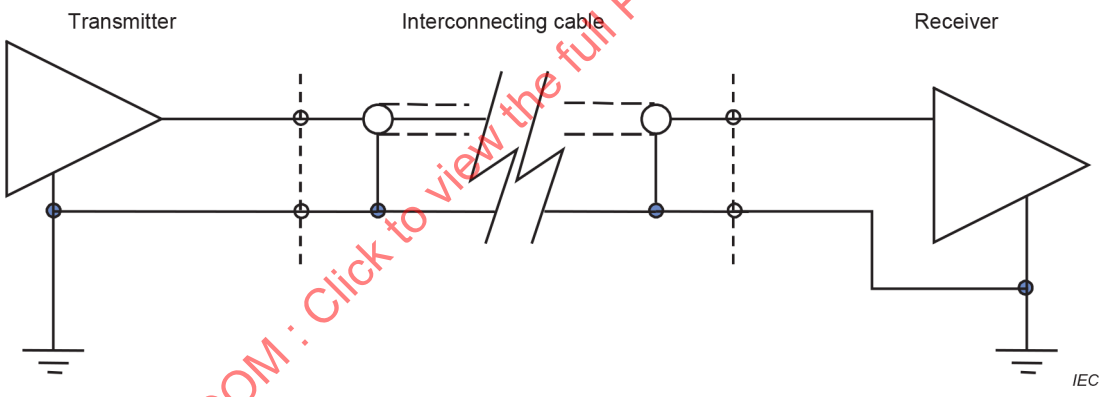


Figure 5 – Simplified example of the configuration of the circuit (unbalanced)

NOTE For implementation, additional components ~~may~~ can be needed. A transformer in the transmitter with a floating (non-earthed) secondary can be used to avoid any potential earth loops and provide a useful bandwidth limitation to reduce high-frequency radiation.

7.1.3.2 Line driver characteristics

7.1.3.2.1 Output impedance

The line driver shall have an unbalanced output with an internal impedance of (75 ± 15) Ω, when measured at the terminals to which the line is connected, at frequencies from 0,1 MHz to 128 times the maximum frame rate.

7.1.3.2.2 Signal amplitude

The signal amplitude shall be (0,5 ± 0,1) V peak-to-peak, when measured across a (75 ± 0,75) Ω resistor connected to the output terminals, without any interconnecting cable present.

7.1.3.2.3 DC output voltage

The d.c. voltage shall be less than 0,05 V, when measured across a (75 ± 0,75) Ω resistor connected to the output terminals, without any interconnecting cable present.

7.1.3.2.4 Rise and fall times

The time difference between the 10 % and 90 % points of any transition shall be less than 0,4 UI (see Figure 6).

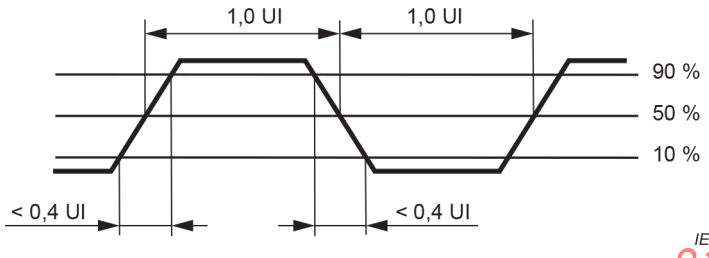


Figure 6 – Rise and fall times

7.1.3.2.5 Intrinsic jitter

The peak intrinsic output jitter measured at all the data transition zero crossings shall be less than 0,05 UI when measured with the intrinsic jitter measurement filter.

NOTE This applies both when the equipment is locked to an effectively jitter-free timing reference (which ~~may~~ can be a modulated digital audio signal) and when the equipment is free-running.

The jitter weighting filter is shown in Figure 7. It is a minimum-phase high pass filter with a 3 dB frequency of 700 Hz, a first order roll-off to 70 Hz and with a passband gain of unity.

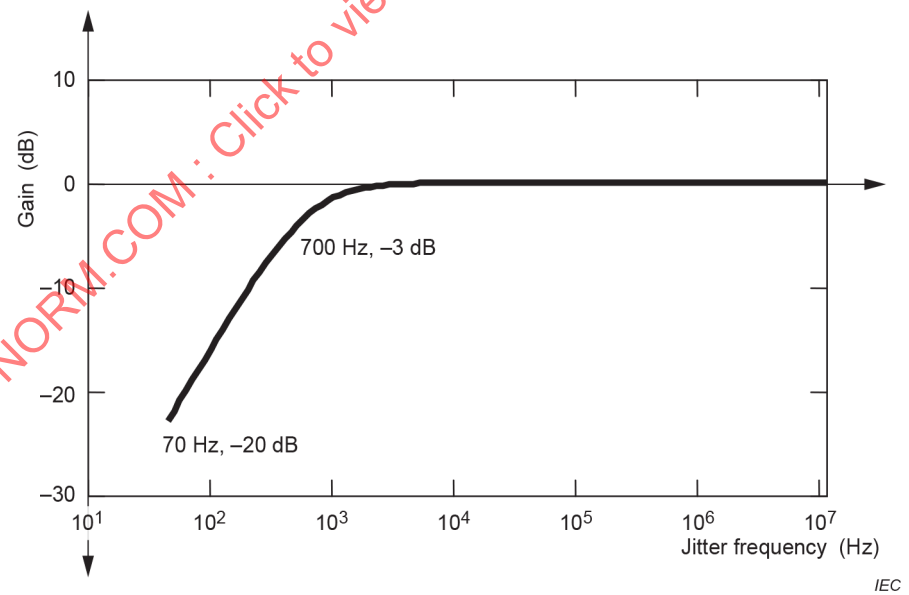


Figure 7 – Intrinsic jitter measurement filter

7.1.3.2.6 Jitter gain or peaking

The sinusoidal jitter gain from any timing reference input to the signal output shall be less than 3 dB at all frequencies.

7.1.3.3 Line receiver characteristics

7.1.3.3.1 Terminating impedance

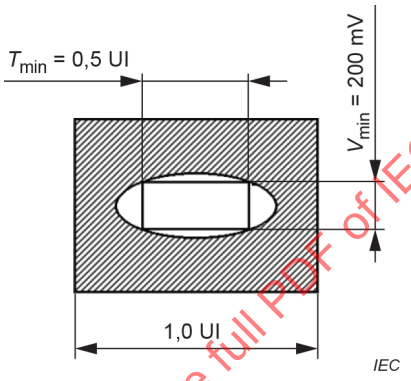
The receiver shall present a substantially resistive impedance of (75 ± 3,75) Ω to the interconnecting cable over the frequency band 0,1 MHz to 128 times the maximum frame rate.

7.1.3.3.2 Maximum input signals

The receiver shall correctly interpret the data when presented with a signal whose peak-to-peak voltage, measured in accordance with 7.1.3.2.2, is 0,6 V.

7.1.3.3.3 Minimum input signals

The receiver shall correctly sense the data when a random input signal produces the eye diagram characterized by a V_{min} of 200 mV and T_{min} of 0,5 UI (see Figure 8).



NOTE This diagram does not define the tolerance to deviation in the zero crossings. These are defined by the jitter tolerance template in 7.1.3.3.4, which requires that the minimum pulse width be not smaller than 0,8 UI.

Figure 8 – Eye diagram

7.1.3.3.4 Receiver jitter tolerance

An interface data receiver should correctly decode an incoming data stream with any sinusoidal jitter defined by the jitter tolerance template of Figure 9.

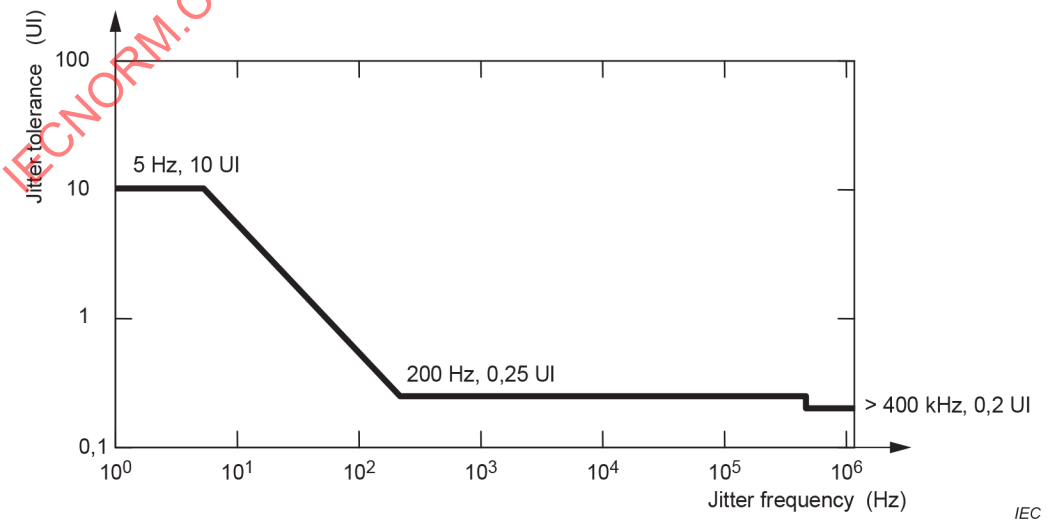


Figure 9 – Receiver jitter tolerance template

~~NOTE~~ The template requires a jitter tolerance of 0,2 UI peak-to-peak at frequencies above 400 kHz, 0,25 UI between 400 kHz and 200 Hz, increasing with the inverse of frequency below 200 Hz to level off at 10 UI peak-to-peak below 5 Hz.

7.1.3.4 Connectors

The standard connector for both outputs and inputs shall be the free pin connector and fixed socket connector described in 8.6 of Table IV of IEC 60268-11:1987.

A male plug shall be used at both ends of the cable.

Equipment manufacturers shall clearly label digital audio inputs and outputs.

7.2 Professional application

Electrical requirements for professional applications are described in IEC 60958-4.

8 Optical requirements

8.1 Consumer application

~~8.1.1 Optical specification~~

8.1.1~~.1~~ Configuration of optical connection

The basic optical connection configuration is shown in Figure 10. The optical matching values are described in Annex G; these values apply at the reference points 2 and 3.

The overall characteristics of a fibre optic cable plant are described in IEC 60793-2 and IEC 60794-2 for fibre and cable, and in IEC 60874-1 for the connectors.

The reference points 1 and 4 apply to the electrical input and output of the electro-optical and opto-electrical converter, respectively. Detailed specifications are provided only in relation to optical reference points 2 and 3.

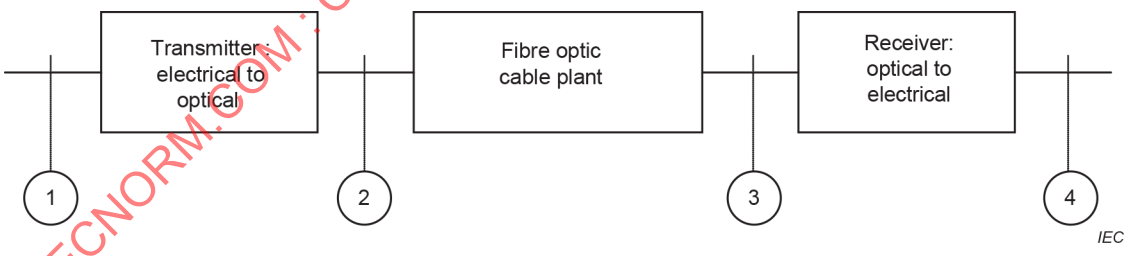


Figure 10 – Basic optical connection

In Figure 10, reference point 1 is the electrical input of the optical transmitter, reference point 2 is the optical interface between optical transmitter and FOCP, reference point 3 is the optical interface between FOCP and optical receiver, and reference point 4 is the electrical output of the optical receiver. "FOCP" means "fibre optic cable plant", which is the serial combination of fibre optic cable sections, connectors and splices providing the optical path between two terminal devices, between two optical devices or between terminal devices and an optical device.

8.1.2 Optical connector

8.1.2.1 Circular type

Refer to JEITA EIAJ RC-5720~~B~~C (see Bibliography).

8.1.2.2 Rectangular type

Refer to ~~IEC 60874-17~~ JEITA EIAJ RC-5720C (see Bibliography).

8.2 Professional applications

Optical requirements for professional applications are described in the IEC 60958-4 series.

Annex A
(informative)

The use of the validity bit

The IEC 60958 series is based on two different industry standards: the AES/EBU digital audio interface standard (AES3 and EBU Tech. 3250-E) and the digital interface specification by Sony and Philips (Sony-Philips Digital Interface Format (SPDIF)) introduced with the Compact Disc Digital Audio system.

Unfortunately, significant differences between the two standards exist, which can contribute in part to the different application areas: professional and consumer. The differences have contributed to many misunderstandings about the use and compatibility of the standards.

Originally, the definition of validity was, in both industry standards, that it indicated whether or not the associated audio sample was "secure and error free". Although, at first glance this ~~may~~ can seem like a clear definition, in practice it has led to important practical problems. It is unclear how the receiver should interpret this. When the sample is signalled not to be in error, it is not clear whether the transmitter has performed a successful concealment. If a sample is signalled in error, it is not clear whether the sample should be passed on unchanged, concealed, or muted.

As a result, the AES has adopted in the 1992 revision of the AES3 standard a different wording: Validity indicates "whether the audio sample bits are suitable for conversion to an analogue audio signal".

Over the years, the application of the IEC 60958 series has gained popularity, resulting in a growing number of products conforming to its provisions. With these in use, applications other than strictly linear PCM audio transmission started to appear as well. The same basic frame structure is used, but the information transferred in the "audio sample word" is not encoded as linear PCM audio. As it is not always clearly indicated what kind of signal is carried, connection of such a transmitter to a linear PCM receiver ~~may~~ can result in a very loud and noisy audio signal.

Therefore, it has been proposed in the revision of IEC 60958 to also adopt the wording of the AES3 standard for the validity bit definition. However, especially in consumer applications, the transmitter often has no active control of the validity bit. In many cases, this is generated by the error correction circuitry and automatically copied in the IEC 60958 bitstream. A change of definition would, in theory, necessitate a redesign of circuits which have been in use for many years.

For this reason, the definition of the validity bit remains basically unchanged in IEC 60958. However, it is noted that for applications not using a linear PCM coding the bit may be set to "1", in which case it can prevent accidental decoding of non-audio data to analogue before a complete channel status block is received. For future applications of IEC 60958 with non-linear PCM data, such a provision is highly recommended.

Additionally, in IEC 60958-4, it is specified that the validity bit shall be used to indicate whether the audio sample is "suitable for conversion to an analogue audio signal using linear PCM coding". This retains, for professional applications, the intention of the wording in the AES3 standard.

Although not a perfect solution to problems relating to the use of the validity bit, the definitions as adopted in IEC 60958 seem to be the best achievable compromise to date.

The use described in this annex should be applied to all other IEC 60958 data conformant formats. This applies, for example, to the IEC 60958 series conformant mode of IEC 61883-6.

Annex B
(informative)

Application documents and specifications

Table B.1 indicates application documents and specifications based on channel status bit 0 and bit 1, as defined in 5.3.

Table B.1 – Application documents and specifications

Byte 0 of channel status		Specifications
Bit 0	Bit 1	
0	0	IEC 60958-3 and IEC 60958-5
1	0	IEC 60958-4
0	1	IEC 61937, IEC 62105 and others
1	1	SMPTE ST 337 and others

For that part of the channel status that is not implemented, the default is logical "0".

Annex C
(informative)

A relationship of the IEC 60958 series families

A relationship between IEC standards and related standards that are based on IEC 60958 is described in Figure C.1.

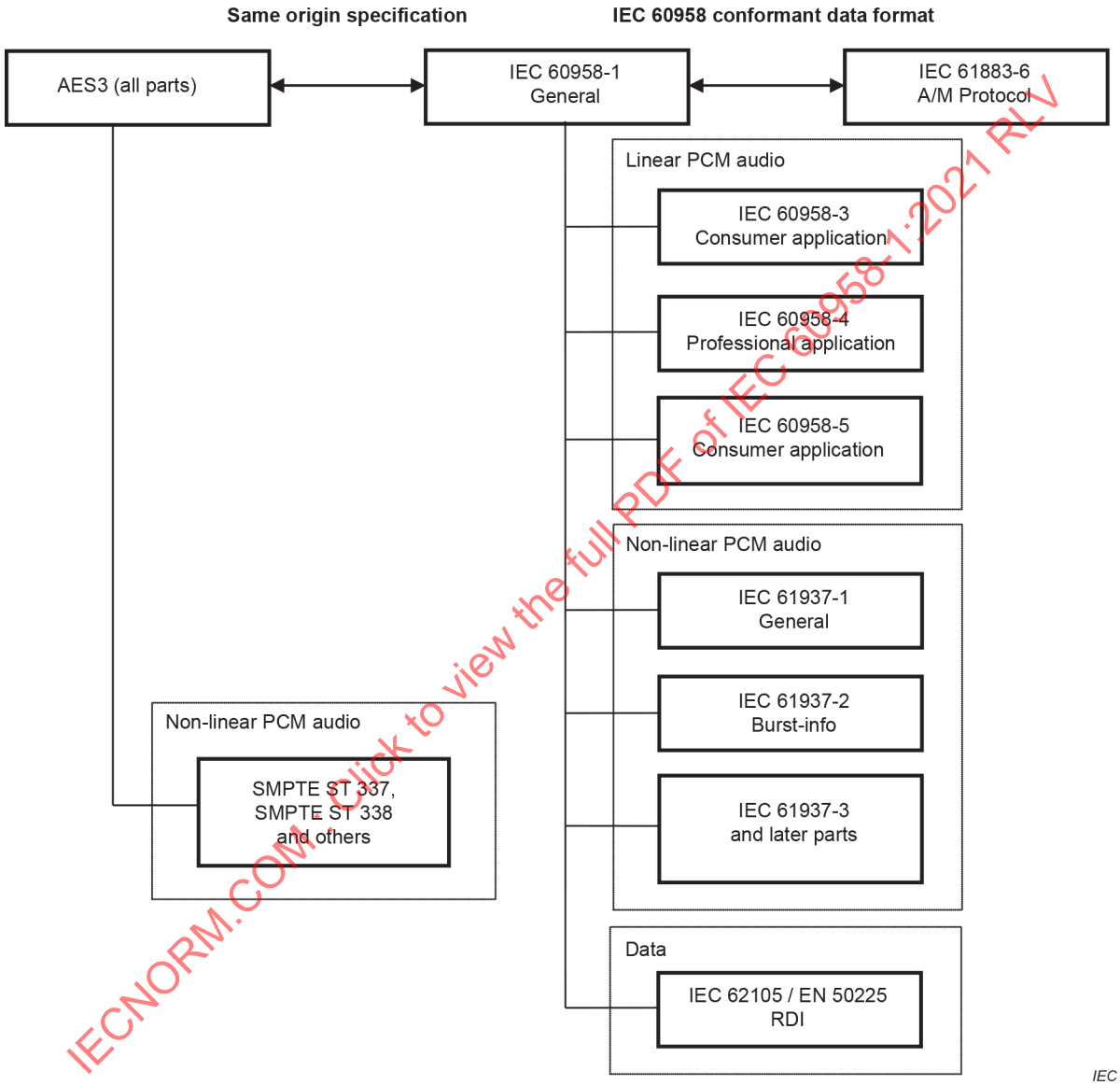


Figure C.1 – Relationships of the IEC 60958 families

As described here, the IEC 60958 series of standards consists of four parts and also forms the basis for other applications. IEC 61937 and IEC 62105 are protocols that use the format of the IEC 60958 series as a transport, and the IEC 60958 series conformant mode in IEC 61883-6 is a variant where the data in an IEC 60958 stream is carried on the format of IEC 61883-6. This means that data formats transported on the IEC 60958 series can themselves be carried on another interface format. As a result, the IEC 60958 series of standards has relevance across various interface formats and systems.

Non-linear PCM audio data transmission is defined by the IEC 61937 series for consumer application and by SMPTE ST 337 for professional application. The channel status of byte 0, bit 0 and 1 identifies each application. However, both data streams may be transmitted with

IEC 60958 conformant data format through other interface specifications. Also, the consumer and professional users use each other's equipment. To understand both applications and data_type values and their utilization, see Table C.1.

Table C.1 – data_type values and application

data_type value	SMPTE ST 337	IEC 61937-2	
		sub data_type	
0	refer to SMPTE ST 338	0	refer to IEC 61937-2
1	refer to SMPTE ST 338	0	refer to IEC 61937-2
2	refer to SMPTE ST 338	0	refer to SMPTE ST 338
3 – ~~1~~17	refer to SMPTE ST 338	0	refer to IEC 61937-2
18 – 25	refer to SMPTE ST 338	0 to 3	refer to IEC 61937-2
26	refer to SMPTE ST 338	0 to 3	refer to IEC 61937-2
27	refer to SMPTE ST 338	0 to 3	refer to SMPTE ST 338
28	refer to SMPTE ST 338	0 to 3	refer to SMPTE ST 338
29	refer to SMPTE ST 338	0 to 3	refer to SMPTE ST 338
30	refer to SMPTE ST 338	0 to 3	refer to SMPTE ST 338
31	refer to SMPTE ST 338	0 to 3	Extended data-type (~~under consideration~~ refer to IEC 61937-2)

Annex D
(informative)

Transmission of CD data other than linear PCM audio

This document allows the interface to carry data related to computer software or signals coded using non-linear PCM and the format specification for these applications is not part of this document. The channel status bit 1 of byte 0 indicates whether the data is linear PCM or not.

However, currently some ~~application of~~ CD ~~sets~~ applications set this bit 1 = "0" as a meaning of linear PCM data while the actual data is not linear PCM, but compressed audio data. Such an application does not conform to the IEC 60958 series.

Current data-processing equipment, such as computers and game machines, have a CD-ROM drive and sometimes an IEC 60958 interface; there is a possibility of non-linear PCM data output that is dependent on the application software.

Therefore, all equipment and applications should respect the channel status definitions in this document for channel status to prevent unexpected behaviour in the decoder.

Consideration is required for applications that, for historic reasons, do not behave in accordance with the IEC 60958 series with respect to channel status bit 1. This is in order to avoid high-level noise being generated by the conversion of this signal as if it were linear PCM data. This noise might damage hearing or equipment.

Annex E
(informative)

The IEC 60958 series conformant data format

The IEC 60958 series conformant data format is defined in IEC 61883-6~~ as IEC 60958 Conformant Data~~. This format carries the contents of sub-frame format of the IEC 60958 series in accordance with IEC 61883-6. Any specific definition and modification of the IEC 60958 series is not defined in IEC 61883-6, all information defined in the IEC 60958 series is transmitted through IEC 61883-6. When a specification other than IEC 61883-6 applies the IEC 60958 series conformant data format, any specific definition and modification of the IEC 60958 series should not be defined by that other specification.

High-rate transmission using the IEC 60958 series conformant data format is possible with the definition in both of the following specifications:

- the IEC 60958 series;
- IEC 61883-6 or other specifications.

Using the IEC 60958 series, all definitions are described within that series. Using IEC 61883-6 or other specifications, all definitions should be described in those other specifications, as IEC 61883-6 indicates.

IEC 61883-6 or another specification may transmit multi-streams of the IEC 60958 families using the IEC 60958 series conformant data format. If any further definition or information for this transmission is required, that should be described in that other specification as IEC 61883-6 indicates.

Annex F
(informative)

Stream change

The initiative to switch between the series of standards of IEC 61937 and IEC 60958 is taken by the user of the audio source in the model shown in Figure F.1. When switching, the AV receiver has to be controlled by this audio source to avoid audible artefacts at the output of the AV receiver. This annex describes the procedure of switching from a non-audio data or a non-linear audio stream in the IEC 61937 format to the IEC 60958 linear PCM stream, and vice versa. It relies on the related standards for further details about the related standards.

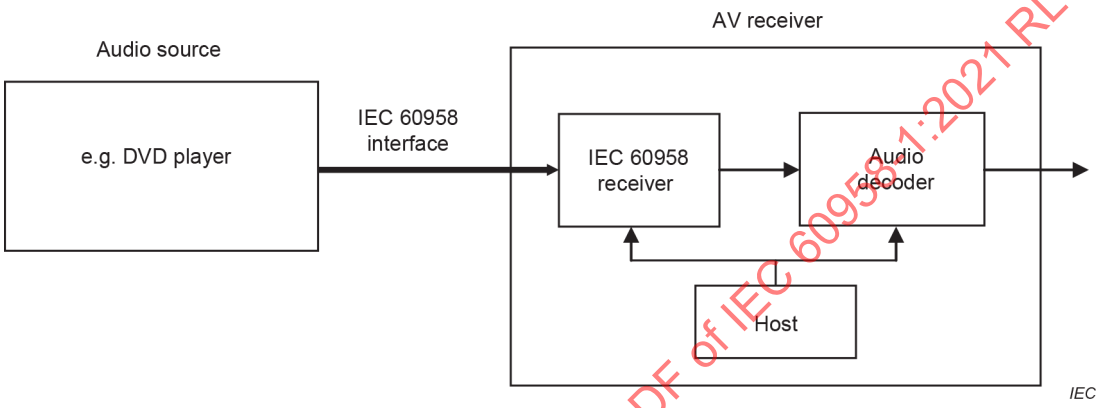


Figure F.1 – Audio sources and AV receiver model

The AV receiver is capable of decoding compressed audio data carried by IEC 61937, or parse the received linear PCM signal carried by IEC 60958 on to the output. Additional features, like multi-channel decoding, may be implemented. The focus of switching is on the signal input of the AV receiver. Further features are allowed~~, and not of any~~; these have no consequence on this procedure.

Each burst in the IEC 61937 format starts with the burst-preamble, bit 0 of Pa, followed by the burst-payload, and ends with stuffing. Switching from IEC 61937 to IEC 60958 is allowed during the stuffing. A burst-payload must be transferred as a whole, otherwise transitions cannot be concealed by the AV receiver. It should be noted that the last bits of a burst-payload may be all "0"s; it is not sufficient to check the length given with Pd.

If the data-type is AC-3, the decoder must decode while receiving the burst-payload due to the permitted latency. The audio decoder is able to distinguish ~~between~~ whether a signal is AC-3 ~~and~~ or MPEG by looking at the burst-preamble Pc. This decoder is not able to distinguish whether a signal is linear PCM ~~and~~ or non-linear PCM, therefore, when the decoder is not able to recognise the encoded data, it ~~may~~ can guess that it concerns linear PCM. By reading the channel status bit 1 (indication of linear PCM or non-linear PCM), the host is able to inform the AV receiver that it concerns linear PCM or non-linear PCM. Therefore, a transition period is defined to allow switching without artefacts; the interface is ‘idle’ during this transition period.

This transition period is a null data; it has data structure and a clock. The null data means that the time slots 4 to 27 (main data field) are set to "0"s. Figure F.2 and Figure F.3 shows this transition of the stream.

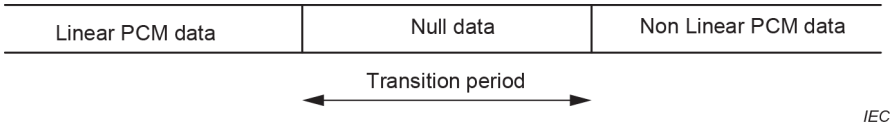


Figure F.2 – Switching from linear PCM to non-linear PCM

Reading the channel status takes time. The length of the transition period should be long enough to read the channel status. This time depends not only on the repetition time of the channel status, but also on the schedule implemented in the host.

The interface should be idle during the transition, the null data is applied, and the channel status bit 1 set to non-linear PCM. Any receiver should be able to mute its outputs during this transition period.

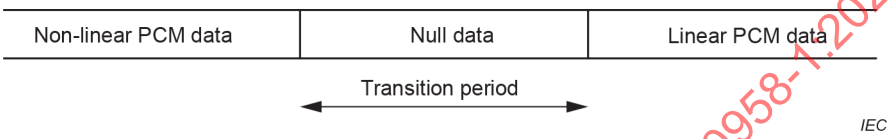


Figure F.3 – Switching from non-linear PCM to linear PCM

If it expects linear PCM, it mutes because the audio content is "0". When it expects bursts in IEC 61937 format, it mutes because it cannot find the next burst-preamble. Therefore, idle is a safe state during the transition.

Audio signals at the start and end portion of linear PCM data can fade in and out, this is effective to avoid artefacts.

All the digital audio interfaces for non-linear PCM applying the IEC 60958 series should adopt this procedure. This procedure may be adapted for switching from one non-linear PCM stream to another non-linear PCM stream. Figure F.4 shows this transition of the stream.

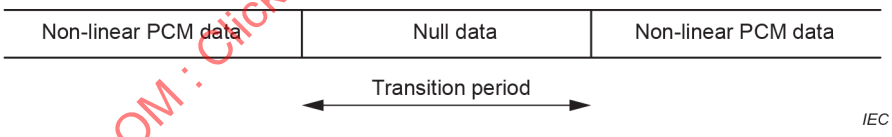


Figure F.4 – Switching from non-linear PCM to non-linear PCM

~~It is allowed that a transition period is defined as no output of the IEC 60958 series. In this case, the transition period should have an additional transition period to capture the clock by the AV receiver.~~

A no-output for transition period instead of null data output from the IEC 60958 series is allowed. In this case, the transition period should have an additional transition period in order for the AV receiver to capture the clock.

Annex G
(informative)

Characteristics of optical connection

The characteristics of optical connection are specified in Table G.1 to Table G.5 giving units, values and ranges or tolerances. The tables contain data that apply to the whole field of digital audio signals. The columns headed "values" specify the matching values that apply to all digital audio applications covered by this document.

Table G.1 gives the standard value for the basic optical connection for digital audio signals. Table G.2 gives the specifications of the optical transmitter and corresponds to reference point 2 in Figure 10. Table G.3 gives the specifications of the optical receiver and corresponds to reference point 3 in Figure 10. Table G.4 gives the specifications of the fibre optic cable plant. Table G.5 gives the optical power budget for the link with plastic fibre.

Table G.1 – Characteristics of standard optical connection (optical interface)

Characteristics	Symbol	Unit	Value	Notes
Bit rate (optical line rate)	B	bit/s	$3{,}1 \times 10^6$ max	Examples; $2{,}8224 \times 10^6$ for 44,1 kHz $3{,}072 \times 10^6$ for 48 kHz
Bit error ratio	BER		10^{-9}	
Wavelength	λ	nm	660	
System budget		dB	6	
NOTE 1 The bit error ratio is the number of incorrect bits divided by the total number of bits over a period of time. NOTE 2 The system budget is a transmission loss caused by optical connection.				

Table G.2 – Characteristics of optical transmitter (optical interface)

Characteristics	Symbol	Unit	Value	Notes
Optical connector				See 8.1.2
Source type	LED			
Optical output power (see Table G.5)	P_T	dBm	−15 to −21	
Signal format				Biphase-mark, see 4.2
Bit rate(optical line rate)	B	bit/s	$3{,}1 \times 10^6$ max	
Central wavelength	λ	nm	660	
Spectral width	$\delta\lambda$	nm	25	Full width, half maximum
NOTE 1 The optical output power is the amount of radiant energy per unit time that passes the optical fibre interface surface. NOTE 2 The full width, half-maximum is the wavelength range between the half-power points.				

Table G.3 – Characteristics of optical receiver (optical interface)

Characteristics	Symbol	Unit	Value	Notes
Optical connector				See 8.1.2
Bit rate (optical line rate)	B	bit/s	$3{,}1 \times 10^6$ max	
Bit rate tolerance		ppm	1 000	
Signal format				Biphase-mark, see 4.2
Wavelength range	$\lambda_{min} - \lambda_{max}$	nm	630 – 690	
Sensitivity	PR	dBm	−27	
NOTE 1 The receiver overload is defined as the maximum optical input signal average power above which the *BER* cannot be maintained. NOTE 2 The receiver sensitivity is defined as the minimum optical input signal average power below which the *BER* cannot be maintained.				

Table G.4 – Characteristics of fibre optic cable

Characteristics	Symbol	Unit	Value	Notes
Fibre type (see notes 1 and 2 below)				Plastic fibre, category A4, see IEC 60793-2
Maximum attenuation	A	dB	6	
Wavelength range	$\lambda_{min} - \lambda_{max}$	nm	630 – 690	
Length-related bandwidth	$B_{(1\ km)}$	Hz·km	10^6	Not less than 3 times bit rate Multimode fibre
NOTE 1 The characteristics of the optical fibre used shall be chosen so as to meet the above requirements. Plastic fibres shall be used (see IEC 60793-2). For span lengths of 20 m or more, other cable types ~~may~~ can be necessary. NOTE 2 Core diameter: 950 µm to 1 000 µm, numerical aperture: 0,5 ± 0,15.				

Table G.5 – Optical power budget for the link with plastic fibre

Fibre type	Transmitter optical power	Cable plant loss	Receiver input power range
Plastic	–15 to –21 dBm	dB	–15 to 27 dBm
NOTE The cable plant loss is defined as the total transmission loss of system budget and connection loss of connectors.			

Bibliography

IEC 60793-2, *Optical fibres – Part ~~1~~2: Product specifications – General*

IEC 60794-2, *Optical fibre cables – Part 2: Indoor cables – Sectional specification*

IEC 60874-1 (all parts), *Fibre optic interconnecting devices and passive components – Connectors for optical fibres and cables – Part 1: Generic specification*

~~IEC 60958 (all parts), *Digital audio interface*~~

IEC 61883-6:2014, *Consumer audio/video equipment – Digital interface – Part 6: Audio and music data transmission protocol*

~~IEC 61937 (all parts), *Digital audio – Interface for non-linear PCM encoded audio bitstreams applying IEC 60958*~~

IEC 61937-1:2021, *Digital audio – Interface for non-linear PCM encoded audio bitstreams applying IEC 60958 - Part 1: General*

IEC 61937-2:2021, *Digital audio – Interface for non-linear PCM encoded audio bitstreams applying IEC 60958 – Part 2: Burst-info*

IEC 61937-3:2017, *Digital audio – Interface for non-linear PCM encoded audio bitstreams applying IEC 60958 – Part 3: Non-linear PCM bitstreams according to the AC-3 format and enhanced AC-3 formats*

IEC 62105:1999, *Digital audio broadcast system – Specification of the receiver data interface (RDI)*

AES3 (all parts), *AES standard for digital audio engineering – Serial transmission format for two-channel linearly represented digital audio data*

EBU Tech. 3250-E:2004, *Specification of the digital audio interface (The AES/EBU interface)*

JEITA EIAJ RC5720C, *Connectors for Optical Fiber Cables for Digital Audio Equipment*

EN 50255:1997, *Digital Audio Broadcasting system – Specification for the Receiver Data Interface (RDI)*

SMPTE ST 337:2015, *Format for Non-PCM Audio and Data in AES3 Serial Digital Audio Interface*

SMPTE ST 338:2016, *Format for Non-PCM Audio and Data in AES3 – Data Types*

IEC 60958-1

Edition 4.0 2021-09

INTERNATIONAL STANDARD

Digital audio interface – Part 1: General

IEC 60958-1:2021-09(en)

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

_____

DIGITAL AUDIO INTERFACE –

Part 1: General

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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IEC 60958-1 has been prepared by technical area 20: Analogue and digital audio, of IEC technical committee 100: Audio, video and multimedia systems and equipment. It is an International Standard.

This fourth edition cancels and replaces the third edition published in 2008, and Amendment 1:2014. This edition constitutes a technical revision.

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

a) The relevant part of IEC 60958-5 is supported.

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

Draft	Report on voting
100/3544/CDV	100/3593/RVC

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

The language used for the development of this International Standard is English.

A list of all parts of the IEC 60958 series, under the general title *Digital audio interface*, can be found on the IEC website.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under 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.

DIGITAL AUDIO INTERFACE –

Part 1: General

1 Scope

This part of IEC 60958 describes a serial, uni-directional, self-clocking interface for the interconnection of digital audio equipment for consumer and professional applications.

It provides the basic structure of the interface. Separate documents define items specific to particular applications.

The interface is primarily intended to carry monophonic or stereophonic programmes, encoded using linear PCM and with a resolution of up to 24 bits per sample.

When used for other purposes, the interface is able to carry audio data coded other than as linear PCM coded audio samples. Provision is also made to allow the interface to carry data related to computer software, multimedia technologies, or signals coded using non-linear PCM. The format specification for these applications is not part of this document.

The interface is intended for operation at audio sampling frequencies of 32 kHz and above. Auxiliary information is transmitted along with the programme.

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 60268-11:1987, *Sound system equipment – Part 11: Application of connectors for the interconnection of sound system components*

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

IEC 60958-4 (all parts), *Digital audio interface – Part 4: Professional applications*

IEC 60958-5, *Digital audio interface – Part 5: Consumer application enhancement*

3 Terms and definitions

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

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

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

3.1
sampling frequency
frequency of the samples representing an audio signal

Note 1 to entry: When more than one signal is transmitted through the same interface, the sampling frequencies are identical.

3.2
audio sample word
value of a digital audio sample; representation is linear in 2's complement binary form

Note 1 to entry: Positive numbers correspond to positive analogue voltages at the input of the analogue-to-digital converter (ADC).

3.3
auxiliary sample bit
four least significant bits (LSBs) which can be assigned as auxiliary sample bits and used for auxiliary information when the number of audio sample bits in the main data field is less than or equal to 20

3.4
validity bit
bit indicating whether the main data field bits in the sub-frame (time slots 4 to 27 or 8 to 27, depending on the audio word length as described in 4.1.1) are reliable or not

3.5
channel status
data carrying, in a fixed format, information associated with each main data field channel which is decodable by any interface user

Note 1 to entry: Examples of information to be carried in the channel status are: length of audio sample words, pre-emphasis, sampling frequency, time codes, alphanumeric source and destination codes.

3.6
user data
data provided to carry any other information

3.7
parity bit
bit provided to permit the detection of an odd number of errors resulting from malfunctions in the interface

3.8
preamble
specific patterns used for synchronization

Note 1 to entry: There are three different preambles (see 4.3).

3.9
sub-frame
fixed structure used to carry information (see 4.1.1 and 4.1.2)

3.10
frame
sequence of two successive and associated sub-frames

3.11
block
group of 192 consecutive frames

Note 1 to entry: The start of a block is designated by a special sub-frame preamble (see 4.3).

3.12
channel coding
coding method by which the binary digits are represented for transmission through the interface

3.13
unit interval (UI)
shortest nominal time interval in the coding scheme

Note 1 to entry: There are 128 UI in a sample frame.

3.14
interface jitter
deviation in the timing of interface data transitions (zero crossings) when compared with an ideal clock

3.15
intrinsic jitter
output interface jitter of a device that is either free-running or is synchronized to a jitter-free reference

3.16
jitter gain
ratio of the amplitude of jitter components at the output to their amplitude at the synchronization input to the device under test

4 Interface format

4.1 Structure of format

4.1.1 Sub-frame format

Each sub-frame is divided into 32 time slots, numbered from 0 to 31 (see Figure 1).

Time slots 0 to 3 (preambles) carry one of the three permitted preambles (see 4.1.2 and 4.3; also see Figure 2).

Time slots 4 to 27 (main data field) carry the audio sample word in linear 2's complement representation. The most significant bit (MSB) is carried by time slot 27.

When a 24-bit coding range is used, the LSB is in time slot 4 (see Figure 1).

When a 20-bit coding range is used, time slots 8 to 27 carry the audio sample word with the LSB in time slot 8. Time slots 4 to 7 may be used for other applications. Under these circumstances, the bits in the time slots 4 to 7 are designated auxiliary sample bits (see Figure 1).

If the source provides fewer bits than the interface allows (either 20 or 24), the unused LSBs are set to a logical "0".

For a non-linear PCM audio application or a data application the main data field may carry any other information.

Time slot 28 (validity bit) carries the validity bit associated with the main data field (see 4.4).

Time slot 29 (user data bit) carries 1 bit of the user data channel associated with the main data field channel transmitted in the same sub-frame. For the applications, refer to the other parts of IEC 60958.

Time slot 30 (channel status bit) carries 1 bit of the channel status information associated with the main data field channel transmitted in the same sub-frame. For details refer to the other parts of IEC 60958.

Time slot 31 (parity bit) carries a parity bit such that time slots 4 to 31 inclusive carry an even number of ones and an even number of zeroes (even parity).

NOTE The preambles have even parity as an explicit property.

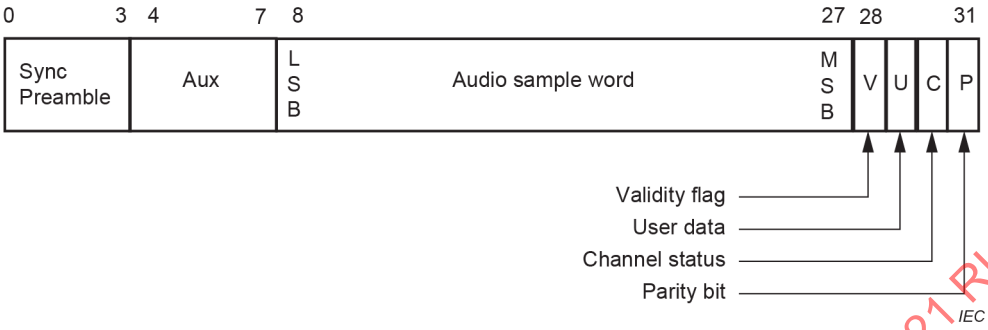


Figure 1 – Sub-frame format (linear PCM application)

Annex E describes the IEC 60958 series conformant data format that utilises the sub-frame format.

4.1.2 Frame format

A frame is uniquely composed of two sub-frames (see Figure 2). For linear coded audio applications, the rate of transmission of frames normally corresponds exactly to the source sampling frequency.

In 2-channel operation mode, the samples taken from both channels are transmitted by time multiplexing in consecutive sub-frames. The first sub-frame (left or "A" channel in stereophonic operation and primary channel in monophonic operation) normally starts with preamble "M". However, the preamble changes to preamble "B" once every 192 frames to identify the start of the block structure used to organize the channel status information. The second sub-frame (right or "B" channel in stereophonic operation and secondary channel in monophonic operation) always starts with preamble "W".

In single channel operation mode in a professional application, the frame format is the same as in the 2-channel mode. Data is carried in the first sub-frame and may be duplicated in the second sub-frame. If the second sub-frame is not carrying duplicate data, then time slot 28, (validity flag) shall be set to logical "1".

NOTE For historical reasons preambles "B", "M" and "W" are, for use in professional applications, referred to as "Z", "X" and "Y", respectively.

Annex C describes the relation of the IEC 60958 series families based on the frame format.

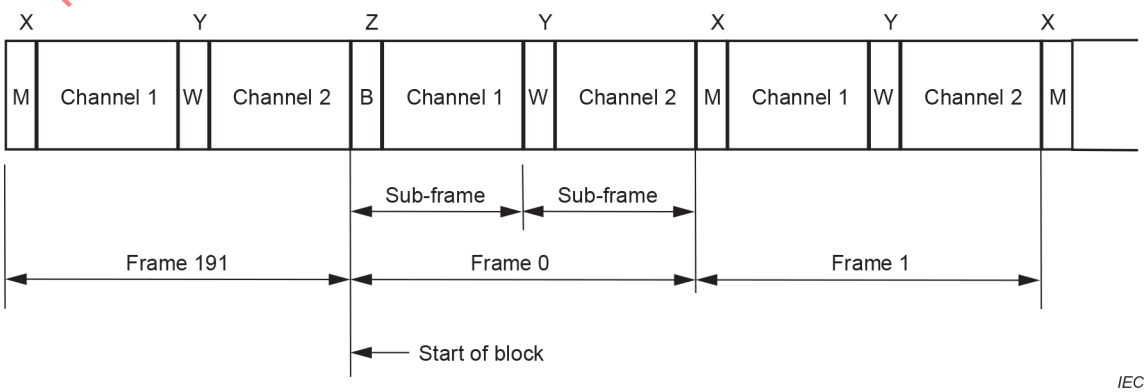


Figure 2 – Frame format

4.2 Channel coding

To minimize the direct current (d.c.) component on the transmission line, to facilitate clock recovery from the data stream and to make the interface insensitive to the polarity of connections, time slots 4 to 31 are encoded in biphase-mark.

Each bit to be transmitted is represented by a symbol comprising two consecutive binary states. The first state of a symbol is always different from the second state of the previous symbol. The second state of the symbol is identical to the first if the bit to be transmitted is logical "0". However, it is different if the bit is logical "1" (see Figure 3).

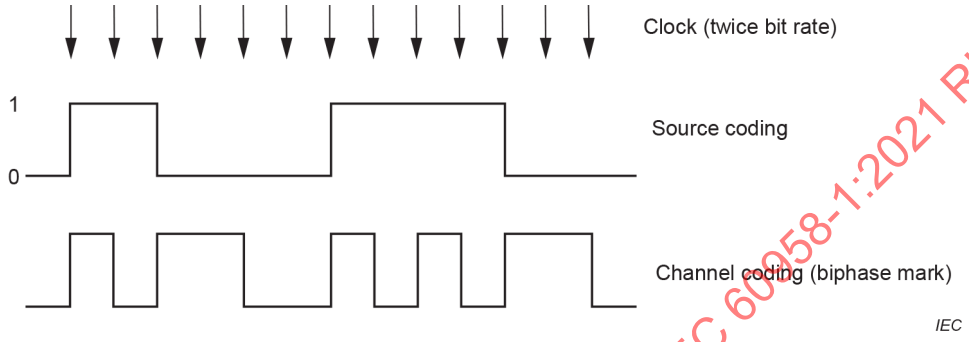


Figure 3 – Channel coding

4.3 Preambles

Preambles are specific patterns providing synchronization and identification of the sub-frames and blocks.

To achieve synchronization within one sampling period and to make this process completely reliable, these patterns violate the biphase-mark code rules, thereby avoiding the possibility of data imitating the preambles.

A set of three preambles is used. These preambles are transmitted in the time allocated to four time slots at the start of each sub-frame (time slots 0 to 3), and are represented by eight successive states. The first state of the preamble is always different from the second state of the previous symbol (representing the parity bit). Depending on this state, the preambles are as shown in Table 1.

Table 1 – Preamble coding

Preceding state	**0**	**1**	
Preamble code	**Channel coding**		
"B" or "Z" (see note to 4.1.2)	11101000	00010111	Sub-frame 1 and the start of the block
"M" or "X"	11100010	00011101	Sub-frame 1
"W" or "Y"	11100100	00011011	Sub-frame 2

Like biphase code, these preambles are d.c. free and provide clock recovery. They differ in at least two states from any valid biphase sequence.

Figure 4 represents preamble "M".

NOTE Owing to the even-parity bit in time slot 31, all preambles start with a transition in the same direction (see 4.1.1). Thus, only one of these sets of preambles is, in practice, transmitted through the interface. However, it is necessary for both sets to be decodable because either polarity is possible in a connection.

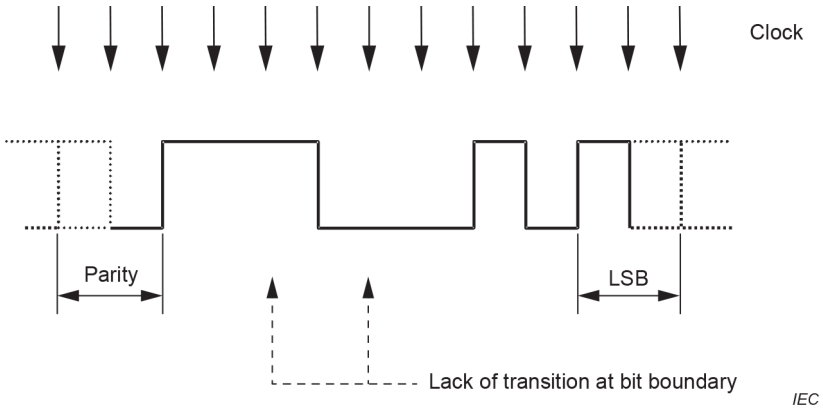


Figure 4 – Preamble M (shown as 11100010)

4.4 Validity bit

The validity bit is logical "0" if the information in the main data field is reliable, and it is logical "1" if it is not. There is no default state for the validity bit.

NOTE For transmissions not using a linear PCM coding, this bit can be set. This is intended to prevent accidental decoding of non-audio data to analogue before a complete channel status block is received. See Annex A.

5 Channel status

5.1 General

For every sub-frame, the channel status provides information related to the data carried in the main data field of that same sub-frame.

Channel status information is organised in a 192-bit block, subdivided into 24 bytes. The first bit of each block is carried in the frame with preamble "B". The channel status data format is defined in Table 2.

The specific organisation depends on the application. In the descriptions, the suffix "0" designates the first byte or bit. Where channel status bits are combined to form non-binary values, the least significant bit should be transmitted first, unless otherwise indicated.

5.2 Applications

The primary application is indicated by the first channel status bit (bit 0) of a block as defined in 5.3.

For professional applications, refer to IEC 60958-4.

For consumer applications, refer to IEC 60958-3 and IEC 60958-5.

Secondary applications may be defined within the framework of these primary applications.

Application documents or specifications are listed in Annex B.

5.3 General assignment of the first and second channel status bits

The first and second channel status bits (bit 0 and bit 1) are specified as follows.

Byte 0		
Bit 0	"0"	Consumer use of channel status block.

	"1"	Professional use of channel status block.
Bit 1	"0"	Main data field represents linear PCM samples.
	"1"	Main data field used for other purposes.

Annex D describes an exception case of bit 1 status. Annex F describes a receiver's behaviour when bit 1 is being altered.

5.4 Category code

Channel status including category code is defined in IEC 60958-3 for consumer applications; these category codes are used for other variations of IEC 60958 for consumer use, such as IEC 61937.

Also, channel status is defined in IEC 60958-4 for professional applications; these channel statuses are used for other variations for professional use such as SMPTE ST 337 and others.

Table 2 – Channel status data format

Byte									
0		a	b						
	bit	0	1	2	3	4	5	6	7
1									
	bit	8	9	10	11	12	13	14	15
2									
	bit	16	17	18	19	20	21	22	23
3									
	bit	24	25	26	27	28	29	30	31
4									
	bit	32	33	34	35	36	37	38	39
5									
	bit	40	41	42	43	44	45	46	47
6									
	bit	48	49	50	51	52	53	54	55
7									
	bit	56	57	58	59	60	61	62	63
8									
	bit	64	65	66	67	68	69	70	71
9									
	bit	72	73	74	75	76	77	78	79
10									
	bit	80	81	82	83	84	85	86	87
11									
	bit	88	89	90	91	92	93	94	95
12									
	bit	96	97	98	99	100	101	102	103
13									
	bit	104	105	106	107	108	109	110	111
14									
	bit	112	113	114	115	116	117	118	119
15									
	bit	120	121	122	123	124	125	126	127
16									
	bit	128	129	130	131	132	133	134	135
17									
	bit	136	137	138	139	140	141	142	143
18									
	bit	144	145	146	147	148	149	150	151
19									
	bit	152	153	154	155	156	157	158	159
20									
	bit	160	161	162	163	164	165	166	167
21									
	bit	168	169	170	171	172	173	174	175
22									
	bit	176	177	178	179	180	181	182	183
23									
	bit	184	185	186	187	188	189	190	191
		a: use of channel status block.							
		b: linear PCM identification.							

6 User data

6.1 General

The default value of the user bits is logical "0".

6.2 Applications

6.2.1 Professional use

User data may be used in any way required by the user. Application details are described in IEC 60958-4.

6.2.2 Consumer use

The application of the user data in digital audio equipment for consumer use is according to rules described in IEC 60958-3 and IEC 60958-5.

7 Electrical requirement

7.1 Consumer application

7.1.1 General

Two types of transmission lines are defined: unbalanced line and optical fibre.

7.1.2 Timing accuracy

7.1.2.1 Accuracy of sampling frequency (clock accuracy)

7.1.2.1.1 General

Three levels of sampling frequency accuracy are defined to meet various requirements of the frequency accuracy. These levels shall be indicated in the channel status data.

7.1.2.1.2 Level I: high-accuracy mode

The transmitted sampling frequency shall be within a tolerance of $\pm 50 \times 10^{-6}$.

7.1.2.1.3 Level II: normal-accuracy mode

The transmitted sampling frequency shall be within a tolerance of $\pm 1\,000 \times 10^{-6}$.

7.1.2.1.4 Level III: variable pitch shifted clock mode

The signal in this mode can be received by specially designed receivers.

NOTE The frequency range is under consideration. A range of ±12,5 % is envisaged.

7.1.2.1.5 Interface frame rate not matched to sampling frequency

This state is used to indicate high speed and other transfers where the interface does not carry an embedded sampling frequency clock.

7.1.2.2 Receiver locking range

By default, receivers should be able to lock to signals of level II accuracy with respect to the supported standard sampling frequencies.

If a receiver is only capable of normal operation with a narrower locking range, then this range should exceed the sample frequency tolerance of level I and it shall be specified as a level I receiver.

If a receiver is capable of normal operation at sample rate variations corresponding to level III, then this shall be specified as a level III receiver.

Until the range for level III has been defined, the frequency range supported by a level III receiver should be at least ±12,5 %. For clarity, the actual value should be specified.

7.1.2.3 Receiver sampling frequency support

The product specification or application standard may define the sampling frequencies that shall be supported by a receiver. In the absence of such a definition, the receiver shall support 32 kHz, 44,1 kHz and 48 kHz operation.

7.1.3 Unbalanced line

7.1.3.1 General characteristics

The interconnecting cable shall be unbalanced and screened (shielded) with a nominal characteristic impedance of (75 ± 26,25) Ω at frequencies from 0,1 MHz to 128 times the maximum frame rate.

The transmission circuit configuration shown in Figure 5 may be used.

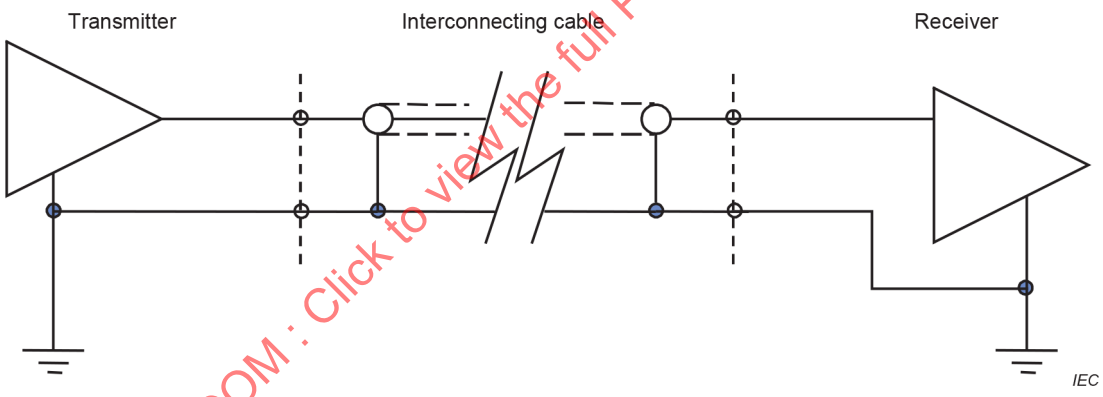


Figure 5 – Simplified example of the configuration of the circuit (unbalanced)

NOTE For implementation, additional components can be needed. A transformer in the transmitter with a floating (non-earthed) secondary can be used to avoid any potential earth loops and provide a useful bandwidth limitation to reduce high-frequency radiation.

7.1.3.2 Line driver characteristics

7.1.3.2.1 Output impedance

The line driver shall have an unbalanced output with an internal impedance of (75 ± 15) Ω, when measured at the terminals to which the line is connected, at frequencies from 0,1 MHz to 128 times the maximum frame rate.

7.1.3.2.2 Signal amplitude

The signal amplitude shall be (0,5 ± 0,1) V peak-to-peak, when measured across a (75 ± 0,75) Ω resistor connected to the output terminals, without any interconnecting cable present.

7.1.3.2.3 DC output voltage

The d.c. voltage shall be less than 0,05 V, when measured across a (75 ± 0,75) Ω resistor connected to the output terminals, without any interconnecting cable present.

7.1.3.2.4 Rise and fall times

The time difference between the 10 % and 90 % points of any transition shall be less than 0,4 UI (see Figure 6).

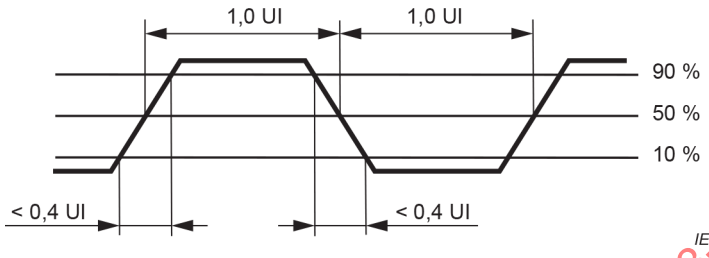


Figure 6 – Rise and fall times

7.1.3.2.5 Intrinsic jitter

The peak intrinsic output jitter measured at all the data transition zero crossings shall be less than 0,05 UI when measured with the intrinsic jitter measurement filter.

NOTE This applies both when the equipment is locked to an effectively jitter-free timing reference (which can be a modulated digital audio signal) and when the equipment is free-running.

The jitter weighting filter is shown in Figure 7. It is a minimum-phase high pass filter with a 3 dB frequency of 700 Hz, a first order roll-off to 70 Hz and with a passband gain of unity.

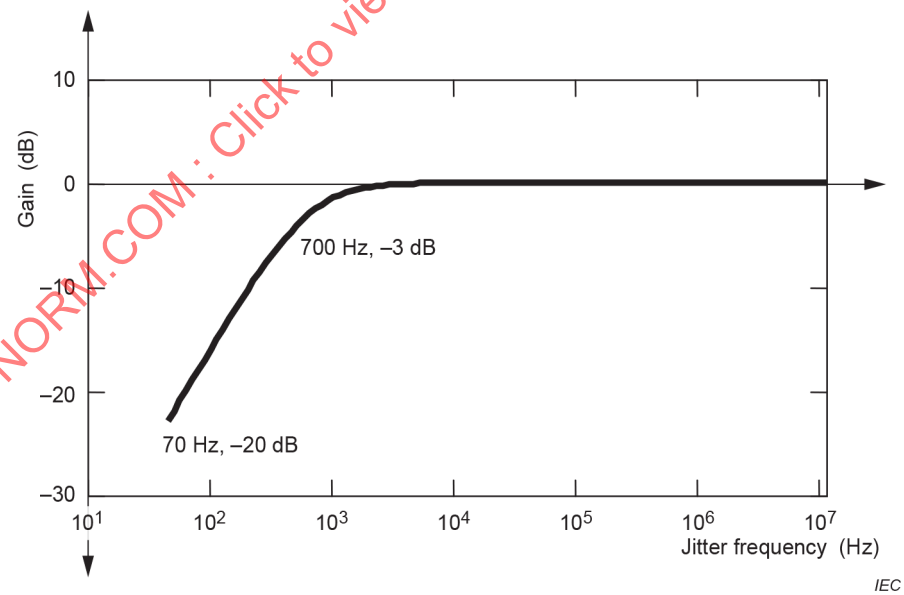


Figure 7 – Intrinsic jitter measurement filter

7.1.3.2.6 Jitter gain or peaking

The sinusoidal jitter gain from any timing reference input to the signal output shall be less than 3 dB at all frequencies.

7.1.3.3 Line receiver characteristics

7.1.3.3.1 Terminating impedance

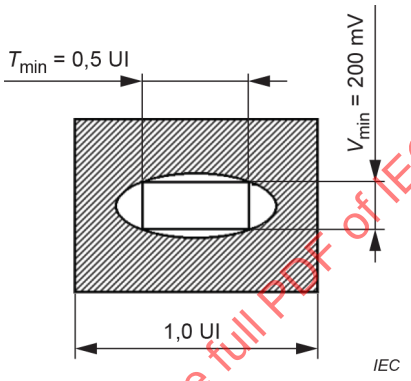
The receiver shall present a substantially resistive impedance of (75 ± 3,75) Ω to the interconnecting cable over the frequency band 0,1 MHz to 128 times the maximum frame rate.

7.1.3.3.2 Maximum input signals

The receiver shall correctly interpret the data when presented with a signal whose peak-to-peak voltage, measured in accordance with 7.1.3.2.2, is 0,6 V.

7.1.3.3.3 Minimum input signals

The receiver shall correctly sense the data when a random input signal produces the eye diagram characterized by a V_{min} of 200 mV and T_{min} of 0,5 UI (see Figure 8).



NOTE This diagram does not define the tolerance to deviation in the zero crossings. These are defined by the jitter tolerance template in 7.1.3.3.4, which requires that the minimum pulse width be not smaller than 0,8 UI.

Figure 8 – Eye diagram

7.1.3.3.4 Receiver jitter tolerance

An interface data receiver should correctly decode an incoming data stream with any sinusoidal jitter defined by the jitter tolerance template of Figure 9.

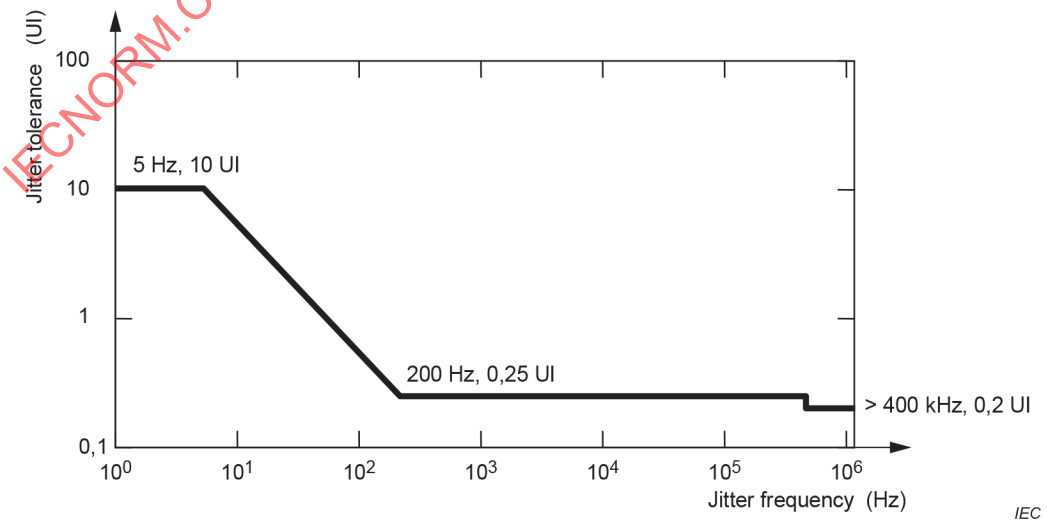


Figure 9 – Receiver jitter tolerance template

The template requires a jitter tolerance of 0,2 UI peak-to-peak at frequencies above 400 kHz, 0,25 UI between 400 kHz and 200 Hz, increasing with the inverse of frequency below 200 Hz to level off at 10 UI peak-to-peak below 5 Hz.

7.1.3.4 Connectors

The standard connector for both outputs and inputs shall be the free pin connector and fixed socket connector described in 8.6 of Table IV of IEC 60268-11:1987.

A male plug shall be used at both ends of the cable.

Equipment manufacturers shall clearly label digital audio inputs and outputs.

7.2 Professional application

Electrical requirements for professional applications are described in IEC 60958-4.

8 Optical requirements

8.1 Consumer application

8.1.1 Configuration of optical connection

The basic optical connection configuration is shown in Figure 10. The optical matching values are described in Annex G; these values apply at the reference points 2 and 3.

The overall characteristics of a fibre optic cable plant are described in IEC 60793-2 and IEC 60794-2 for fibre and cable, and in IEC 60874-1 for the connectors.

The reference points 1 and 4 apply to the electrical input and output of the electro-optical and opto-electrical converter, respectively. Detailed specifications are provided only in relation to optical reference points 2 and 3.

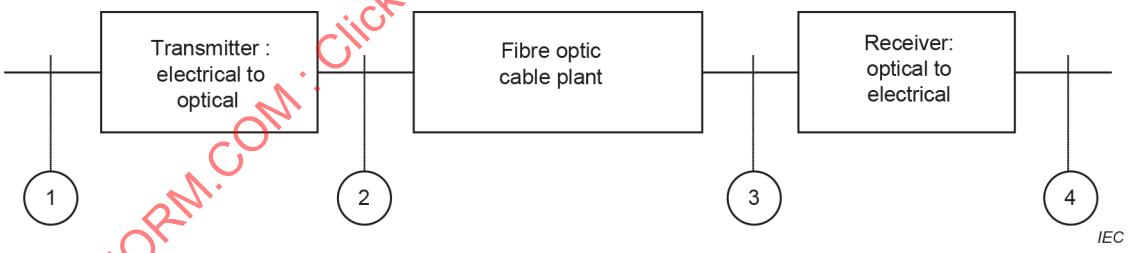


Figure 10 – Basic optical connection

In Figure 10, reference point 1 is the electrical input of the optical transmitter, reference point 2 is the optical interface between optical transmitter and FOCP, reference point 3 is the optical interface between FOCP and optical receiver, and reference point 4 is the electrical output of the optical receiver. "FOCP" means "fibre optic cable plant", which is the serial combination of fibre optic cable sections, connectors and splices providing the optical path between two terminal devices, between two optical devices or between terminal devices and an optical device.

8.1.2 Optical connector

8.1.2.1 Circular type

Refer to JEITA EIAJ RC-5720C (see Bibliography).