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INTERNATIONAL STANDARD

Interface for loudspeakers with digital input signals based on IEC 60958

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FOREWORD

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International Standard IEC 62537 has been prepared by technical area 4: Digital system interfaces and protocols, of IEC technical committee 100: Audio, video and multimedia systems and equipment.

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

CDV	Report on voting
100/1433/CDV	100/1700/RVC

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

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

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

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- withdrawn,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

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

INTRODUCTION

The IEC 60958 interface allows transmission of 2-channel digital audio with up to 24 bit word length at 192 kHz sampling rate. This is adequate for loudspeakers, however, there are additional needs in practice that require standardisation, which go beyond what's currently defined in IEC 60958. This standard is aimed at fulfilling those needs.

IEC 60958 features a user bit that can form the basis of a control data channel that addresses those additional requirements. The format of this user bit data channel is based on the existing MIDI standard.

Beyond the needs given in IEC 60958, the following offers an exemplary, but incomplete list of of what a digital loudspeaker interface should support:

- Remote control of operating parameters of the loudspeaker.
- Remote power-on of the loudspeaker – preferably without requiring standby power in the loudspeaker.
- Remote configuration of loudspeaker, for example crossover configuration, or firmware update.
- Remote supervision of loudspeakers, for example chassis temperature or amplifier integrity.
- Remote identification of loudspeakers, to allow auto-configuration of the entire system.
- Control of individual or groups of loudspeakers through a single interface.
- Remote control of Audio System through remote control receiver mounted in loudspeaker enclosure (allowing Audio System to be placed out of sight).
- Extensions to allow for future applications.

NOTE 1 Level and mute control in the loudspeaker is preferred over digital attenuation by the signal source, as this allows the full audio data word length for the filter network; level should be controlled at the last stage in front of power amplifiers. In this case, the advantage is that the full audio word length of the given format is available at any time and at any volume setting. Especially, if a fully digitally constructed crossover network has been implemented, more precise arithmetical operations can also be made at low volumes. Volume control can thus be carried out after the crossover network or even after the relevant final amplifier. Even under the most unfavourable conditions (digital pre-attenuation and analogue gain) the filters and controllers receive the full audio word width under all operating conditions (ideal state).

NOTE 2 Not all of the listed features are required in all applications. It should therefore be up to the implementer to select from this standard the parts that are required in his application, and omit the unnecessary features. See Annex D for application examples.

INTERFACE FOR LOUDSPEAKERS WITH DIGITAL INPUT SIGNALS BASED ON IEC 60958

1 Scope

This International Standard specifies the requirements for a digital loudspeaker interface based on the IEC 60958 series of standards and the MIDI specification. It maximizes flexibility and value by combining these previously separate standards. Together, the two standards provide a simple and flexible digital interface for loudspeakers.

Examples for applications of the interface can be found in Annex C of this standard.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

IEC 60958-4, *Digital audio interface – Part 4: Professional applications*

The Complete MIDI 1.0 Detailed Specification v96.1:2001, (Second edition)

3 Terms, definitions and abbreviations

3.1 Terms and definitions

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

3.1.1
digitally interfaced loudspeaker
device that combines a loudspeaker with an amplifier, where the amplifier has a digital audio input port

NOTE The amplifier and loudspeaker may share a common enclosure, or they may occupy separate enclosures. The connection between amplifier and loudspeaker and the operating principle of the transducer are left unspecified and may be analogue. In the context of this standard, the term may be abbreviated as loudspeaker or speaker when there is no risk of confusion.

3.1.2
phantom power
scheme of transmitting electrical power from a source device to a target device using the balanced wiring employed for data transfer; in particular, the power is applied between both balanced signal wires and the ground or shield connection

3.1.3
audio data
data sent to the loudspeaker that is rendered as sound by the loudspeaker

NOTE Typically this data would be in PCM 2's complement format.

3.1.4
control data
data sent to the loudspeaker that controls its operating parameters

3.1.5
controller
source device for control data

3.1.6
solid state relay
assembly of an optically controlled power switch and a LED

3.2 Abbreviations

AES	Audio Engineering Society
ASIC	Application Specific Integrated Circuit
CODEC	Coder / Decoder
CPLD	Complex Programmable Logic Device
CRC	Cyclic Redundancy Check
DSP	Digital Signal Processor
FPGA	Field Programmable Gate Array
LED	Light Emitting Diode
LSB	Least Significant Bit
MIDI	Musical Instrument Digital Interface
MSB	Most Significant Bit
MSC	MIDI Show Control
MTC	MIDI Time Code
NRPN	Non Registered Parameter Number
PCM	Pulse Code Modulation
Sysex	System-exclusive

4 General

4.1 Feature set

A digitally interfaced loudspeaker conforming to this standard shall implement the following.

- A control data channel from the controller to the loudspeaker which supports transmission of MIDI messages. This may be implemented using the U-bit embedded in the IEC 60958-4 protocol as described in Clause 5.
- A command set as described in Clause 6. A basic command set is mandatory, with optional commands and manufacturer extensions being supported at the manufacturer’s discretion.
- Optional: Power transmission from a controller to the loudspeaker, in order to activate the loudspeaker's power switch. It is sufficient to transmit the power to operate a LED. The power switch in the loudspeaker may be implemented with a solid state relay. A phantom supply scheme is used, which employs the balanced interface wiring defined in IEC 60958-4, see 7.1.
- Optional: A backwards data channel from the loudspeaker to the controller. As this runs opposite to the signal flow on the IEC 60958 interface, it is implemented as a data channel riding on the phantom power mentioned above, see 7.2

4.2 Audio formats

As a configuration setting, the loudspeaker may select from the two subchannels. A mono loudspeaker shall use the left channel audio data by default, but may optionally be configured to use the right channel audio data in a manufacturer defined way.

NOTE 1 An optional parameter specifies panning between left and right channels. Speakers that implement this feature can render an arbitrary mix of the two subchannels.

It is the manufacturer's decision which audio sampling frequencies to support, and whether single channel double sampling frequency mode is supported. It is highly recommended that 48 kHz two-channel mode with no emphasis be amongst the supported formats.

NOTE 2 The manufacturer should document clearly which formats are supported.

5 Control data channel using the U-bit of IEC 60958-4

5.1 General

In the IEC 60958 interface there is a U-bit for each of the two subchannels, these form two separate control data channels with a capacity of one bit per sample each.

NOTE Using both together to form a single data channel with twice the capacity would be possible but unwise in the presence of signal routers, hence the two U-bit channels are kept separate, except when single channel double frequency mode is used.

5.2 Formatting

The U-channel shall carry data formatted according to the MIDI standard, with the bits being transmitted in inverted state. That is, a MIDI 1-bit is transmitted as a zero U-bit, and a MIDI 0-bit is transmitted as a one U-bit. This inversion ensures that an unused U-channel (which carries 0-bits by default) is interpreted by the receiver as an idle line. For each information byte, 10 bits are transmitted in the usual asynchronous frame format. The 8 data bits of a byte are framed by a start bit and a stop bit.

NOTE 1 This allows the receiver to detect the start of each byte, and it also allows the transmitter to insert an arbitrary number of idle bits between each data byte to adjust the bandwidth used.

NOTE 2 If the bits were transmitted in the non-inverted state, an idle U-channel would be seen by the MIDI receiver as a line with a continuous break condition, which is a sequence of framing errors.

NOTE 3 As the U-bit is transmitted in lockstep with the audio data, it is possible to maintain a defined and sample accurate reaction time between control data and audio data. One MIDI byte can be transmitted for every 10 sample periods. Through insertion of idle bits, it is theoretically possible to position MIDI messages in a sample accurate way.

5.3 Mode indication

The channel status bits shall indicate that the U-channel is carrying MIDI formatted data. The binary value 0110 in the channel status of the respective subchannel (byte 1, bits 4 to 7) is used to indicate this usage of the U-bit. This value is currently reserved.

NOTE The necessary amendments need to be added to IEC 60958-4. The amendment does not need to mention any particular application, such as speakers. The definition allows the transmission of MIDI data for any purpose. MIDI is a good match with IEC 60958 for several reasons: MIDI is an open-loop protocol that does not need a backwards channel, although it can take advantage of one, should it be available. The data rate of MIDI is within the same ballpark as the U-bit data rate in the IEC 60958 series. And MIDI is a general control protocol with a lot of flexibility for custom extensions, and a lot of support in the industry, for example in the form of hardware and software products. There are also various ways in which MIDI data can be transported in other interface standards, such as IEEE 1394, USB or other computer networks.