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STANDARDS

AES recommended practice for digital audio engineering -
Synchronization of digital audio equipment in studio operations
(Revision of AES11-2009)

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AES recommended practice for digital audio engineering - Synchronization of digital audio equipment in studio operations

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Abstract

This standard provides a systematic approach to the synchronization of digital audio signals. Recommendations are made concerning the accuracy of sample clocks as embodied in the interface signal and the use of this format as a convenient synchronization reference where signals must be rendered co-timed for digital processing. Synchronism is defined, and limits are given which take account of relevant timing uncertainties encountered in an audio studio.

Contents

Foreword

[These forewords are not part of AES11, *Recommended practice for digital audio engineering - Synchronization of digital audio equipment in studio operations*.]

Foreword to original standard (1991)

This document provides operating standards and guidance for users needing to synchronize digital audio signals. This is an essential requirement in studios for the handling of remote program sources. The development of a working practice for this aspect of system engineering follows from the standardization of sampling frequency and the international agreement on the serial transmission format for the professional environment.

A working group was established in 1984 by the Subcommittee on Digital Audio of the AES Standards Committee to consider the topic with the possibility of formulating a policy on behalf of the industry. An approach was made to some 60 manufacturers of equipment to seek their advice and comment. Meetings were attended by engineers able to represent views from the SMPTE, EBU, and IEC. The final conclusions endorse the AES3-1985 and AES5-1984 standards and seek to address, primarily, the principles to be applied in synchronizing operations, thus allowing for future developments affecting digital audio systems.

During the course of this work the biannual meetings have been regularly supported by representatives of broadcasting, recording studios, and equipment manufacturers worldwide. A European-based subgroup met at various times for more detailed study. Input documents were provided by N. Gilchrist, A. Komly, R. Lagadec, P. Lidbetter, A. Weisser, J. Wilkinson, and the chairman. The following individuals have contributed to the work leading up to these proposals: K. Altmann, G. Barton, B. Bluthgen, S. Busby, R. Cabot, R. Caine, L. Fieldcr, R. Finger, N. Gilchrist, A. Griffiths, R. Hankinson, D. Haynes, R. Hoffner. T. Holman, Y. Ishida, A. Komly, R. Lagadec, P. Lidbetter, B. Locanthi. S. Lyman. G. McNally, J . Nunn. K. Tanaka, N. Taylor, D. Walstra, A. Weisser, J . Wilkinson.

W. T. Shelton
Chair, AES Standards Committee Working Group on Synchronization, 1989 May

Foreword to second revision (1997)

This document is a revision of AES11-1991. It provides operating standards and guidance for users needing to synchronize digital audio signals. This is an essential requirement in studios for the handling of remote program sources. The development of a working practice for this aspect of system engineering follows from the standardization of sampling frequencies and the international agreement on the serial transmission format for the professional environment.

A working group was established in 1984 by the Subcommittee on Digital Audio of the AES Standards Committee to consider the topic with the possibility of formulating a policy on behalf of the industry. An approach was made to some 60 manufacturers of equipment to seek their advice and comment. Meetings were attended by engineers able to represent views from the Society of Motion Picture and Television Engineers (SMPTE), the European Broadcast Union (EBU), and the International Electrotechnical Commission (IEC). The final conclusions endorse the AES3 and AES5 standards and seek to address, primarily, the principles to be applied in synchronizing operations, thus allowing for future developments affecting digital audio systems.

Following adoption in 1991, considerable interest developed in the use of AES3 signals for audio associated with digital video applications. In 1993, the AES published a proposal in the Journal of the Audio Engineering Society, vol. 41, no. 5. In 1994-10, a joint meeting was held between the working group and the corresponding SMPTE group. Other meetings were held with representatives of SMPTE, IEC, and EBU. This revision is the result of the proposal and the subsequent meetings.

The following individuals have contributed directly to the writing of this revision: R. Cabot, R. Caine, J. Dunn, L. Fielder, R. Finger, N. Gilchrist, A. Griffiths, P. Lidbetter, J. Nunn, and G. Roe.

Paul Lidbetter
Chair, AESSC SC-02-05 Working Group on Synchronization, 1996-08

Foreword to third revision (2003)

This document revises AES11-1997. The revision was undertaken as project AES11-R by the AES Standards Committee, Working Group SC-02-05 on Synchronisation. Development in working practices in digital audio and networking have given rise to more complex hierarchical systems of synchronisation, and the growth of metadata also makes more demands on reference signals. These developments are ongoing, but provision is made to expedite implementation of these when required. An annex is added by popular request to describe Word Clock, even though it has been found not to be possible to standardise it. This work has been carried out by a Task Group led by R. Caine, chair of SC-02-05. Contributors included: S. Dimond, R. Foss, J. Grant, R. Harris, B. Klinkradt, S. Lyman, A. Mason, J. Nunn, M. Poimboeuf, S. Scott, Y. Sohma, M. Yonge.

Robin Caine
Chair, AESSC SC-02-05 Working Group on Synchronization, 2003-06

Foreword to fourth revision (2009)

This document revises AES11-2003, including corrigenda and addenda. The revision was undertaken as project AES11-R by Working Group SC-02-02 on Digital Input/Output Interfacing.

The relationship with AES5 has been clarified, with tolerances specified only in AES11 and nomenclature for multiple rates only in AES5. The subclause on video referencing (4.5) and Annex B (Word Clock) have been revised to more accurately reflect the current situation in the field. Annex C has been added.

Contributors included R. Caine, D. Errock, K. Hamasaki, S. Heinzmann, and J. Woodgate.

John Grant
Chair, AESSC SC-02-02 Working Group on Digital Input/Output Interfacing, 2009-02

Addendum 2010-02-19

A new multi-part revision of AES3 was published in 2009. Its technical content is intended to be identical to the relevant parts of the 2003 edition as amended by Amendment 5 (2008) and Amendment 6 (2008). Where this document refers to clauses of earlier editions of AES3, equivalent references to AES3-2009 are also offered, *[identified by italic text in square brackets]*.

Foreword to fifth edition (2020)

This revision includes minor changes to remove insensitive terms.

J. Grant
Chair, SC-02-02 Working Group on Digital Input/Output Interfacing, 2020-11-27

Note on normative language

In AES standards documents, sentences containing the word "shall" are requirements for compliance with the document. Sentences containing the verb "should" are strong suggestions (recommendations). Sentences giving permission use the verb "may". Sentences expressing a possibility use the verb "can".

AES recommended practice for digital audio engineering - Synchronization of digital audio equipment in studio operations

1 Scope

1.1 General

This document provides a recommended practice for manufacturers and users of digital audio equipment aimed at promoting economical and efficient methods for synchronizing interconnected digital audio equipment.

Synchronization of digital audio signals is a necessary function for the exchange of signals between equipment. The objective of synchronization is primarily to time align sample clocks within digital audio signal sources. The provisions address only essential aspects necessary for successful studio operation.

The provisions make use of the two-channel digital audio interface standard for professional use, AES3. It is expected that the recommendations will be adopted for synchronizing all other digital audio interfaces.

The document addresses two groups of parameters. The first concerns the performance requirements for the successful interchange of digital audio data between equipment (5). The second concerns the performance requirements for the regeneration of clocks used for analog-to-digital and digital-to-analog, conversion (6).

1.2 Area of application

Items of stand-alone digital audio equipment interconnected via analog inputs and outputs require no consideration in this document.

The primary area of application is the digital interconnection of digital audio equipment wholly contained within the studio environment. There is a further application in which signal sources and destinations external to the studio environment interface with the equipment within the studio environment.

1.2.1 Digital interconnections within the studio environment
Digital audio equipment within a self-contained area, such as a studio or studio center, exchanges digital signals with the timing from all items of equipment controlled.

1.2.2 Digital interconnections involving sources and destinations outside the studio environment
Digital interconnections involve equipment, either local or remote, with timing not under the control of the studio or studio center.

1.2.3 Digital audio associated with video
Digital audio equipment within a self-contained area exchanges audio signals between audio and video equipment, or both, in which the timing is derived from a video reference.

2 Normative references

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

AES3 *AES recommended practice for digital audio engineering - serial transmission format for linearly represented digital audio data*. Audio Engineering Society, New York, NY, US.

AES5 *AES recommended practice for professional digital audio applications employing pulse code modulation - Preferred Sampling Frequencies*. Audio Engineering Society, New York, NY, US.

> NOTE A new multi-part revision of AES3 was published in 2009. Its technical content is intended to be identical to the relevant parts of the 2003 edition as amended by Amendment 5 (2008) and Amendment 6 (2008).

3 Definitions

For the purposes of this document, the following definitions shall apply.

3.1 synchronism
Condition in which frame frequency and phase for two digital audio signals are identical. This is distinct from isochronism which only requires identical frequencies and random but constant phase.

> Note: There is no requirement for alignment at block level in this context. (see AES3)
> *[AES3-3-2009]*

3.2
AES3 frame
Sequence of two subframes, each carrying audio sample data for each of two channels, and transmitted in one sample period.

3.3
timing reference point
Initial transition of the X or Z preamble of the frame of a digital audio signal as specified in AES3 *[AES3-3-2009, 7]*.

3.4 digital audio reference signal
DARS
A reference signal conforming to AES11

> NOTE definitions of basic-rate double-rate and quadruple-rate sampling frequencies have been removed from this document because they are adequately specified in AES5.