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Methods for Calculation of the Speech Intelligibility Index

Secretariat

Acoustical Society of America

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Abstract

This Standard defines a method for computing a physical measure that is highly correlated with the intelligibility of speech as evaluated by speech perception tests given a group of talkers and listeners. This measure is called the Speech Intelligibility Index, or SII. The SII is calculated from acoustical measurements of speech and noise. This standard is **not** a substitute for ANSI S3.2-1989 (R 1995) *American National Standard Method for Measuring the Intelligibility of Speech over Communication Systems*.

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Standards Secretariat
Acoustical Society of America
120 Wall Street, 32nd Floor
New York, New York 10005-3993

Telephone: +1 212 248 0373
Telefax: +1 212 248 0146
E-mail: asastds@aip.org

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Foreword

[This Foreword is for information only and is not an integral part of ANSI S3.5-1997 *American National Standard Methods for Calculation of the Speech Intelligibility Index.*]

This Standard defines a method for computing a physical measure that is highly correlated with the intelligibility of speech under a variety of adverse listening conditions, such as noise, filtering, and reverberation. It is a major revision of ANSI S3.5-1969 (R 1986), *American National Standard Methods for the Calculation of the Articulation Index*. The most important changes in the present version of the Standard relate to the need to provide a general framework into which various methods for determining the input variables of the Speech Intelligibility Index model (e.g., the equivalent speech spectrum level, the equivalent noise spectrum level, and the equivalent hearing threshold level) can be incorporated. For some applications these methods already exist (e.g., the modulation transfer function for determining the apparent speech-to-noise ratio in reverberation), while others still may be developed in future revisions of this Standard. In addition, the generality of the Standard has been extended to include various measurement points (e.g., free-field for architectural acoustics or eardrum for telephony). The other changes of the Standard are due to new data which have been accumulated since 1969 for various parameters and procedures used in the calculations. These new data include spread of masking, standard speech spectrum level, and relative importance of various frequencies to speech intelligibility. Finally, the name has been changed from the Articulation Index to the Speech Intelligibility Index (SII). In this Standard, *speech intelligibility* refers to how well an individual understands speech.

It should be noted that SII should **not** be used as a substitute for determining speech intelligibility as described in ANSI S3.2-1989 (R 1995), *American National Standard Method for Measuring the Intelligibility of Speech over Communication Systems*.

This Standard was developed under the jurisdiction of Accredited Standards Committee S3, Bioacoustics, which has the following scope:

Standards, specifications, methods of measurement and test, and terminology, in the fields of psychological and physiological acoustics, including aspects of general acoustics, shock and vibration which pertain to biological safety, tolerance, and comfort.

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Individual experts of Accredited Standards Committee S3, Bioacoustics, were:

J. R. Bareham	R. S. Gales	H. E. von Gierke
S. J. Barry	W. J. Galloway	D. E. Wasserman
R. W. Benson	D. L. Johnson	L. A. Wilber
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K. M. Eldred	R. L. McKinley	R. W. Young
L. S. Finegold	J. D. Royster	
J. L. Fletcher	E. S. Thalheimer	

Working Group S3/WG 79, Calculation of the Speech Intelligibility Index, which assisted Accredited Standards Committee S3, Bioacoustics, in the development of this Standard, had the following membership:

C. Pavlovic, *Chair*

R. Bilger	Z. Hou	G. Popelka
A. Boothroyd	T. Houtgast	C. Rankovic
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Suggestions for improvement will be welcomed. Send suggestions for improvement in writing to Accredited Standards Committee S3, Bioacoustics, in care of the ASA Standards Secretariat, 120 Wall Street, 32nd floor, New York, New York 10005-3993, USA, Telephone: + 1 212 248 0373; FAX: +1 212 248 0146; E-mail: asastds@aip.org.

American National Standard

Methods for Calculation of the Speech Intelligibility Index

1 Scope, purpose and applications

1.1 Scope

The predictions of this Standard apply to listening conditions where the input variables of the Speech Intelligibility Index (SII) model can be accurately estimated. The input variables include the equivalent speech spectrum level, the equivalent noise spectrum level, and the equivalent hearing threshold level. This includes the conditions where either speech or noise may not exist as directly measurable physical quantities (e.g., conditions where speech correlated noise is present, such as reverberated speech) but where equivalent speech spectrum level, equivalent noise spectrum level, and equivalent hearing threshold level can, nevertheless, be calculated. The predictions made by use of this Standard are correct only on the average, that is, across a group of talkers and a group of listeners of both genders. The scope of the Standard is limited to natural speech, otologically normal listeners, and communication conditions which do not include multiple, sharply filtered bands of speech or sharply filtered noise. In addition, the listeners should have no linguistic or cognitive deficiencies with respect to the language used.

1.2 Purpose

This Standard defines methods for computing a measure, called the Speech Intelligibility Index (SII), that is highly correlated with the intelligibility of speech under a variety of adverse listening conditions, such as noise masking, filtering, and reverberation. The SII is computed from acoustical measurements or estimates of speech spectrum level, from noise spectrum level, and from psychoacoustical measurements or estimates of hearing threshold level. Various frequencies contribute different amounts to speech intelligibility, and, within a certain range, a higher speech-to-noise ratio contributes to intelligibility. By measuring the

speech-to-noise ratio in each contributing frequency band and adding the results, the intelligibility of a speech communication system can be predicted.

1.3 Applications

SII procedures in this Standard consist of several parts. Clause 4 specifies calculation methods when the input variables (i.e., equivalent speech spectrum level, equivalent noise spectrum level, and equivalent hearing threshold level) are known. The application domain of this framework is quite general and extends to all listening conditions, within the scope of the Standard, where adequate methods for specifying these input variables exist.

Measurement and calculation procedures for specifying the input variables with which to calculate SII for a number of conditions encountered in practice, such as external noise masking, reverberant speech, monaural listening, and some conditions of binaural listening are provided in clause 5.

Extension of the SII calculation methods to individuals with hearing loss is contained in annex A. Annex B provides procedures for taking into account the content of speech materials in the assessment of speech intelligibility.

Examples of the basic SII computational procedures applied to octave and one-third octave frequency band procedures are contained in annex C.

2 References

The following Standards contain provisions which, through reference in this text, constitute provisions of this American National Standard. At the time of approval by the American National Standards Institute, Inc. (ANSI), the editions indicated were valid. Because Standards are revised from time to time, users should consult the latest version approved by the American National Standards Institute. For purposes of this Standard, the use of the latest revision of a referenced Standard is not mandatory. Information on recent editions is available from the ASA Standards Secretariat.

2.1 Normative references

[1] ANSI S3.2-1989 (R 1995) *American National Standard Method for Measuring the Intelligibility of Speech over Communication Systems.*