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American National Standard

# 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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# 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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## 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*.

[2] ANSI S3.6-1996 *American National Standard Specifications for Audiometers*.

[3] ANSI S3.20-1995 *American National Standard Bioacoustical Terminology*.

[4] ANSI S3.21-1978 (R 1997) *American National Standard Method for Pure-tone Threshold Audiometry*.

[5] ANSI S3.35-1985 (R 1997) *American National Standard Method of Measurement of Performance Characteristics of Hearing Aids under Simulated in situ Working Conditions*.

## 2.2 Informative references

[6] Bentler, R. and Pavlovic, C.V. (1989) "Transfer functions and correction factors used in hearing aid evaluation and research," *Ear and Hearing* **10**, 58-63.

[7] Dugal, R.L., Braida, L.D., and Durlach, N.I. (1978) "Implications of previous research for the selection of frequency-gain characteristics," in *Acoustical Factors Affecting Hearing Aid Performance*, edited by B.A. Studebaker & I. Hochberg, University Park, Baltimore, MD, 379-403.

[8] French, N.R. and Steinberg, J.C. (1947) "Factors governing the intelligibility of speech sounds," *J. Acoust. Soc. Am.* **19**, 90-119.

[9] Kryter, K.D. (1962) "Methods for the calculation and use of the articulation index," *J. Acoust. Soc. Am.* **34**, 1689-1697.

[10] Ludvigsen, C. (1985) "Relations among some psychoacoustic parameters in normal and cochlearly impaired listeners," *J. Acoust. Soc. Am.* **78**, 1271-1280.

[11] Pavlovic, C.V. (1987) "Derivation of primary parameters and procedures for use in speech intelligibility predictions," *J. Acoust. Soc. Am.* **82**, 413-422.

[12] Pavlovic, C.V., Rossi, M., and Espesser, R. (1990) "Statistical distribution of speech for various languages," *J. Acoust. Soc. Am.* **88**, Suppl. 1, S176.

[13] Pearsons, K.S., Bennett, R.L., and Fidell, S. (1978) "Speech Levels in Various Environments," Bolt, Beranek and Newman Report 3281, as cited in Skinner, M.W., *Hearing Aid Evaluation*, Prentice-Hall, Englewood Cliffs, N.J. 14-16.

[14] Schroeder, M. (1981) "Modulation transfer

functions: definition and measurement," *Acustica* **49**(3), 179-182.

[15] Steeneken, H.J.M. and Houtgast, T. (1980) "A physical method for measuring speech-transmission quality," *J. Acoust. Soc. Am.* **67**, 318-326.

[16] Studebaker, G.A., Taylor, R., and Sherbecue, R.L. (1994) "The effect of noise spectrum on speech recognition performance-intensity functions," *J. Speech. Hear. Res.* **37**(2), 439-448.

[17] Zwicker, E. (1961) "Subdivision of audible frequency range into critical bands," *J. Acoust. Soc. Am.* **33**, 248.

## 3 Definitions

For the purpose of this Standard, the following terms apply:

NOTE - Some of the following definitions have been adapted from S3.20-1995 for use in this Standard.

**3.1 band importance function.** For a given frequency band specified by frequency  $f_i$ , a numerical value characterizing the relative significance of this frequency band to speech intelligibility. Symbol,  $I_i$ .

### NOTES

1 Band importance functions are listed for different speech intelligibility index computational procedures in tables 1-4.

2 Band importance function depends on the type of speech material whose intelligibility needs to be predicted. As used in this Standard, it applies to *average speech*. It produces accurate predictions across different communication situations and for communication situations where contextual, linguistic, semantic, and syntactic constraints vary within a situation. The user interested in predicting speech intelligibility for a specific speech material should refer to annex B, where band importance functions for a number of speech tests are given.

3 Reference 11 contains details on the derivation of the band importance function.

**3.2 band audibility function.** For a given frequency band designated by frequency  $f_i$ , a numerical value between 0.0 and 1.0 specifying the effective proportion of the speech dynamic range within the band that contributes to speech intelligibility under conditions which are less than optimal (e.g., the presence of noise or reverberation, a high presentation level, some speech frequencies below the threshold of hearing, etc). Symbol,  $A_i$ .

**3.3 speech Intelligibility Index (SII).** Product of band importance function and band audibility func-

**Table 1 — Critical band SII procedure — frequencies, band importance function, standard speech spectra, internal noise, hearing threshold levels, and free-field to eardrum transfer function.**

| Critical band   |                      |                      |                         | Standard speech spectrum level<br>for stated vocal effort, dB |        |       |       | Reference<br>internal<br>noise<br>spectrum<br>level<br>dB | Free-<br>field to<br>eardrum<br>transfer<br>function<br>dB |
|-----------------|----------------------|----------------------|-------------------------|---------------------------------------------------------------|--------|-------|-------|-----------------------------------------------------------|------------------------------------------------------------|
| Band<br>no.     | Center<br>freq<br>Hz | Band<br>limits<br>Hz | Band<br>import-<br>ance | Normal                                                        | Raised | Loud  | Shout |                                                           |                                                            |
| 1               | 150                  | 100-200              | 0.0103                  | 31.44                                                         | 34.06  | 34.21 | 28.69 | 1.50                                                      | 0.60                                                       |
| 2               | 250                  | 200-300              | 0.0261                  | 34.75                                                         | 38.98  | 41.55 | 42.50 | -3.90                                                     | 1.00                                                       |
| 3               | 350                  | 300-400              | 0.0419                  | 34.14                                                         | 38.62  | 43.68 | 47.14 | -7.20                                                     | 1.40                                                       |
| 4               | 450                  | 400-510              | 0.0577                  | 34.58                                                         | 39.84  | 44.08 | 48.46 | -8.90                                                     | 1.40                                                       |
| 5               | 570                  | 510-630              | 0.0577                  | 33.17                                                         | 39.44  | 45.34 | 50.17 | -10.30                                                    | 1.90                                                       |
| 6               | 700                  | 630-770              | 0.0577                  | 30.64                                                         | 37.99  | 45.22 | 51.68 | -11.40                                                    | 2.80                                                       |
| 7               | 840                  | 770-920              | 0.0577                  | 27.59                                                         | 35.85  | 43.60 | 51.43 | -12.00                                                    | 3.00                                                       |
| 8               | 1000                 | 920-1080             | 0.0577                  | 25.01                                                         | 33.86  | 42.16 | 51.31 | -12.50                                                    | 2.60                                                       |
| 9               | 1170                 | 1080-1270            | 0.0577                  | 23.52                                                         | 32.56  | 41.07 | 49.40 | -13.20                                                    | 2.60                                                       |
| 10              | 1370                 | 1270-1480            | 0.0577                  | 22.28                                                         | 30.91  | 39.68 | 49.03 | -14.00                                                    | 3.60                                                       |
| 11              | 1600                 | 1480-1720            | 0.0577                  | 20.15                                                         | 28.58  | 37.70 | 47.65 | -15.40                                                    | 6.10                                                       |
| 12              | 1850                 | 1720-2000            | 0.0577                  | 18.29                                                         | 26.37  | 35.62 | 45.47 | -16.90                                                    | 10.50                                                      |
| 13              | 2150                 | 2000-2320            | 0.0577                  | 16.37                                                         | 24.34  | 33.17 | 43.13 | -18.80                                                    | 13.80                                                      |
| 14              | 2500                 | 2320-2700            | 0.0577                  | 13.80                                                         | 22.35  | 30.98 | 40.80 | -21.20                                                    | 16.80                                                      |
| 15              | 2900                 | 2700-3150            | 0.0577                  | 12.21                                                         | 21.04  | 29.01 | 39.15 | -23.20                                                    | 15.80                                                      |
| 16              | 3400                 | 3150-3700            | 0.0577                  | 11.09                                                         | 19.56  | 27.71 | 37.30 | -24.90                                                    | 14.90                                                      |
| 17              | 4000                 | 3700-4400            | 0.0577                  | 9.33                                                          | 16.78  | 25.41 | 34.41 | -25.90                                                    | 14.30                                                      |
| 18              | 4800                 | 4400-5300            | 0.0460                  | 5.84                                                          | 12.14  | 19.20 | 29.01 | -24.20                                                    | 12.40                                                      |
| 19              | 5800                 | 5300-6400            | 0.0343                  | 3.47                                                          | 9.04   | 15.37 | 25.17 | -19.00                                                    | 7.90                                                       |
| 20              | 7000                 | 6400-7700            | 0.0226                  | 1.78                                                          | 6.36   | 12.61 | 22.08 | -11.70                                                    | 4.30                                                       |
| 21              | 8500                 | 7700-9500            | 0.0110                  | -0.14                                                         | 3.44   | 9.62  | 18.76 | -6.00                                                     | 0.50                                                       |
| Overall SPL, dB |                      |                      |                         | 62.35                                                         | 68.34  | 74.85 | 82.30 |                                                           |                                                            |

tion, summed over the total number of frequency bands in the computational method. In symbols:

$$S = \sum_{i=1}^n I_i A_i \quad (1)$$

where  $n$  is the number of SII computational bands, while  $I_i$  and  $A_i$  are the values of the band importance function and the band audibility function associated with the frequency band designated by the summation index  $i$ .

#### NOTES

1 Combination rules other than addition of the products  $I_i$  and  $A_i$  may be used to improve predictions under some circumstances, but are not considered in this Standard.

2 The calculated SII is not converted to any corresponding speech intelligibility score. It may be inter-

preted as a proportion of the total number of speech cues available to the listener. The maximal value of the SII, 1.0, signifies that all speech cues reach the listener, while its minimum value, 0.0, signifies that no speech cues are available to the listener. The SII value of 0.5 would likewise suggest that half of the speech cues are delivered to the listener.

**3.4 SII computational procedures.** Method for calculating speech intelligibility index taking into account band importance function, speech spectrum level, and noise spectrum level. (See clauses 4 and 5.)

#### NOTES

1 Depending on the number and size of discrete frequency bands used in the SII calculations, different SII computational procedures can be implemented. In this Standard, four computational procedures are provided. In the order of accuracy they are:

**Table 2 — Equally-contributing (17 band) critical-band SII procedure — frequencies, band importance function, standard speech spectra, internal noise, hearing threshold levels, and free-field to eardrum transfer function.**

| Band no.        | Critical band  |                |                 | Standard speech spectrum level for stated vocal effort, dB |        |       |       | Reference internal noise spectrum level dB | Free-field to eardrum transfer function dB |
|-----------------|----------------|----------------|-----------------|------------------------------------------------------------|--------|-------|-------|--------------------------------------------|--------------------------------------------|
|                 | Center freq Hz | Band limits Hz | Band importance | Normal                                                     | Raised | Loud  | Shout |                                            |                                            |
| 1               | 350            | 300-400        | 0.0588          | 34.14                                                      | 38.62  | 43.68 | 47.14 | -7.20                                      | 1.40                                       |
| 2               | 450            | 400-510        | 0.0588          | 34.58                                                      | 39.84  | 44.08 | 48.46 | -8.90                                      | 1.40                                       |
| 3               | 570            | 510-630        | 0.0588          | 33.17                                                      | 39.44  | 45.34 | 50.17 | -10.30                                     | 1.90                                       |
| 4               | 700            | 630-770        | 0.0588          | 30.64                                                      | 37.99  | 45.22 | 51.68 | -11.40                                     | 2.80                                       |
| 5               | 840            | 770-920        | 0.0588          | 27.59                                                      | 35.85  | 43.60 | 51.43 | -12.00                                     | 3.00                                       |
| 6               | 1000           | 920-1080       | 0.0588          | 25.01                                                      | 33.86  | 42.16 | 51.31 | -12.50                                     | 2.60                                       |
| 7               | 1170           | 1080-1270      | 0.0588          | 23.52                                                      | 32.56  | 41.07 | 49.40 | -13.20                                     | 2.60                                       |
| 8               | 1370           | 1270-1480      | 0.0588          | 22.28                                                      | 30.91  | 39.68 | 49.03 | -14.00                                     | 3.60                                       |
| 9               | 1600           | 1480-1720      | 0.0588          | 20.15                                                      | 28.58  | 37.70 | 47.65 | -15.40                                     | 6.10                                       |
| 10              | 1850           | 1720-2000      | 0.0588          | 18.29                                                      | 26.37  | 35.62 | 45.47 | -16.90                                     | 10.50                                      |
| 11              | 2150           | 2000-2320      | 0.0588          | 16.37                                                      | 24.34  | 33.17 | 43.13 | -18.80                                     | 13.80                                      |
| 12              | 2500           | 2320-2700      | 0.0588          | 13.80                                                      | 22.35  | 30.98 | 40.80 | -21.20                                     | 16.80                                      |
| 13              | 2900           | 2700-3150      | 0.0588          | 12.21                                                      | 21.04  | 29.01 | 39.15 | -23.20                                     | 15.80                                      |
| 14              | 3400           | 3150-3700      | 0.0588          | 11.09                                                      | 19.56  | 27.71 | 37.30 | -24.90                                     | 14.90                                      |
| 15              | 4000           | 3700-4400      | 0.0588          | 9.33                                                       | 16.78  | 25.41 | 34.41 | -25.90                                     | 14.30                                      |
| 16              | 4800           | 4400-5300      | 0.0588          | 5.84                                                       | 12.14  | 19.20 | 29.01 | -24.20                                     | 12.40                                      |
| 17              | 5800           | 5300-6400      | 0.0588          | 3.47                                                       | 9.04   | 15.37 | 25.17 | -19.00                                     | 7.90                                       |
| Overall SPL, dB |                |                |                 | 62.35                                                      | 68.34  | 74.85 | 82.30 |                                            |                                            |

- (1) Critical band procedure (21 bands),
- (2) One-third octave band procedure (18 bands),
- (3) Equally-contributing critical band procedure (17 bands),
- (4) Octave band procedure (6 bands).

2 The octave band procedure should not be used if either the speech level or the noise level varies greatly within any one octave.

**3.5 reference communication situation.** Specific set of conditions assumed in the computation of speech intelligibility index:

- 1) Listener faces both the speech and noise source in an otherwise free field or noise and speech are assumed to be omnidirectional sound sources,
- 2) Listening is monaural,
- 3) The speech and noise sound sources are independent of each other and their properties can be accurately measured in the absence of the other.

NOTE - For communication situations that do not satisfy these conditions (e.g., binaural listening) see 3.11 and 3.15.

**3.6 speech spectrum level.** Level of the limit, as the width of the frequency band approaches zero, of the ratio of the quotient of the time-mean-square pressure of a speech signal in a specified frequency band, by the width of the band, to the quotient of the square of the reference pressure of  $20\mu\text{Pa}$  by the reference bandwidth of 1 Hz. Unit, decibel (dB).

#### NOTES

1 Speech literature often refers to speech spectrum level as being the "power" average over time of speech sound pressure level contained within a frequency band 1 Hz in width.

2 In symbols, speech spectrum level  $E(f)$  is expressed as:

$$E(f) = 10 \lg \left\{ \lim_{\Delta f \rightarrow 0} [p_f^2(f)/\Delta f] / [p_o^2/\Delta o f] \right\} \quad (2)$$