SLOVENSKI STANDARD
SIST EN 60268-16:1999

01-april-1999

Sound system equipment -- Part 16: Objective rating of speech intelligibility by speech transmission index (IEC 60268-16:1998)

Sound system equipment -- Part 16: Objective rating of speech intelligibility by speech transmission index

Elektroakustische Geräte -- Teil 16: Objektive Bewertung der Sprachverständlichkeit durch den Sprachübertragungsindex

Equipements pour systèmes électroacoustiques -- Partie 16: Evaluation objective de l'intelligibilité de la parole au moyen de l'indice de transmission de la parole

Ta slovenski standard je istoveten z: EN 60268-16:1998

ICS:

33.160.30	Avdio sistemi	Audio systems

SIST EN 60268-16:1999 en

EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

EN 60268-16

April 1998

ICS 33.160.01

Descriptors: Sound system equipment, warning system, sound alarm, evacuation of people, intelligibility, sound transmission, definitions, specifications, measuring methods, tests, marking

English version

Sound system equipment
Part 16: Objective rating of speech intelligibility by speech transmission index
(IEC 60268-16:1998)

Equipements pour systèmes électroacoustiques
Partie 16: Evaluation objective de l'intelligibilité de la parole au moyen de l'indice de transmission de la parole
(CEI 60268-16:1998)

Elektroakustische Geräte
Teil 16: Objektive Bewertung der Sprachverständlichkeit durch den Sprachübertragungsindex
(IEC 60268-16:1998)

This European Standard was approved by CENELEC on 1998-04-01. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the Central Secretariat has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

CENELEC
European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

Central Secretariat: rue de Stassart 35, B - 1050 Brussels

Ref. No. EN 60268-16:1998 E

Foreword

The text of document 100C/189/FDIS, future edition 2 of IEC 60268-16, prepared by SC 100C, Audio, video and multimedia subsystems and equipment, of IEC TC 100, Audio, video and multimedia systems and equipment, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 60268-16 on 1998-04-01.

The following dates were fixed:

- latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 1999-01-01
- latest date by which the national standards conflicting with the EN have to be withdrawn (dow) 2001-01-01

Endorsement notice

The text of the International Standard IEC 60268-16:1998 was approved by CENELEC as a European Standard without any modification.

NORME INTERNATIONALE
INTERNATIONAL STANDARD

CEI
IEC
60268-16

Deuxième édition
Second edition
1998-03

Equipements pour systèmes électroacoustiques –

Partie 16:
Evaluation objective de l'intelligibilité de la parole au moyen de l'indice de transmission de la parole

Sound system equipment –

Part 16:
Objective rating of speech intelligibility by speech transmission index

International Electrotechnical Commission 3, rue de Varembé Geneva, Switzerland
Telefax: +41 22 919 0300 e-mail: inmail@iec.ch IEC web site http: //www.iec.ch

Commission Electrotechnique Internationale
International Electrotechnical Commission
Международная Электротехническая Комиссия

CODE PRIX
PRICE CODE U

Pour prix, voir catalogue en vigueur
For price, see current catalogue

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

SOUND SYSTEM EQUIPMENT –

Part 16: Objective rating of speech intelligibility by speech transmission index

FOREWORD

1) The IEC (International Electrotechnical Commission) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of the 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, the IEC publishes International Standards. 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. The IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
2) The formal decisions or agreements of the IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested National Committees.
3) The documents produced have the form of recommendations for international use and are published in the form of standards, technical reports or guides and they are accepted by the National Committees in that sense.
4) In order to promote international unification, IEC National Committees undertake to apply IEC International Standards transparently to the maximum extent possible in their national and regional standards. Any divergence between the IEC Standard and the corresponding national or regional standard shall be clearly indicated in the latter.
5) The IEC provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with one of its standards.
6) Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. The IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 60268-16 has been prepared by subcommittee 100C: Audio, video and multimedia subsystems and equipment, of IEC technical committee 100: Audio, video and multimedia systems and equipment.

This second edition cancels and replaces the first edition, published in 1988. This second edition constitutes a technical revision.

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

FDIS	Report on voting
100C/189/FDIS	100C/218/RVD

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

Annex A forms an integral part of this standard.

Annexes B, C, D and E are for information only.

SOUND SYSTEM EQUIPMENT –

Part 16: Objective rating of speech intelligibility by speech transmission index

1 Scope

This part of IEC 60268 concerns objective methods for rating the transmission quality of speech with respect to intelligibility. The three methods, which are closely related are referred to as the "STI," the "STITEL" and the "RASTI" methods (see clause 3). The methods are intended for rating speech transmission with or without sound systems.

A survey of other methods of determining speech intelligibility is also included, together with a method of correlating the results of different methods of determination.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of IEC 60268. At the time of publication, the editions indicated were valid. All normative documents are subject to revision, and parties to agreements based on this part of IEC 60268 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO/TR 4870:1991, *Acoustics – The construction and calibration of speech intelligibility tests*

ITU-T Recommendation P.50:1994, *Artificial voices*

ITU-T Recommendation P.51:1996, *Artificial mouth*

3 Definitions and abbreviations

For the purpose of this part of IEC 60268, the following definitions apply:

3.1
speech transmission index (STI)
a physical quantity, representing the transmission quality of speech with respect to intelligibility

3.2
speech transmission index for telecommunication systems (STITEL)
index obtained by a condensed version of the STI method but still responsive to distortions found in communication systems

3.3
rapid speech transmission index; room acoustics speech transmission index (RASTI)
index obtained by a condensed version of the STI method focused on noise interference and distortions in the time domain (echoes, reverberation)

4 Description of the methods

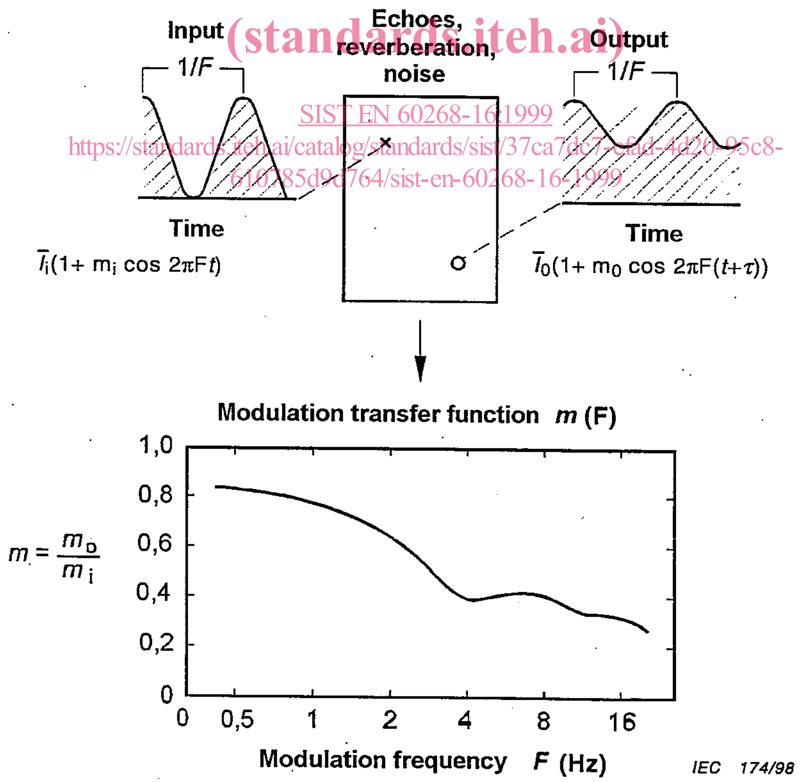
4.1 General

The methods can be used to compare speech transmission quality at various positions and for various conditions within the same listening space, in particular for assessing the effect of changes in the acoustic properties. This includes effects from the presence of an audience, or of changes in any sound system [1][1]) The methods are also able to determine the absolute rating of the speech transmission quality with respect to intelligibility, when comparing different listening spaces under similar conditions. Annex A provides a more detailed description of the basis of the speech transmission index.

The determination of the transmission quality of speech with respect to intelligibility is based on the reduction of the modulation index m_i of a test signal, simulating the speech characteristics of a real talker, when sounded in a room. The test signal is transmitted by a sound source situated at the talker's position to a microphone at any listener's position, where the modulation index is m_o.

For the sound source, the important characteristics are: the physical size, the directivity, the position and the sound pressure level.

The typical test signal consists of a noise carrier with a speech-shaped frequency spectrum and a sinusoidal intensity modulation with modulation frequency F (see figure 1).



NOTE – m_i and m_o are the modulation indices of the input and the output signals, respectively. $\bar{I}_i$ and $\bar{I}_o$ are the input and output intensities.

Figure 1 – Modulation transfer function: input/output comparison

1) Figures in square brackets refer to the bibliography given in annex E.

The reduction in the modulation index is quantified by the modulation transfer function *m(F)* which is determined by:

$$m(F) = \frac{m_o}{m_i}$$

and is interpreted in terms of an apparent signal-to-noise ratio (SNR), irrespective of the cause of the reduction which can be reverberation, echoes or interfering noise, determined by:

$$SNR_{App} = 10\ \lg\left(\frac{m(F)}{1 - m(F)}\right)$$

The values of the apparent signal-to-noise ratio are limited to the range ±15 dB. Values less than –15 dB are given the value of –15 dB and values greater than 15 dB are given the value of 15 dB.

4.2 The STI method

4.2.1 General

The STI method, described in annex A, is based on the determination of the modulation transfer function *m(F)* for 98 data points, obtained for 14 modulation frequencies at one-third octave intervals ranging from 0,63 Hz up to and including 12,5 Hz and for seven octave bands with centre frequencies ranging from 125 Hz up to and including 8 kHz (see figure A.3).

4.2.2 Precision of the STI method

Because the test signal is band-limited random, or pseudo-random, noise, repetition of measurement does not normally produce identical results, even under conditions of steady interference. The results centre on a mean with a certain standard deviation. This depends, amongst other factors, on the number of discrete measurements of the modulation transfer function (usually 98 for the STI method) and the measuring time involved. Typically, the value of the standard deviation is about 0,02 for a measuring time of 10 s for each *m(F)* and with stationary noise interference. With fluctuating noise (e.g. a babble of voices), higher standard deviations may be found possibly with a systematic error. This can be checked by carrying out a measurement in the absence of the test signal. This should result in a residual STI value less than 0,20. An estimate of the standard deviation should be made by repeating measurements for at least a restricted set of conditions.

4.2.3 Limitations of the STI method

Due to the form of the test signals and the analysis, the types of distortion not accounted for are: frequency shifts (such as those found with devices for preventing acoustic feedback and with single sideband radio transmissions), frequency multiplication (e.g. analogue tape recordings played at incorrect speed) and systems such as vocoders that encode speech fragments (e.g. linear predictive coding which introduces errors related to voiced/unvoiced speech fragments and pitch errors).

The method should not be used for transmission channels

a) which introduce frequency shifts or frequency multiplication, or

b) which include vocoders (i.e. linear predictive speech coder (LPC), code-excited linear predictive coder (CELP), residually-excited linear predictive coder (RELP), etc.).

4.3 The STITEL method

4.3.1 General

A simplification can be applied to the test signal if the uncorrelated (speech-like) modulations, required for the correct interpretation of non-linear distortions, are omitted. This opens the possibility of modulating and parallel processing all frequency bands simultaneously, so reducing measuring time. The STITEL method, described in annex B, employs this simplification and takes 10 s to 15 s for a measurement.

4.3.2 Precision of the STITEL method

As with the STI method (see 4.2.2), results are mean values with a certain standard deviation, due to the randomness of noise. The standard deviation depends on the number of discrete measurements of the modulation transfer function (typically seven for the STITEL method) and the measuring time involved. The standard deviation should be estimated by performing repeated measurements, at least for a restricted number of conditions.

4.3.3 Limitations of the STITEL method

The STITEL method should not be used for transmission channels:

a) which introduce frequency shifts or frequency multiplication;

b) which include vocoders (i.e. LPC, CELP, RELP, etc.);

c) for which reverberation time is strongly frequency dependent;

d) having echoes stronger than –10 dB referred to the primary signal;

e) if the background noise has audible tones and/or marked peaks or troughs in the octave-band spectrum;

f) if the background noise is impulsive and/or the space is not substantially free of discrete echoes, particularly flutter echoes whose repetition frequency is an integral multiple of one or more of the modulation frequencies [2];

g) if the reverberation time is strongly frequency dependent. Over the range of centre frequencies 125 Hz to 8 kHz the uniformities of the octave-band early decay times and signal-to-noise ratios should fall within the permitted area shown in figure 3.

If c) or d) or both apply, or possibly apply, the STI method should be used instead, or used to verify the results obtained by the STITEL method.

4.4 The RASTI method

4.4.1 General

Another simplification that can be applied is a reduction in the number of octave bands. This is the case with the RASTI method, described in annex C, in which the analysis is restricted to only two octave bands with centre frequencies 500 Hz and 2 kHz, and to only four and five modulation frequencies, respectively, in these bands. This implies that bandpass limiting and background noise with an irregular spectrum are not accounted for correctly, nor is the effect of non-linear distortion included. The RASTI method can, however, be used as a screening approach for most room acoustic applications. As with the STI method, certain distortions, particularly those from reverberation, if smooth and monotonic, are accounted for correctly [3].

The RASTI method is not a reliable measure of the intelligibility of speech uttered in high noise environments, or of normal speech to the hard of hearing or to the wearers of ear defenders.

4.4.2 Precision of the RASTI method

As with the STI method (see 4.2.2), results are mean values with a certain standard deviation, due to the randomness of noise. The standard deviation depends upon the measuring time involved, amongst other factors. The standard deviation should be estimated by performing repeated measurements, at least for a restricted number of conditions. In practice, a measuring time of 10 s is a useful compromise between speed and accuracy. Figure 2 illustrates the accuracy obtainable with a measuring time of that order.

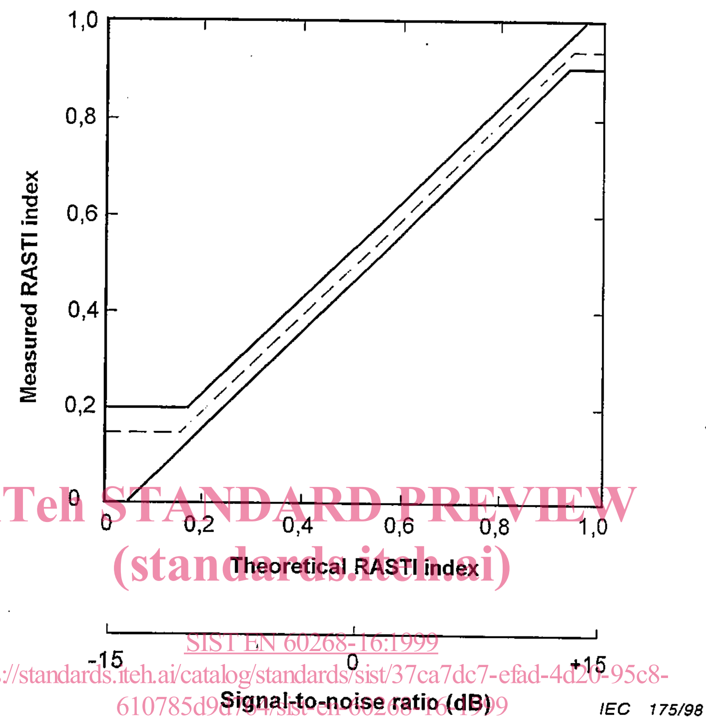


Figure 2 – Relationship between the theoretical STI by the RASTI method and the STI measured by a proprietary equipment with a measurement time of 12 s approximately

4.4.3 Limitations of the RASTI method

The application of the RASTI method is limited by factors concerned with speech transmission, background noise and reverberation. Therefore its use should be restricted to cases where the following conditions are met:

a) no frequency shifts or frequency multiplication;

b) no use of vocoders (i.e. LPC, CELP, RELP, etc.);

c) essentially linear speech transmission (any amplitude compression or expansion limited to 1 dB) and no peak clipping of a sinusoidal signal giving the same sound pressure level at the measuring position as the test signal;

d) overall system frequency response between the octave bands centred on 125 Hz and 8 kHz is uniform, i.e. the difference in sound pressure level between any two adjacent octave bands should not exceed 5 dB;

e) background noise is free of audible tones and of marked peaks or troughs in the octave-band spectrum;

f) background noise is not impulsive and the space is substantially free of discrete echoes, particularly flutter echoes whose repetition frequency is an integral multiple of one or more of the modulation frequencies [2];

g) reverberation time is not strongly frequency dependent. Over the range of centre frequencies 125 Hz to 8 kHz, the uniformities of the octave-band early decay times and signal-to-noise ratios should fall within the permitted area shown in figure 3;