

SLOVENSKI STANDARD

SIST EN IEC 60268-16:2021

01-julij-2021

Nadomešča:
SIST EN 60268-16:2011

Oprema za zvokovne sisteme - 16. del: Objektivno ocenjevanje govorne razumljivosti z uporabo indeksa prenosa govora (IEC 60268-16:2020)

Sound system equipment - Part 16: Objective rating of speech intelligibility by speech transmission index (IEC 60268-16:2020)

Elektroakustische Geräte - Teil 16: Objektive Bewertung der Sprachverständlichkeit durch den Sprachübertragungsindex (IEC 60268-16:2020)

Equipements pour systèmes électroacoustiques - Partie 16: Evaluation objective de l'intelligibilité de la parole au moyen de l'indice de transmission de la parole (IEC 60268-16:2020)

Ta slovenski standard je istoveten z: EN IEC 60268-16:2020

ICS:

33.160.30	Avdio sistemi	Audio systems
-----------	---------------	---------------

SIST EN IEC 60268-16:2021	en,fr,de
----------------------------------	-----------------

iTeh STANDARD PREVIEW
(standards.iteh.ai)

SIST EN IEC 60268-16:2021

<https://standards.iteh.ai/catalog/standards/sist/085ef6f7-9ba7-4b6b-ad13-8f56893d3071/sist-en-iec-60268-16-2021>

EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

EN IEC 60268-16

November 2020

ICS 33.160.01

Supersedes EN 60268-16:2011 and all of its
amendments and corrigenda (if any)

English Version

**Sound system equipment - Part 16: Objective rating of speech
intelligibility by speech transmission index
(IEC 60268-16:2020)**

Équipements pour systèmes électroacoustiques - Partie 16:
Évaluation objective de l'intelligibilité de la parole au moyen
de l'indice de transmission de la parole
(IEC 60268-16:2020)

Elektroakustische Geräte - Teil 16: Objektive Bewertung der
Sprachverständlichkeit durch den Sprachübertragungsindex
(IEC 60268-16:2020)

This European Standard was approved by CENELEC on 2020-10-30. 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 CEN-CENELEC Management Centre 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 CEN-CENELEC Management Centre has the same status as the official versions.

<https://standards.iteh.ai/catalog/standards/sist/085ef6f7-9ba7-4b6b-ad13-106c38a7f88a/iec-60268-16-2020>

CENELEC members are the national electrotechnical committees of Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.



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

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

EN IEC 60268-16:2020 (E)**European foreword**

The text of document 100/3202/CDV, future edition 5 of IEC 60268-16, prepared by IEC/TC 100 "Audio, video and multimedia systems and equipment" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN IEC 60268-16:2020.

The following dates are fixed:

- latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2021-07-30
- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2023-10-30

This document supersedes EN 60268-16:2011 and all of its amendments and corrigenda (if any).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC shall not be held responsible for identifying any or all such patent rights.

Endorsement notice**iTeh STANDARD PREVIEW**

The text of the International Standard IEC 60268-16:2020 was approved by CENELEC as a European Standard without any modification. (standards.iteh.ai)

In the official version, for Bibliography, the following notes have to be added for the standards indicated:

https://standards.iteh.ai/catalog/standards/sist/085ef6f7-9ba7-4b6b-ad13-8f56893d3071/sist-en-iec-60268-16-2021		
IEC 60318-1:2009	NOTE	Harmonized as EN 60318-1:2009 (not modified)
IEC 61672-1	NOTE	Harmonized as EN 61672-1
IEC 60118-4	NOTE	Harmonized as EN 60118-4
ISO 9921:2003	NOTE	Harmonized as EN ISO 9921:2003 (not modified)
ISO/TR 22411:2008	NOTE	Harmonized as CEN ISO/TR 22411:2011 (not modified)
ISO 3382-1:2009	NOTE	Harmonized as EN ISO 3382-1:2009 (not modified)

Annex ZA (normative)

Normative references to international publications with their corresponding European publications

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

NOTE 1 Where an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

NOTE 2 Up-to-date information on the latest versions of the European Standards listed in this annex is available here: www.cenelec.eu.

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 61260-1	2014	Electroacoustics - Octave-band and fractional-octave-band filters - Part 1: Specifications	EN 61260-1	2014

iTeh STANDARD PREVIEW
(standards.iteh.ai)

SIST EN IEC 60268-16:2021
<https://standards.iteh.ai/catalog/standards/sist/085ef6f7-9ba7-4b6b-ad13-8f56893d3071/sist-en-iec-60268-16-2021>

iTeh STANDARD PREVIEW
(standards.iteh.ai)

[SIST EN IEC 60268-16:2021](https://standards.iteh.ai/catalog/standards/sist/085ef6f7-9ba7-4b6b-ad13-8f56893d3071/sist-en-iec-60268-16-2021)

<https://standards.iteh.ai/catalog/standards/sist/085ef6f7-9ba7-4b6b-ad13-8f56893d3071/sist-en-iec-60268-16-2021>



IEC 60268-16

Edition 5.0 2020-09

INTERNATIONAL STANDARD

NORME INTERNATIONALE



Sound system equipment –

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

Équipements pour systèmes électroacoustiques –

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

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

ICS 33.160.01

ISBN 978-2-8322-8862-7

Warning! Make sure that you obtained this publication from an authorized distributor.

Attention! Veuillez vous assurer que vous avez obtenu cette publication via un distributeur agréé.

CONTENTS

FOREWORD	7
INTRODUCTION	9
1 Scope	12
2 Normative references	12
3 Terms and definitions	12
4 Description of the STI model	18
4.1 Overview	18
4.2 Applicability of the STI model	19
4.3 Theoretical details	19
4.3.1 Envelope function and envelope spectrum	19
4.3.2 Reduction of modulation	20
4.3.3 Role of the octave-band noise carriers	20
4.3.4 Theoretical overview	20
4.4 Measurement of STI	22
4.4.1 Direct and indirect methods	22
4.4.2 Full STI	23
4.4.3 STIPA	23
4.4.4 Choice of method	23
5 Direct method of measuring STI – User guidance	25
5.1 Overview	25
5.2 STIPA	26
5.3 Application	26
5.4 Limitations	26
6 Indirect method of measuring STI (impulse response) – User guidance	27
6.1 Overview	27
6.2 Application	27
6.3 Limitations (non-linear distortion)	28
7 Limitations of the STI model	29
7.1 General	29
7.2 Frequency shifts	30
7.3 Centre clipping	30
7.4 Dropouts	30
7.5 Jitter	30
7.6 Digital voice compression systems	30
7.7 Overestimation of STI under low background noise conditions	31
7.8 Frequency response	31
7.9 Echoes	32
7.10 Fast amplitude compression and expansion	34
7.11 Non-linear distortion	35
7.12 Hearing impaired listeners	35
7.13 Impulsive and fluctuating noise	35
7.14 Conclusion	35
8 Measurement procedures, post-processing of data and applications	36
8.1 General	36
8.2 Acoustical input	36

8.3	Acoustical output	38
8.4	Electrical input	38
8.5	Electrical output	38
8.6	Examples of input/output combinations	38
8.6.1	Acoustical input – Acoustical output	38
8.6.2	Electrical input – Electrical output (e.g. assessment of wired and wireless) communication systems)	38
8.6.3	Acoustical input – Electrical output (e.g. assessment of microphones)	38
8.6.4	Electrical input – Acoustical output (e.g. assessment of PA systems)	39
8.7	Spatial averaging of STI measurements	39
8.8	Post-processing of measured MTF data	40
8.9	Issues concerning noise	40
8.9.1	General	40
8.9.2	Measurement of background noise	41
8.9.3	Fluctuating noise	41
8.10	Analysis and interpretation of the results	41
8.11	Binaural STI measurements	42
9	Use of the STI as a design prediction tool	42
9.1	Overview	42
9.2	Statistical predictions	43
9.3	Prediction from simulated impulse response	43
Annex A (informative)	The basis of the STI concept	44
A.1	Introduction to this annex	44
A.1.1	Purpose	44
A.1.2	Modulation transfer function (MTF)	44
A.1.3	STI model	45
A.1.4	STI modulation frequencies	46
A.2	Calculation of the STI	46
A.2.1	General equation for STI	46
A.2.2	Gender-specific octave band weighting and redundancy factors	47
A.2.3	Adjustment of the MTF for ambient noise	48
A.2.4	Adjustment of the MTF for auditory masking and threshold effects	48
A.3	Calculation of the modulation transfer ratio values	49
A.3.1	Direct method: Analysis of the STI test signal	49
A.3.2	Indirect method: Determination of the modulation transfer function (MTF)	50
A.4	Auditory effects on the STI	51
A.4.1	Overview	51
A.4.2	Level-dependent auditory masking	51
A.4.3	Absolute speech reception threshold	54
A.5	Generation of the STI test signal (direct method)	54
A.5.1	Pink noise source signal	54
A.5.2	Generating octave band carrier signals	54
A.5.3	Intensity modulation of the carrier signals	55
A.5.4	Applying the speech spectrum to the STI test signal	55
A.6	Spectrum of STI test signal	55
A.6.1	Standardized speech spectrum	55
A.6.2	Speech-shaped noise	55
Annex B (normative)	STIPA method	57

B.1	Overview.....	57
B.2	Test signal	57
Annex C	(normative) Verification of STI measuring devices	59
C.1	Specification of the measuring device	59
C.2	Signals for testing STI implementations	59
C.3	Testing the dynamic range in the modulation domain	59
C.3.1	General	59
C.3.2	Modulation depth testing for STIPA direct method	59
C.3.3	Modulation depth testing for STI indirect method	60
C.4	Testing of cross-talk between octave-band filters	61
C.4.1	Flank attenuation slopes	61
C.4.2	Octave band filter testing – STIPA direct method	61
C.4.3	Performance verification files.....	62
Annex D	(informative) Use of STI measuring devices	63
D.1	Overview.....	63
D.2	STIPA characterises only the speech transmission channel	63
D.3	Examples of test scenarios for STIPA tests	64
D.4	Equipment and resources needed for a STIPA test	67
D.4.1	Availability of the test signal	67
D.4.2	A source of the STIPA test signal	67
D.4.3	A STIPA analyser	67
D.5	Steps in the overall procedure	67
Annex E	(informative) Qualification of the STI and relationships with other speech intelligibility measures	68
E.1	Relationship between the STI and word/sentence scores	68
E.2	Relationship between STI and listening difficulty	68
Annex F	(informative) Nominal qualification bands for STI	70
Annex G	(informative) Examples of STI qualification bands and typical applications	71
Annex H	(informative) Non-native listeners	72
Annex I	(informative) Effect of age-related hearing loss and hearing impairment on speech intelligibility.....	73
Annex J	(normative) Setting and adjustment of STI test signal level.....	74
J.1	Overview.....	74
J.2	The concept of 'speech level' and the method of measurement	74
J.3	Real speech level	74
J.4	Corrected speech level derived from real speech level.....	75
J.5	Comparison of dynamic structures of speech and test signals.....	75
Annex K	(informative) Example test report sheet for STI measurements	77
Annex L	(normative) Prediction of the STI using statistical methods.....	79
Annex M	(informative) Adjustments to STI data to simulate alternative ambient noise spectra and different speech levels	81
Annex N	(informative) Other methods of determining speech intelligibility	91
N.1	Overview.....	91
N.2	Word tests	91
N.3	Modified rhyme tests	91
N.4	Speech intelligibility index (SII)	92
N.5	PESQ	92
Annex O	(informative) Alternative direct methods for measuring Full STI	93

Annex P (normative) Information to be provided by manufacturers	94
P.1 Purpose of this annex	94
P.2 Form in which the information is to be provided	94
P.3 Required information	94
P.4 Declaration	94
Annex Q (informative) Effect of uncertainties of selected parameters on STI uncertainty	95
Q.1 STI calculation framework	95
Q.1.1 Overview	95
Q.1.2 Statistical MTF	95
Q.1.3 Corrections	95
Q.1.4 Effective SNR	96
Q.1.5 Modulation transfer index (MTI)	96
Q.1.6 Speech transmission index (STI)	96
Q.2 The effect of RT uncertainty on STI uncertainty	97
Q.2.1 General	97
Q.2.2 Modulation transfer function	97
Q.2.3 Uncertainty in the STI	97
Q.2.4 Conclusions:	99
Q.3 The effect of S/N uncertainty on STI uncertainty	99
Q.3.1 General	99
Q.3.2 Ideal transfer function	99
Q.3.3 Reverberation	100
Q.3.4 Conclusions:	101
Q.4 The effect of signal level uncertainty on STI uncertainty	101
Q.4.1 Overview	101
Q.4.2 Auditory masking	101
Q.4.3 Conclusions	103
Bibliography	104
Figure 1 – Envelope function (panel A) of a 10 s speech signal for the 250 Hz octave band and corresponding envelope spectrum (panel B)	20
Figure 2 – Modulation transfer function – Input/output comparison	21
Figure 3 – Effect of a single delayed arrival on the MTF (idealised conditions)	33
Figure 4 – Idealised STI (Male speech Spectrum) versus delay and level of secondary arrival	34
Figure A.1 – Theoretical expression of the MTF	44
Figure A.2 – Measurement system and frequencies for the STI method	46
Figure A.3 – Auditory masking of octave band ($k-1$) on octave band (k)	52
Figure A.4 – Relationship between STI and speech level for different reverberation times	53
Figure D.1 – Schematic representation of the definition of a speech transmission channel	64
Figure E.1 – Relationships between some speech intelligibility measures	68
Figure E.2 – Relationship between STI, speech intelligibility scores and listening difficulty ratings [43], [44]	69
Figure F.1 – STI qualification bands	70

Figure Q.1 – Uncertainty in absolute value of STI vs reverberation time RT with various degrees of uncertainty in RT	99
Figure Q.2 – Uncertainty in absolute value of STI vs reverberation time RT with 1 dB uncertainty in SNR at various SNRs	101
Figure Q.3 – Uncertainty in absolute value of STI versus reverberation time RT with various degrees of masking.	103
Table 1 – How to use this document	10
Table 2 – Comparison of direct and indirect methods	22
Table 3 – Suitability of STI test methods for different types of distortion	24
Table 4 – Test-method suitability	24
Table 5 – Measurement applications	25
Table A.1 – MTI octave band weighting factors	48
Table A.2 – Auditory masking as a function of the octave band level.....	53
Table A.3 – Absolute speech reception threshold level in octave bands	54
Table A.4 – Octave band levels (dB) relative to the A-weighted speech level	55
Table A.5 – Filter parameters and s-plane polynomials that produce speech-shaped pink noise.	56
Table B.1 – Modulation frequencies for the STIPA method.....	57
Table C.1 – Specification of an STI measuring device	59
Table D.1 – Scenario 1, PA with "live" announcer.....	65
Table D.2 – Scenario 2, PA with pre-recorded announcements	65
Table D.3 – Scenario 3, "live" meetings and conversations.....	66
Table D.4 – Scenario 4, lecture.....	66
Table E.1 – Categories for listening difficulty	69
Table G.1 – Examples between STI qualification bands and typical applications	71
Table H.1 – Adjusted intelligibility qualification tables for non-native listeners.....	72
Table I.1 – Adjusted intelligibility qualification tables for normal listeners and people over 60 years old with hearing loss	73
Table J.1 – Typical speech and test signal dynamics	75
Table J.2 – Comparison of speech and the test signal	76
Table K.1 – Example test report sheet	77
Table K.2 – Measurement data record sheet.....	78
Table M.1 – Flow chart of post-processing adjustment steps.....	82
Table M.2 – Example calculation.....	87

INTERNATIONAL ELECTROTECHNICAL COMMISSION

SOUND SYSTEM EQUIPMENT –

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

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of 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, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). 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. 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 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 IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

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

This fifth edition cancels and replaces the fourth edition published in 2011. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- a) the spectrum of the male speech test signal has been changed, with significant reductions in the 125 Hz and 250 Hz bands being implemented;
- b) some corrections to formulae have been made;
- c) additional information has been included on prediction and measurement procedures;
- d) spectrum and weighting factors for female speech have been removed;
- e) verification information for STI measurement devices added;
- f) the relationships between STI and number of other speech intelligibility measures have been updated in Annex E;

- g) greater information is given in Annex M about adjustments to the measured STI results to simulate effects of alternative ambient noise and speech levels.

NOTE See Introduction for a historical summary listing the various changes from the first to the fifth edition (current edition).

The text of this International Standard is based on the following documents:

CDV	Report on voting
100/3202/CDV	100/3422/RVC

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

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

A list of all parts in the IEC 60268 series, published under the general title *Sound system equipment*, can be found on the IEC website.

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

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

iTeh STANDARD PREVIEW
(standards.iteh.ai)

[SIST EN IEC 60268-16:2021](https://standards.iteh.ai/catalog/standards/sist/085ef6f7-9ba7-4b6b-ad13-8f56893d3071/sist-en-iec-60268-16-2021)
<https://standards.iteh.ai/catalog/standards/sist/085ef6f7-9ba7-4b6b-ad13-8f56893d3071/sist-en-iec-60268-16-2021>

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INTRODUCTION

Speech is considered to be the major method of communication between humans. In many situations, the speech signal is degraded by the signal path or the transmission channel between talker and listener, resulting in a reduction of the intelligibility of the speech at the listener's location.

To quantify the deterioration of the speech intelligibility induced by the transmission channel, a fast and objective measuring method was developed; the Speech Transmission Index (STI).

The STI method applies a specific test signal to the transmission channel and by analysing the received test signal; the speech transmission quality of the channel is derived and expressed in a value between 0 and 1, as the Speech Transmission Index (STI). Using the obtained STI-value, the potential speech intelligibility can be determined.

Although there are limitations to the STI method, the use of STI has proved useful in many situations and has gained international acceptance.

The STI method has been the subject of ongoing development and refinement since its introduction in the 1970s. Major improvements of the STI have been consolidated by incorporating them in successive revisions of IEC 60268-16.

To avoid misinterpretation of STI results, it is important that all users of the STI understand the basic principles behind the operation of the STI, the application domain and the limitations. This document provides substantial information to assist users.

Potential applications of the STI

The STI can be used to measure the potential intelligibility of a wide range of electronic systems and acoustic environments. Typical applications include:

- measurement of public address and sound reinforcement systems;
- measurement and certification of emergency sound and communication systems;
- measurement of communication channels and systems such as intercoms and wireless communication;
- measurement of potential speech intelligibility and communication in rooms and auditoria;
- evaluation of direct speech communication (situations without electronic amplification) in rooms or acoustic spaces, including vehicles;
- evaluation of the potential intelligibility of assistive hearing systems.

NOTE The STI method was not designed for the measurement and evaluation of speech privacy or speech masking systems and, therefore, has not been validated for these situations. It is not recommended to use the STI below 0,3, but if this is to be undertaken, specialist expertise and techniques beyond the scope of this standard are required.

Potential users of STI

The range of users of STI measurements is diverse. Among the users who might apply this method are:

- certifiers of voice alarm and other types of emergency systems;
- certifiers of sound reinforcement and audio systems;
- audio and telecommunication equipment manufacturers;
- audio and communication engineers;
- acoustic and electroacoustic consultants;
- sound system installers;
- researchers into STI methods and developers of instruments to measure the STI.