



NSAI
Standards

Irish Standard
I.S. EN 60268-16:2011

Sound system equipment -- Part 16:
Objective rating of speech intelligibility
by speech transmission index (IEC
60268-16:2011 (EQV))

I.S. EN 60268-16:2011

Incorporating amendments/corrigenda issued since publication:

The National Standards Authority of Ireland (NSAI) produces the following categories of formal documents:

I.S. xxx: Irish Standard – national specification based on the consensus of an expert panel and subject to public consultation.

S.R. xxx: Standard Recommendation - recommendation based on the consensus of an expert panel and subject to public consultation.

SWiFT xxx: A rapidly developed recommendatory document based on the consensus of the participants of an NSAI workshop.

<i>This document replaces:</i> EN 60268-16:2003	<i>This document is based on:</i> EN 60268-16:2011 EN 60268-16:2003	<i>Published:</i> 26 August, 2011 10 July, 2003
This document was published under the authority of the NSAI and comes into effect on: 5 September, 2011		ICS number: 33.160.01
NSAI 1 Swift Square, Northwood, Santry Dublin 9	T +353 1 807 3800 F +353 1 807 3838 E standards@nsai.ie W NSAI.ie	Sales: T +353 1 857 6730 F +353 1 857 6729 W standards.ie
Údarás um Chaighdeáin Náisiúnta na hÉireann		

EUROPEAN STANDARD

EN 60268-16

NORME EUROPÉENNE

EUROPÄISCHE NORM

August 2011

ICS 33.160.01

Supersedes EN 60268-16:2003

English version

**Sound system equipment -
Part 16: Objective rating of speech intelligibility by speech transmission
index
(IEC 60268-16:2011)**

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 60268-16:2011)

Elektroakustische Geräte -
Teil 16: Objektive Bewertung der
Sprachverständlichkeit durch den
Sprachübertragungsindex
(IEC 60268-16:2011)

This European Standard was approved by CENELEC on 2011-08-02. 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, 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, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.

CENELEC

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

Management Centre: Avenue Marnix 17, B - 1000 Brussels

Foreword

The text of document 100/1812/FDIS, future edition 4 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 was approved by CENELEC as EN 60268-16 on 2011-08-02.

This European Standard supersedes EN 60268-16:2003.

EN 60268-16:2011 includes the following technical changes with respect to EN 60268-16:2003:

- development of more comprehensive, complete and unambiguous standardization of the STI methodology;
- the term STI_r is discontinued. A new function for the prediction of auditory masking effects is introduced;
- the concept of 'speech level' and the setting of the level of the test signal have been introduced;
- additional information has been included on prediction and measurement procedures.

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

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) 2012-05-02
- latest date by which the national standards conflicting with the EN have to be withdrawn (dow) 2014-08-02

Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 60268-16:2011 was approved by CENELEC as a European Standard without any modification.

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

- [2] IEC 60318-1:2009 NOTE Harmonized as EN 60318-1:2009 (not modified).
 - [3] IEC 61672 series NOTE Harmonized in EN 61672 series.
 - [37] ISO 7029:2000 NOTE Harmonized as EN ISO 7029:2000.
 - [44] ISO 3382-1:2009 NOTE Harmonized as EN ISO 3382-1:2009.
-

Annex ZA (normative)

Normative references to international publications with their corresponding European publications

The following referenced documents are indispensable for the application 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 When an international publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 61260	1995	Electroacoustics - Octave-band	EN 61260	1995
+ A1	2001	and fractional-octave-band filters	+ A1	2001
ISO 18233	2006	Acoustics - Application of new measurement methods in building and room acoustics	EN ISO 18233	2006

This page is intentionally left BLANK.

CONTENTS

FOREWORD.....	5
INTRODUCTION.....	7
1 Scope.....	9
2 Normative references	9
3 Terms and definitions	9
4 Description of the STI method	15
4.1 General.....	15
4.1.1 Rationale for the STI method.....	15
4.1.2 Applicability of the STI method	15
4.2 Background of the STI method	16
4.2.1 General	16
4.2.2 Theoretical overview.....	17
4.2.3 Measurement of STI	18
4.3 Applicability of STI test methods	19
4.4 Use of direct and indirect methods	20
4.5 Limitations of the STI method.....	21
4.5.1 General	21
4.5.2 Frequency shifts	21
4.5.3 Centre clipping	22
4.5.4 Drop outs	22
4.5.5 Jitter.....	22
4.5.6 Vocoders	22
4.5.7 Overestimation of STI under low background noise conditions.....	22
4.5.8 Frequency response	22
4.5.9 Echoes	23
4.5.10 Fast amplitude compression and expansion.....	23
4.5.11 Non-linear distortion	24
4.5.12 Impulsive and fluctuating noise.....	24
4.5.13 Hearing impaired listeners	24
4.6 Conclusion	24
5 Direct method of measuring STI	24
5.1 Overview	24
5.2 STIPA	25
5.3 Application	26
5.4 Limitations.....	26
6 Indirect method of measuring STI using the impulse response.....	26
6.1 Overview	26
6.2 Application	27
6.3 Limitations (non-linear distortion)	28
7 Measurement procedures, post-processing of data and applications.....	28
7.1 General.....	28
7.2 Acoustical input.....	28
7.3 Acoustical output.....	30
7.4 Electrical input	30
7.5 Electrical output	30
7.6 Examples of input/output combinations.....	30

7.6.1	Acoustical input – Acoustical output	30
7.6.2	Electrical input – Electrical output (e.g. assessment of wired and wireless) communication systems).....	30
7.6.3	Acoustical input – Electrical output (e.g. assessment of microphones).....	31
7.6.4	Electrical input – Acoustical output (e.g. assessment of PA systems)	31
7.7	Post-processing of measured MTF data	31
7.8	Issues concerning noise	31
7.8.1	General	31
7.8.2	Measurement of background noise	32
7.8.3	Fluctuating noise	32
7.9	Analysis and interpretation of the results	32
7.10	Binaural STI measurements	33
8	Use of STI as a design prediction tool	33
8.1	Overview	33
8.2	Statistical predictions	33
8.3	Prediction from simulated impulse response.....	34
Annex A (normative)	Speech transmission index (STI) and revised STI methods	35
Annex B (normative)	STIPA method.....	47
Annex C (normative)	STITEL method.....	48
Annex D (informative)	RASTI method (obsolete).....	49
Annex E (informative)	Qualification of the STI and relationships with other speech intelligibility measures.....	51
Annex F (informative)	Nominal qualification bands for STI	53
Annex G (informative)	Examples of STI qualification bands and typical applications	54
Annex H (informative)	Non-native listeners	55
Annex I (informative)	Effect of age-related hearing loss and hearing impairment on speech intelligibility.....	56
Annex J (normative)	Calibration of STI test signal level	57
Annex K (informative)	Example test report sheet for STI measurements	59
Annex L (normative)	Prediction of STI using statistical methods	61
Annex M (informative)	Adjustments to measured STI and STIPA results for simulation of occupancy noise and different speech levels	63
Annex N (informative)	Other methods of determining speech intelligibility.....	67
Bibliography	69
Figure 1	– Concept of the reduction in modulation due to a transmission channel	16
Figure 2	– Modulation transfer function – Input/output comparison.....	17
Figure A.1	– Envelope function (panel A) of a 10 s speech signal for the 250 Hz octave band and corresponding envelope spectrum (panel B).....	35
Figure A.2	– Theoretical expression of the MTF	36
Figure A.3	– Measurement system and frequencies for the STI method	38
Figure A.4	– Auditory masking of octave band ($k - 1$) on octave band (k).....	39
Figure D.1	– Illustration of a practical RASTI test signal	50
Figure E.1	– Relationships between some speech intelligibility measures	51
Figure E.2	– Relationship between STI, speech intelligibility scores and listening difficulty ratings [34], [35].....	52
Figure F.1	– STI qualification bands.....	53

Table 1 – Comparison of STI test methods for different types of distortion	19
Table 2 – Applicability of test	20
Table 3 – Choice of method	21
Table A.1 – Auditory masking as a function of the octave band level.....	40
Table A.2 – Absolute speech reception threshold level in octave bands	41
Table A.3 – MTI octave band weighting factors	41
Table A.4 – Octave band levels (dB) relative to the A-weighted speech level	42
Table B.1 – Modulation frequencies for the STIPA method.....	47
Table C.1 – Modulation frequencies for the STITEL method.....	48
Table D.1 – Modulation frequencies for the RASTI method	49
Table E.1 – Categories for listening difficulty	52
Table G.1 – Examples between STI qualification bands and typical applications	54
Table H.1 – Adjusted intelligibility qualification tables for non-native listeners	55
Table I.1 – Adjusted intelligibility qualification tables for normal listeners and people over 60 years old with hearing loss	56
Table M.1 – Example calculation	63

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: Multimedia equipment and systems.

This fourth edition cancels and replaces the third edition, published in 2003, and constitutes a technical revision.

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

- development of more comprehensive, complete and unambiguous standardization of the STI methodology;
- the term STI_r is discontinued. A new function for the prediction of auditory masking effects is introduced;
- the concept of 'speech level' and the setting of the level of the test signal have been introduced;

- additional information has been included on prediction and measurement procedures.

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

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

FDIS	Report on voting
100/1812/FDIS	100/1849/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.

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

A list of all the 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 publication will remain unchanged until the stability date indicated on the IEC web site under "<http://webstore.iec.ch>" in the data related to the specific publication. At this date, the publication will be

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

A bilingual version of this publication may be issued at a later date.

INTRODUCTION

The Speech Transmission Index (STI) is an objective measure to predict the intelligibility of speech transmitted from talker to listener by a transmission channel. 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.

The history of revisions is as follows.

- Revision 1: 1988. In the first version of the STI standard, a gender-independent test signal spectrum was used.
- Revision 2: 1998. Gender specific test signals were introduced, for male and female talkers, each gender relating to a specific set of weighting factors. In addition, weightings were introduced for redundancy factors. The term STI_r was introduced to signify the use of these redundancy factors.
- Revision 3: 2003. Important differences between Revision 2 and Revision 3 are the introduction of
 - level dependent masking functions,
 - the STI derivative STIPA.STIPA was specially developed as a fast measurement method that could deal with electro-acoustic and acoustic effects while determining the speech transmission quality of PA systems.
- Revision 4: 2010. The aim of Revision 4 (this revision) is to provide a more comprehensive, complete and unambiguous standardization of the STI methodology. The term STI_r is now discontinued. A new function for the prediction of auditory masking effects is introduced.

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.

Items that have changed in this revision

Specific changes that have been incorporated in this revision are:

- refinement of the STI model with respect to the level dependent masking function;
- Room Acoustic Speech Transmission Index (RASTI) has become obsolete and should not be used;
- calculations to add or remove the effects of background noise and to change the speech level and a worked example;
- notes regarding limitations of the STI method;
- methods to predict the STI performance of transmission channels based on the predicted (as distinct from measured) performance of parts or all of the transmission channel;

- introduction of STI corrections for non-native language listeners;
- introduction of STI corrections for listeners with some specific forms of hearing loss;
- relationships between STI and 'Listening Difficulty' scale.

Potential applications of STI

STI may 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 Voice Alarm and emergency sound systems;
- measurement of communication channels / 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 is not validated for the measurement and evaluation of speech privacy or speech masking systems.

Potential users of STI

The range of users of STI measurements is diverse. Among the users who may 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;
- acoustical and electro-acoustical engineers;
- sound system installers;
- researchers into STI methods and developers of instruments to measure STI.

To avoid misinterpretation of STI results, it is important that all users have an understanding of the basic principles, the application domain and its limitations.

SOUND SYSTEM EQUIPMENT –

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

1 Scope

This part of IEC 60268 specifies objective methods for rating the transmission quality of speech with respect to intelligibility.

The objective of this standard is to provide a comprehensive manual for all types of users of the STI method in the fields of audio, communications and acoustics.

This standard does not provide STI criteria for certification of transmission channels (e.g. criteria for a voice-alarm system).

Three methods are presented, which are closely related and are referred to as STI, STIPA, and STITEL. The first two methods are intended for rating speech transmission performance with or without sound systems. The STITEL method has more restricted uses.

NOTE None of the methods are suitable for the measurement and assessment of speech privacy and speech masking systems, as STI has not been validated for conditions that represent speech privacy applications [1]¹.

The following information is included:

- measurement techniques;
- prediction techniques.

2 Normative references

The following referenced documents are indispensable for the application 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:

IEC 61260:1995, *Electroacoustics – Octave-band and fractional-octave-band filters*
Amendment 1 (2001)

ISO 18233:2006, *Acoustics – Application of new measurement methods in building and room acoustics*

3 Terms and definitions

For the purpose of this document, the following terms and definitions apply.

3.1

speech intelligibility

rating of the proportion of speech that is understood

¹ Figures in square brackets refer to the Bibliography.

This is a free preview. Purchase the entire publication at the link below:

[Product Page](#)

-
- [Looking for additional Standards? Visit Intertek Inform Infostore](#)
 - [Learn about LexConnect, All Jurisdictions, Standards referenced in Australian legislation](#)
-