BS EN 60076-10:2016



BSI Standards Publication

# Power transformers

## Part 10: Determination of sound levels

bsi.

**National foreword**

This British Standard is the UK implementation of EN 60076-10:2016. It is identical to IEC 60076-10:2016. It supersedes BS EN 60076-10:2001 which will be withdrawn on 17 October 2019.

The UK participation in its preparation was entrusted to Technical Committee PEL/14, Power transformers.

A list of organizations represented on this committee can be obtained on request to its secretary.

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# Power transformers - Part 10: Determination of sound levels (IEC 60076-10:2016)

Transformateurs de puissance - Partie 10: Détermination des niveaux de bruit (IEC 60076-10:2016)

Leistungstransformatoren - Teil 10: Bestimmung der Geräuschpegel (IEC 60076-10:2016)

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## European foreword

This document (EN 60076-10:2016) consists of the text of IEC 60076-10:2016 prepared by IEC/TC 14 "Power transformers".

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) | 2017-10-17 |
| • latest date by which the national standards conflicting with the document have to be withdrawn | (dow) | 2019-10-17 |

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## Endorsement notice

The text of the International Standard IEC 60076-10:2016 was approved by CENELEC as a European Standard without any modification.

# Annex ZA
(normative)

## Normative references to international publications with their corresponding European publications

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

NOTE 1 When 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

| Publication | Year | Title | EN/HD | Year |
|---|---|---|---|---|
| IEC 60076-1 | 2011 | Power transformers - Part 1: General | EN 60076-1 | 2011 |
| IEC 60076-8 | 1997 | Power transformers - Part 8: Application guide | - | - |
| IEC 61043 | 1993 | Electroacoustics - Instruments for the measurement of sound intensity - Measurement with pairs of pressure sensing microphones | EN 61043 | 1994 |
| IEC 61672-1 | - | Electroacoustics - Sound level meters - Part 1: Specifications | EN 61672-1 | - |
| IEC 61672-2 | - | Electroacoustics - Sound level meters - Part 2: Pattern evaluation tests | EN 61672-2 | - |
| ISO 3382-2 | 2008 | Acoustics - Measurement of room acoustic parameters - Part-2: Reverberation time in ordinary rooms | EN ISO 3382-2 | 2008 |
| ISO 3746 | 2010 | Acoustics - Determination of sound power levels and sound energy levels of noise sources using sound pressure - Survey method using an enveloping measurement surface over a reflecting plane | EN ISO 3746 | 2010 |
| ISO 9614-1 | 1993 | Acoustics - Determination of sound power levels of noise sources using sound intensity - Part 1: Measurement at discrete points | EN ISO 9614-1 | 2009 |
| ISO 9614-2 | 1996 | Acoustics - Determination of sound power levels of noise sources using sound intensity - Part-2: Measurement by scanning | EN ISO 9614-2 | 1996 |

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

# POWER TRANSFORMERS –

## Part 10: Determination of sound levels

## FOREWORD

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International Standard IEC 60076-10 has been prepared by IEC technical committee 14: Power transformers

This second edition cancels and replaces the first edition published in 2001 and constitutes a technical revision.

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

– additional useful definitions introduced;
– definition of distribution type transformers introduced for the purpose this standard;
– new clause for sound level measurement specification introduced;
– requirement for 1/3 octave band measurements introduced for transformers other than distribution type transformers;

– standard measurement distance changed from 0,3 m to 1 m for transformers other than distribution type transformers;
– height of measurement surface is now clearly defined to count from the reflecting plane;
– measurement surface formula unified;
– correction criteria for intensity method introduced;
– rules for sound measurements on dry-type reactors introduced;
– figures revised;
– new informative test report templates introduced (Annex B);
– IEC 60076-10-1 (application guide) revised in parallel providing worthwhile information for the use of this standard.

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

| FDIS | Report on voting |
|---|---|
| 14/846/FDIS | 14/849/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 parts in the IEC 60076 series, published under the general title *Power transformers*, 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.

**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

One of many parameters considered when specifying, designing and placing transformers, reactors and their associated cooling devices is the sound level that the equipment is likely to emit under defined in-service conditions. This part of IEC 60076 provides the basis for the specification and test of sound levels.

This standard describes in a logical sequence the loading conditions, how to specify and to test as well as how to evaluate and report sound levels for the equipment under test. A new section for the specification of sound levels has been introduced as Clause 5.

For the purpose of this standard, the definition “distribution type transformers” was introduced. This reflects industry’s need to maintain simpler and faster sound measurements for this category of transformers.

The new requirement for reporting 1/3-octave band spectra for all sound levels (including the background noise) on units for installation in substations reflects the more onerous conditions imposed by planning authorities on the purchaser and also the improved functionality of modern instrumentation.

When the sound intensity method was introduced in this standard limited experience was available. During subsequent years of operating this standard levels of experience have significantly increased and necessary changes have become evident. The equivalence of the pressure and the intensity methods has been demonstrated within certain test limitations.

The introduction of new validation criteria for the intensity method recognises these limitations. The permissible pressure – intensity index $\Delta L$ remains 8 dB however the difference between measured sound pressure level and reported sound intensity level is limited to 4 dB.

For the pressure method the correction procedure for reflections has been enhanced by recommending the application of frequency dependent $K$ values derived by measurement of the reverberation time of the test facility. Where $K$ is derived from absorption coefficients the table for the average absorption coefficients has been rationalised to represent surfaces likely to be found in the working environment.

Walk-around procedure and point-by-point procedure are equally applicable. The walk-around procedure reflects the evolution of working practice allowing more time efficient measurements mainly on large units. For distribution type transformers and in special situations (health and safety) the point-by-point procedure is more appropriate.

In order to mitigate near-field effects the preferred measurement distance is set to 1 m with exceptions for distribution type transformers, small test facilities, situations with low signal-to-noise ratio and for health and safety where the distance is maintained at 0,3 m.

One single formula for the calculation of the measurement surface area $S$ has been introduced because the former complexity could only result in differences always smaller than 1 dB.

All figures describing the measurement surface area have been revised to be in accordance with the enveloping method for sound power determination. The height $h$ is always measured from the test facility floor regardless of the height of the supports beneath the test object unless the test object is mounted on a support with a sufficiently large surface acting as reflecting plane.

Additional figures explain the procedure for the determination of the measurement surface area and the prescribed contour for a number of configurations of dry-type reactors.

When using this standard, it is recommended to frequently refer to the corresponding application guide IEC 60076-10-1:2016 as it promotes understanding with important background information and helpful details. IEC 60076-10 and IEC 60076-10-1 were revised in parallel by the same maintenance team resulting in fully aligned documents.

# POWER TRANSFORMERS –

# Part 10: Determination of sound levels

## 1 Scope

This Part of IEC 60076 defines sound pressure and sound intensity measurement methods from which sound power levels of transformers, reactors and their associated cooling devices are determined.

NOTE For the purposes of this standard, the term "transformer" frequently means "transformer or reactor".

The methods are applicable to transformers, reactors and their cooling devices – either fitted to or separate from the transformer – as covered by the IEC 60076 and IEC 61378 series.

This standard is primarily intended to apply to measurements made at the factory. Conditions on-site can be very different because of the proximity of objects, including other transformers. Nevertheless, this standard is applied to the extent possible for on-site measurements.

## 2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60076-1:2011, *Power transformers – Part 1: General*

IEC 60076-8:1997, *Power transformers – Part 8: Application guide*

IEC 61043:1993, *Electroacoustics – Instruments for the measurement of sound intensity – Measurements with pairs of pressure sensing microphones*

IEC 61672-1, *Electroacoustics – Sound level meters – Part 1: Specifications*

IEC 61672-2, *Electroacoustics – Sound level meters – Part 2: Pattern evaluation tests*

ISO 3382-2:2008, *Acoustics – Measurement of room acoustic parameters – Part 2: Reverberation time in ordinary rooms*

ISO 3746:2010, *Acoustics – Determination of sound power levels and sound energy levels of noise sources using sound pressure – Survey method using an enveloping measurement surface over a reflecting plane*

ISO 9614-1:1993, *Acoustics – Determination of sound power levels of noise sources using sound intensity – Part 1: Measurement at discrete points*

ISO 9614-2:1996, *Acoustics – Determination of sound power levels of noise sources using sound intensity – Part 2: Measurement by scanning*