

# INTERNATIONAL STANDARD



**Power transformers –  
Part 10-1: Determination of sound levels – Application guide**



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### POWER TRANSFORMERS –

#### Part 10-1: Determination of sound levels – Application guide

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**IEC 60076-10-1 edition 2.1 contains the second edition (2016-03) [documents 14/847/FDIS and 14/850/RVD] and its amendment 1 (2020-11) [documents 14/1037/CDV and 14/1047/RVC].**

**In this Redline version, a vertical line in the margin shows where the technical content is modified by amendment 1. Additions are in green text, deletions are in strikethrough red text. A separate Final version with all changes accepted is available in this publication.**

International Standard IEC 60076-10-1 has been prepared by technical committee 14: Power transformers.

This second edition constitutes a technical revision.

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

- a) extended information on sound fields provided;
- b) effect of current harmonics in windings enfolded;
- c) updated information on measuring methods sound pressure and sound intensity given;
- d) supporting information on measuring procedures walk-around and point-by-point given;
- e) clarification of A-weighting provided;
- f) new information on frequency bands given;
- g) background information on measurement distance provided;
- h) new annex on sound-built up due to harmonic currents in windings introduced.

This standard is to be read in conjunction with IEC 60076-10.

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 the base publication and its amendment 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

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## POWER TRANSFORMERS –

### Part 10-1: Determination of sound levels – Application guide

#### 1 Scope

This part of IEC 60076 provides supporting information to help both manufacturers and purchasers to apply the measurement techniques described in IEC 60076-10. Besides the introduction of some basic acoustics, the sources and characteristics of transformer and reactor sound are described. Practical guidance on making measurements is given, and factors influencing the accuracy of the methods are discussed. This application guide also indicates why values measured in the factory may differ from those measured in service.

This application guide is applicable to transformers and reactors together with their associated cooling auxiliaries.

#### 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 60076-10:2016, *Power transformers – Part 10: Determination of sound levels*

#### 3 Basic physics of sound

##### 3.1 Phenomenon

Sound is a wave of pressure variation (in air, water or other elastic media) that the human ear can detect. Pressure variations travel through the medium (for the purposes of this document, air) from the sound source to the listener's ears.

The number of cyclic pressure variations per second is called the 'frequency' of the sound measured in hertz, Hz. A specific frequency of sound is perceived as a distinctive tone or pitch. Transformer 'hum' is low in frequency, typically with fundamental frequencies of 100 Hz or 120 Hz, while a whistle is of higher frequency, typically above 3 kHz. The normal frequency range of hearing for a healthy young person extends from approximately 20 Hz to 20 kHz.

##### 3.2 Sound pressure, $p$

The root-mean-square (r.m.s.) of instantaneous sound pressures over a given time interval at a specific location is called the sound pressure. It is measured in pascal, Pa.

Sound pressure is a scalar quantity, meaning that it is characterised by magnitude only.

The lowest sound pressure that a healthy human ear can detect is strongly dependent on frequency; at 1 kHz it has a magnitude of 20  $\mu$ Pa. The threshold of pain corresponds to a sound pressure of more than a million times higher, 20 Pa. Because of this large range, to avoid the use of large numbers, the decibel scale (dB) is used in acoustics. The reference level for sound pressure for the logarithmic scale is 20  $\mu$ Pa corresponding to 0 dB and the 20 Pa threshold of pain corresponds to 120 dB.