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



CONTENTS

FOREWORD	5
1 Scope	7
2 Normative references	7
3 Basic physics of sound	7
3.1 Phenomenon	7
3.2 Sound pressure, p	7
3.3 Particle velocity, u	8
3.4 Sound intensity, \bar{I}	8
3.5 Sound power, W	8
3.6 Sound fields	9
3.6.1 General	9
3.6.2 The free field	9
3.6.3 The diffuse field	9
3.6.4 The near-field	9
3.6.5 The far-field	10
3.6.6 Standing waves	10
4 Sources and characteristics of transformer and reactor sound	11
4.1 General	11
4.2 Sound sources	11
4.2.1 Core	11
4.2.2 Windings	14
4.2.3 Stray flux control elements	14
4.2.4 Sound sources in reactors	15
4.2.5 Effect of current harmonics in transformer and reactor windings	15
4.2.6 Fan noise	18
4.2.7 Pump noise	18
4.2.8 Relative importance of sound sources	18
4.3 Vibration transmission	18
4.4 Sound radiation	19
4.5 Sound field characteristics	19
5 Measurement principles	20
5.1 General	20
5.2 A-weighting	20
5.3 Sound measurement methods	22
5.3.1 General	22
5.3.2 Sound pressure method	23
5.3.3 Sound intensity method	24
5.3.4 Selection of appropriate sound measurement method	27
5.4 Information on frequency bands	27
5.5 Information on measurement surface	29
5.6 Information on measurement distance	29
5.7 Information on measuring procedures (walk-around and point-by-point)	30
6 Practical aspects of making sound measurements	31
6.1 General	31
6.2 Orientation of the test object to avoid the effect of standing waves	31
6.3 Device handling for good acoustical practice	32

6.4	Choice of microphone spacer for the sound intensity method	33
6.5	Measurements with tank mounted sound panels providing incomplete coverage	33
6.6	Testing of reactors	34
7	Difference between factory tests and field sound level measurements	34
7.1	General	34
7.2	Operating voltage	34
7.3	Load current	34
7.4	Load power factor and power flow direction	35
7.5	Operating temperature	35
7.6	Harmonics in the load current and in voltage	35
7.7	DC magnetization	36
7.8	Effect of remanent flux	36
7.9	Sound level build-up due to reflections	36
7.10	Converter transformers with saturable reactors (transducers)	37
Annex A (informative)	Sound level built up due to harmonic currents in windings	38
A.1	Theoretical derivation of winding forces due to harmonic currents	38
A.2	Force components for a typical current spectrum caused by a B6 bridge	39
A.3	Estimation of sound level increase due to harmonic currents by calculation	42
Bibliography	44

Figure 1	– Simulation of the spatially averaged sound intensity level (solid lines) and sound pressure level (dashed lines) versus measurement distance d in the near-field	10
Figure 2	– Example curves showing relative change in lamination length for one type of electrical core steel during complete cycles of applied 50 Hz a.c. induction up to peak flux densities B_{\max} in the range of 1,2 T to 1,9 T	11
Figure 3	– Induction (smooth line) and relative change in lamination length (dotted line) as a function of time due to applied 50 Hz a.c. induction at 1,8 T – no d.c. bias	12
Figure 4	– Example curve showing relative change in lamination length during one complete cycle of applied 50 Hz a.c. induction at 1,8 T with a small d.c. bias of 0,1 T	12
Figure 5	– Induction (smooth line) and relative change in lamination length (dotted line) as a function of time due to applied 50 Hz a.c. induction at 1,8 T with a small d.c. bias of 0,1 T	13
Figure 6	– Sound level increase due to d.c. current in windings	13
Figure 7	– Typical sound spectrum due to load current	14
Figure 8	– Simulation of a sound pressure field (coloured) of a 31,5 MVA transformer at 100 Hz with corresponding sound intensity vectors along the measurement path	20
Figure 9	– A-weighting graph derived from function $A(f)$	21
Figure 10	– Distribution of disturbances to sound pressure in the test environment	24
Figure 11	– Microphone arrangement	25
Figure 12	– Illustration of background sound passing through test area and sound radiated from the test object	26
Figure 13	– 1/1- and 1/3-octave bands with transformer tones for 50 Hz and 60 Hz systems	28
Figure 14	– Logging measurement demonstrating spatial variation along the measurement path	31
Figure 15	– Test environment	32
Figure A.1	– Current wave shape for a star and a delta connected winding for the current spectrum given in Table A.2	40

Table 1 – A-weighting values for the first fifteen transformer tones	22
Table A.1 – Force components of windings due to harmonic currents	39
Table A.2 – Current spectrum of a B6 converter bridge	39
Table A.3 – Calculation of force components and test currents	41
Table A.4 – Summary of harmonic forces and test currents.....	42

INTERNATIONAL ELECTROTECHNICAL COMMISSION

POWER TRANSFORMERS –

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

FOREWORD

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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].

This Final version does not show where the technical content is modified by amendment 1. A separate Redline version with all changes highlighted 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

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

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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 μ 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 μ Pa corresponding to 0 dB and the 20 Pa threshold of pain corresponds to 120 dB.