

Power transformers - Part 19: Rules for the
determination of uncertainties in the measurement of
the losses on power transformers and reactors

EESTI STANDARDI EESSÕNA

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English Version

**Power transformers - Part 19: Rules for the determination of
uncertainties in the measurement of the losses on power
transformers and reactors
(IEC/TS 60076-19:2013 , modified)**

Transformateurs de puissance - Partie 19: Règles pour la
détermination des incertitudes de mesure des pertes des
transformateurs de puissance et bobines d'inductance
(IEC/TS 60076-19:2013 , modifiée)

Leistungstransformatoren - Teil 19: Regeln für die
Bestimmung von Unsicherheiten in der Messung der
Verluste von Leistungstransformatoren und Drosselspulen
(IEC/TS 60076-19:2013 , modifiziert)

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European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
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Foreword

This document (EN 60076-19:2015) consists of the text of IEC/TS 60079:2013 prepared by IEC/TC 14 "Power transformers", together with the common modifications prepared by CLC/TC 14 "Power transformers".

The following dates are fixed:

- latest date by which this document has to be (dop) 2016-06-25
implemented
at national level by publication of an identical
national standard or by endorsement
- latest date by which the national standards (dow) 2018-06-25
conflicting with this document
have to be withdrawn

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Endorsement notice

The text of the International Standard IEC/TS 60079:2013 was approved by CENELEC as a European Standard with agreed common modifications.

COMMON MODIFICATIONS

Introduction

Modify the first paragraph as follows:

The losses of the transformers (no- load and load losses) are object of guarantee and penalty in the majority of the contracts and play an important role in the evaluation of the total (service) costs and therefore in the investments involved. Furthermore, regional regulations, such as the European Union directive for EcoDesign, may also pose requirements on establishment of reliable values for losses.

Modify the third and fourth paragraphs as follows:

Corrections and uncertainties are also considered in IEC 60076-8 where some general indications are given for their determination.

This European Standard deals with the measurement of the losses that from a measuring point of view consist of the estimate of a measurand and the evaluation of the uncertainty that affects the measurand itself. The procedures can also be applied to loss measurements on power transformers and reactors as evaluation of the achievable performance of a test facility in the course of prequalification processes, as estimations of achievable uncertainty in the enquiry stage of an order or prior to beginning final testing at manufacturer's premises and for evaluations of market surveillance measurements.

Add before the fifth paragraph:

Evaluation of uncertainty in testing is often characterized as "top-down" or "bottom-up", where the first one relies on inter-laboratory comparisons on a circulated test object to estimate the dispersion and hence the uncertainty. The latter method instead relies on the formulation of a model function, where the test result y is expressed as a function of input quantities. This function is often the formula used for the calculation of the result. The "bottom-up" method is applied in this Document.

Replace the sixth paragraph by:

It is recommended that guarantee and penalty calculations should refer to the best estimated values of the losses without considering the measurement uncertainties, based on a shared risk concept, where both parties are aware of and accept the consequences of non-negligible measurement uncertainty.

In cases where the losses are required to conform to stated tolerance limits, it is recommended that the estimated uncertainty is less than the tolerance limit. This situation will occur for example in market surveillance activities. In lieu of other specifications it can be noted that 3 % is often used as estimate for the required uncertainty.

Modify the eighth paragraph as follows:

Standards mentioned in the text but not indispensable are listed at the end of the document.

Replace the last paragraph by:

This European document is based on IEC/TS 60076-19. The technical content of the TS was not changed, but small numerical mistakes and consistent use of symbols in Annex A were corrected. The introduction was modified to enhance clarity.

1 Scope

Modify the first paragraph as follows:

This European Standard illustrates the procedures that should be applied to evaluate the uncertainty affecting the measurements of no-load and load losses during the routine tests on power transformers.

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.

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

EN 60076-2:2011, *Power transformers – Part 2: Temperature rise for liquid-immersed transformers* (IEC 60076-2:2011)

Annex A (informative)

Example of load loss uncertainty evaluation for a large power transformer

A.4 Model function of the measurand and deviation correction (see 7.2)

A.4.2 Correction of known systematic deviations

Modify the paragraph after the first equation as follows:

The remaining corrective term is given by the following equation: (erroneous K_C replaced by F_D)

Replace the second and the third equations by the following ones:

$$F_D = \frac{1}{1 - (\Delta_{\varphi V} - \Delta_{\varphi C}) \cdot \tan \varphi}$$

$$P_2 = k_{CN} \cdot k_{VN} \cdot P_W \cdot F_D$$

A.5 Results of the measurements

A.5.1 Load loss measurements

Modify the paragraph after Table A.2 as follows:

The estimate of the phase angle between voltage and current results (see 7.2 and A.6.1):

Replace the first equation by:

$$\varphi = \arccos\left(\frac{P_W}{I_M U_M}\right) - \Delta_{\varphi V} + \Delta_{\varphi C} = \arccos\left(\frac{6,625}{3,608 \times 86,60}\right) - \left(\frac{0,09}{100} + \frac{0,11}{100}\right) \cdot \frac{180}{\pi} = 88,782 - 0,115 = 88,670^\circ$$

Modify the paragraph after the first equation as follows:

The corresponding $\tan \varphi$ is therefore equal to 43,087.

Replace the second equation by:

$$F_D = \frac{1}{1 - (\Delta_{\varphi V} + \Delta_{\varphi C}) \cdot \tan \varphi} = \frac{1}{1 - (0,09/100 + 0,11/100) \cdot 43,087} = 1,0943$$

Replace the third equation by:

$$P_2 = k_{\text{CN}} \cdot k_{\text{VN}} \cdot P_{\text{W}} \cdot F_{\text{D}} = 60 \cdot 200 \cdot 6,625 \cdot 1,0943 = 86\,997 \text{ W}$$

Add after the third equation:

NOTE This result differs slightly from the result obtained with the full formula given in clause A.4.1 because of the simplifications introduced in A.4.2.