SLOVENSKI STANDARD
SIST EN 60076-18:2012

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Močnostni transformatorji - 18. del: Merjenje frekvenčne odzivnosti

Power transformers - Part 18: Measurement of frequency response

Transformateurs de puissance - Partie 18: Mesure de la réponse en fréquence

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Power transformers - Part 18: Measurement of frequency response (IEC 60076-18:2012)

Transformateurs de puissance - Partie 18: Mesure de la réponse en fréquence (CEI 60076-18:2012)

Leistungstransformatoren - Teil 18: Messung des Frequenzübertragungsverhaltens (IEC 60076-18:2012)

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CENELEC

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Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

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Foreword

The text of document 14/718/FDIS, future edition 1 of IEC 60076-18, prepared by IEC/TC 14 "Power transformers" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN 60076-18:2012.

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)	2013-05-13
• latest date by which the national standards conflicting with the document have to be withdrawn	(dow)	2015-08-13

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The text of the International Standard IEC 60076-18:2012 was approved by CENELEC as a European Standard without any modification.

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Power transformers –
Part 18: Measurement of frequency response

Transformateurs de puissance –
Partie 18: Mesure de la réponse en fréquence

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CONTENTS

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POWER TRANSFORMERS –

Part 18: Measurement of frequency response

FOREWORD

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International Standard IEC 60076-18 has been prepared by IEC technical committee 14: Power transformers.

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

FDIS	Report on voting
14/718/FDIS	14/728/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 of the IEC 60076 series can be found, under the general title *Power transformers*, 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.

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POWER TRANSFORMERS –

Part 18: Measurement of frequency response

1 Scope

This part of the IEC 60076 series covers the measurement technique and measuring equipment to be used when a frequency response measurement is required either on-site or in the factory either when the test object is new or at a later stage. Interpretation of the result is not part of the normative text but some guidance is given in Annex B. This standard is applicable to power transformers, reactors, phase shifting transformers and similar equipment.

2 Terms and definitions

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

2.1
frequency response
amplitude ratio and phase difference between the voltages measured at two terminals of the test object over a range of frequencies when one of the terminals is excited by a voltage source

Note 1 to entry: The frequency response measurement result is a series of amplitude ratios and phase differences at specific frequencies over a range of frequency.

Note 2 to entry: The measured voltage is the voltage developed across an impedance and so it is also related to current.

2.2
frequency response analysis
FRA
technique used to detect damage by the use of frequency response measurements

Note 1 to entry: The terms SFRA and IFRA are commonly used and refer to the use of either a swept frequency voltage source or an impulse voltage source. Provided the measuring equipment complies with the requirements of Clause 5, this standard can be applied to both techniques.

2.3
source lead
lead connected to the voltage source of the measuring instrument used to supply an input voltage to the test object

2.4
reference lead
V_{in}
lead connected to the reference channel of the measuring instrument used to measure the input voltage to the test object

2.5
response lead
V_{out}
lead connected to the response channel of the measuring instrument used to measure the output voltage of the test object

2.6
end-to-end measurement
frequency response measurement made on a single coil (phase winding) with the source and reference (V_{in}) leads connected to one end and the response (V_{out}) lead connected to the other end

2.7
capacitive inter-winding measurement
frequency response measurement made on two adjacent coils (windings of the same phase) with the source and reference (V_{in}) leads connected to one end of a winding, the response (V_{out}) lead connected to one end of another winding and with the other winding ends floating

Note 1 to entry: This type of measurement is not applicable to windings which have common part or connection between them.

2.8
inductive inter-winding measurement
frequency response measurement made on two adjacent coils (windings of the same phase) with the source and reference (V_{in}) leads connected to one end of the higher voltage winding, the response (V_{out}) lead connected to one end of the other winding and with the other ends of both windings grounded

2.9
end-to-end short circuit measurement
frequency response measurement made on a single coil (phase winding) with the source and reference (V_{in}) leads connected to one end, the response (V_{out}) lead connected to the other end, and another winding of the same phase short-circuited

2.10
baseline measurement
frequency response measurement made on a test object to provide a basis for comparison with a future measurement on the same test object in the same configuration

3 Purpose of frequency response measurements

Frequency response measurements are made so that Frequency Response Analysis (FRA) can be carried out. FRA can be used to detect changes to the active part of the test object (windings, leads and core).

NOTE FRA is generally used to detect geometrical changes and electrical short-circuits in the windings, see Annex B.

Some examples of conditions that FRA can be used to assess are:

- damage following a through fault or other high current event (including short-circuit testing),
- damage following a tap-changer fault,
- damage during transportation, and
- damage following a seismic event.

Further information on the application of frequency response measurements is given in Annex C.

The detection of damage using FRA is most effective when frequency response measurement data is available from the transformer when it is in a known good condition (baseline measurement), so it is preferable to carry out the measurement on all large transformers either in the factory or when the transformer is commissioned at site or both. If a baseline

measurement is not available for a particular transformer, reference results may be obtained from either a similar transformer or another phase of the same transformer (see Annex B).

Frequency response measurements can also be used for power system modelling including transient overvoltage studies.

4 Measurement method

4.1 General

To make a frequency response measurement, a low voltage signal is applied to one terminal of the test object with respect to the tank. The voltage measured at this input terminal is used as the reference signal and a second voltage signal (the response signal) is measured at a second terminal with reference to the tank. The frequency response amplitude is the scalar ratio between the response signal (V_{out}) and the reference voltage (V_{in}) (presented in dB) as a function of the frequency. The phase of the frequency response is the phase difference between V_{in} and V_{out} (presented in degrees).

The response voltage measurement is made across an impedance of 50 Ω. Any coaxial lead connected between the test object terminal and the voltage measuring instrument shall have a matched impedance. To make an accurate ratio measurement, the technical parameters of the reference and response channels of the measuring instrument and any measurement leads shall be identical.

NOTE 1 The characteristic impedance of the coaxial measuring leads is chosen to match the measuring channel input impedance to minimise signal reflections and reduce the influence of the coaxial lead on the measurement to the point where it has little or no practical effect on the measurement within the measurement frequency range. With a matched impedance lead, the measuring impedance is effectively applied at the test object terminal.

NOTE 2 As V_{out}/V_{in} varies over a wide range, it is expressed in decibels (dB). The relative voltage response in dB is calculated as $20 \times \log_{10}(V_{out}/V_{in})$, where (V_{out}/V_{in}) is the scalar ratio.

An example of the general layout of the measurement method using coaxial measuring leads is shown in Figure 1.