IEC 60076-24

Edition 1.0 2020-07

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Power transformers –
Part 24: Specification of voltage regulating distribution transformers (VRDT)

Transformateurs de puissance –
Partie 24: Spécification des transformateurs de distribution régulateurs de tension (VRDT)

IEC 60076-24:2020-07(en-fr)

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FOREWORD

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International Standard IEC 60076-24 has been prepared by IEC technical committee 14: Power transformers.

The text of this International Standard is based on the following documents:

FDIS	Report on voting
14/1050/FDIS	14/1055/RVD

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

This document 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 document will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific document. At this date, the document will be

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- withdrawn,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

POWER TRANSFORMERS –

Part 24: Specification of voltage regulating distribution transformers (VRDT)

1 Scope

This document applies to medium power transformers from 25 kVA up to 3 150 kVA with highest voltage for equipment up to 36 kV, or in low voltage (LV) networks with highest voltage for equipment of up to 1,1 kV equipped with voltage regulating devices.

Voltage regulating distribution transformers are transformers equipped with components to control primary or secondary voltage for on-load voltage regulation purposes.

The main objective of the installation of a VRDT is to regulate the LV network voltage level (i.e. 400 V), to avoid violation of the limits defined by relevant standards or regulations. The VRDT must operate properly as a step down and step up transformer.

Transformers covered by this document comply with the relevant requirements set out in IEC 60076 (all parts) and, unless otherwise stated in this document, they also comply with European Standards EN 50160 and EN 50588-1.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60068-2-1, *Environmental testing – Part 2-1: Tests – Test A: Cold*

IEC 60068-2-2, *Environmental testing – Part 2-2: Tests – Test B: Dry heat*

IEC 60068-2-11, *Basic environmental testing procedures – Part 2-11: Tests – Test Ka: Salt mist*

IEC 60068-2-30, *Environmental testing – Part 2-30: Tests – Test Db: Damp heat, cyclic (12 h + 12 h cycle)*

IEC 60068-2-78, *Environmental testing – Part 2-78: Tests – Test Cab: Damp heat, steady state*

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

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

IEC 60076-5, *Power transformers – Part 5: Ability to withstand short circuit*

IEC 60076-7, *Power transformers – Part 7: Loading guide for mineral-oil-immersed power transformers*

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

IEC 60076-11, *Power transformers – Part 11: Dry-type transformers*

IEC 60076-12, *Power transformers – Part 12: Loading guide for dry-type power transformers*

IEC 60255-21-1, *Electrical relays – Part 21: Vibration, shock, bump and seismic test on measuring relays and protection equipment – Section 1: Vibration tests (sinusoidal)*

IEC 60255-21-2, *Electrical relays – Part 21: Vibration, shock, bump and seismic tests on measuring relays and protection equipment – Section 2: Shock and bump tests*

IEC 60529, *Degrees of protection provided by enclosures (IP Code)*

IEC 61000-6-2, *Electromagnetic compatibility (EMC) – Part 6-2: Generic standards – Immunity standard for industrial environments*

IEC 61000-6-4, *Electromagnetic compatibility (EMC) – Part 6-4: Generic standards – Emission standard for industrial environments*

IEC 61000-6-5, *Electromagnetic compatibility (EMC) – Part 6-5: Generic standards – Immunity for equipment used in power station and substation environment*

IEC 61010-1, *Safety requirements for electrical equipment for measurement, control, and laboratory use – Part 1: General requirements*

IEC 61010-2-201, *Safety requirements for electrical equipment for measurement, control, and laboratory use – Part 2-201: Particular requirements for control equipment*

EN 50708, *Power transformers – Additional European requirements*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60076-1, EN 50708, and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1
voltage regulating distribution transformer
VRDT
transformer equipped with components to control primary or secondary voltage for on-load voltage regulation purposes within the scope of this document

3.2
regulation voltage
ratio Ud/UN or 100 Ud/UN (percentage) where: UN is the rated voltage of the transformer; Ud is the voltage which would be developed at no-load at the terminals of the transformer, connected on the tapping concerned, by applying rated voltage to an untapped winding related to IEC 60214

3.3
regulation range
variation range of the regulation voltage expressed as a percentage, compared with value "100"

Note 1 to entry: If this factor ranges from 100 + a to 100 − b, the tapping range is said to be: + a % − b % or ± a % if a = b.

3.4
regulation steps
ratio between regulation range divided by number of steps

3.5
regulating unit
system or device that physically facilitates the change in voltage of the transformer, for example, electromagnetic or electronic devices

3.6
control unit
unit which operates the regulating unit

Note 1 to entry: It can have various modes of operation, for example, automatic, manual or remote control. Manual mode is mandatory for erection and commissioning. It can also have a human-machine interface.

4 Environmental conditions

Service conditions for VRDTs are the same as those specified for power transformers in IEC 60076-1 and IEC 60076-11.

The purchaser shall identify in the enquiry to the manufacturer any service conditions not covered by the normal service conditions as specified in IEC 60076-1 and IEC 60076-11 and, for the control unit, the normal service conditions as specified in IEC 60068-2 (all parts). Any different applications shall be agreed between manufacturer and purchaser.

NOTE 1 Transformer with regulating unit:

Application liquid immersed transformer: indoor or outdoor use and storage.

Application dry transformer: indoor use and storage.

NOTE 2 Control unit:

Application is indoor use and storage.

5 Electrical characteristics and general requirements

5.1 General

As per IEC 60076-1:2011, 5.3 for transformers connected to generators, the value of the rated voltage is as given in IEC 60076-1:2011, 5.4.3, the 110 % of overvoltage is at no load and limited at 5 % at rated power.

For specifying the rated low voltage, the purchaser shall take into account the possible over-excitation which can increase no-load losses, depending on the technology of the VRDT.

5.2 Regulation steps

Unless otherwise specified, there are 3 to 11 on-load steps.

The regulation can be symmetric or asymmetric.

Unless otherwise agreed, step sizes are to be uniform to give constant flux voltage variation (CFVV).

5.3 Voltage steps

Unless otherwise specified, voltage steps are 1,0 % up to 3,0 % and shall be agreed between manufacturer and purchaser.

5.4 Regulation range

Unless otherwise specified, the on-load regulation range is ±5 % up to ±10 % of the rated voltage ratio for symmetrical regulation.

6 Service life

Loading guides (IEC 60076-7 and IEC 60076-12) are applicable.

Deviations shall be agreed between manufacturer and purchaser.

The manufacturer shall indicate the number of operations for which the VRDT is designed.

The manufacturer shall indicate a future need for firmware updates of the control unit.

7 Parallel operation of the VRDT

For parallel operation of the VRDT, special precautions should be taken to avoid high circulating currents.

NOTE Depending on the impedance of the connections between the VRDTs, significant circulating currents are possible (IEC 60076-8). A typical solution can be a master/follower arrangement or a single grid controller.

8 Loss level

Measurement of the loss level shall be in accordance with IEC 60076-1.

The maximum loss level for the VRDT (transformer and regulating unit) shall be compliant with local standards, for example, EN 50708.

No-load and load losses shall include regulating unit losses.

9 Sound power level

Measurement of the sound power shall be in accordance with IEC 60076-10.

The maximum sound power level shall be compliant with local standards, for example, EN 50708.

Operating noise during the switching process of voltage regulation should not be taken into account.

This noise and its values shall be agreed between manufacturer and purchaser.

10 Rating plate

Rating plate requirements are in accordance with IEC 60076-1, IEC 60076-11, and with applicable local standards, for example, EN 50708.

For voltage regulating distribution transformers, a visible marking of "VRDT" shall be placed on the rating plate.

11 Tests

11.1 Routine tests

Apply IEC 60076-1 and IEC 60076-11, but with different test sequences, in accordance with this document.

11.2 Functional tests

With the regulating unit fully assembled on the transformer, the following sequence of operations shall be performed as a routine test, without any failure:

a) with the transformer de-energized, three complete cycles of operation (a cycle of operation goes from one end of the tapping range to the other, and back again);

b) with the transformer de-energized, and with the auxiliary voltage reduced to 85 % of its rated value, one complete cycle of operation;

c) with the transformer energized at rated voltage and frequency at no load, one complete cycle of operation.

11.3 Type tests

If the regulating unit contains electronic components, the test conditions shall be agreed between manufacturer and purchaser.

If the operation of the regulating unit occurs in conditions that differ from those of IEC 60076-1, a heat run test according to IEC 60076-2 shall be agreed between purchaser and manufacturer.

With the regulating unit fully assembled on the transformer, the following sequence of operations shall be performed, without any failure:

With one winding short-circuited and, as far as practicable, rated current in the tapped winding, 10 cycles of tap-change operations across the complete range.

NOTE In order to check the correct coordination of over-current protection and to have all information regarding the operation of the VRDT, the purchaser can request the measurement of the impedance voltage and load losses on all the taps, related to the high voltage (HV) rated voltage and rated power of the VRDT.

The functional tests shall be repeated.

11.4 Special tests

The transformer, including the regulating unit, shall pass the short-circuit withstand test in accordance with IEC 60076-5.

If the regulating unit contains electronic components, the test conditions shall be agreed between manufacturer and purchaser.

Partial discharge measurement shall be agreed between manufacturer and purchaser (e.g. IEC 60076-13).

The functionality test (11.5.1) shall be repeated.