Irish Standard
I.S. EN 60076-16:2011

Power transformers -- Part 16: Transformers for wind turbines applications (IEC 60076-16:2011 (EQV))

I.S. EN 60076-16:2011

Incorporating amendments/corrigenda issued since publication:

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Power transformers - Part 16: Transformers for wind turbines applications

(IEC 60076-16:2011)

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Foreword

The text of document 14/690/FDIS, future edition 1 of IEC 60076-16, prepared by IEC/TC 14 "Power transformers", was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN 60076-16:2011.

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)	2012-06-29
• latest date by which the national standards conflicting with the document have to be withdrawn	(dow)	2014-09-29

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Endorsement notice

The text of the International Standard IEC 60076-16:2011 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following notes have to be added for the standards indicated:

IEC 60071-1:2006	NOTE	Harmonized as EN 60071-1:2006 (not modified).
IEC 60071-2:1996	NOTE	Harmonized as EN 60071-2:1997 (not modified).
IEC 60137:2008	NOTE	Harmonized as EN 60137:2008 (not modified).
IEC 60270:2000	NOTE	Harmonized as EN 60270:2001 (not modified).
IEC 62271-100:2008	NOTE	Harmonized as EN 62271-100:2009 (not modified).
IEC 62271-202:2006	NOTE	Harmonized as EN 62271-202:2007 (not modified).

Annex ZA
(normative)

Normative references to international publications with their corresponding European publications

The following referenced documents are indispensable for the application 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.

NOTE When an international publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

Publication	Year	Title	EN/HD	Year
IEC 60076-1	2011	Power transformers - Part 1: General	EN 60076-1	2011
IEC 60076-2	2011	Power transformers - Part 2: Temperature rise for liquid-immersed transformers	EN 60076-2	2011
IEC 60076-3 + corr. December	2000 2000	Power transformers - Part 3: Insulation levels, dielectric tests and external clearances in air	EN 60076-3	2001
IEC 60076-5	2006	Power transformers - Part 5: Ability to withstand short circuit	EN 60076-5	2006
IEC 60076-7	2005	Power transformers - Part 7: Loading guide for oil-immersed power transformers	-	-
IEC 60076-8	1997	Power transformers - Part 8: Application guide	-	-
IEC 60076-11	2004	Power transformers - Part 11: Dry-type transformers	EN 60076-11	2004
IEC 60076-12	2008	Power transformers - Part 12: Loading guide for dry-type power transformers	-	-
IEC 60076-13	2006	Power transformers - Part 13: Self-protected liquid-filled transformers	EN 60076-13	2006
IEC 61100	-	Classification of insulating liquids according to fire point and net calorific value	EN 61100	-
IEC 61378-1	2011	Convertor transformers - Part 1: Transformers for industrial applications	EN 61378-1	2011
IEC 61378-3	2006	Convertor transformers - Part 3: Application guide	-	-
IEC 61400-1	2005	Wind turbines - Part 1: Design requirements	EN 61400-1	2005
ISO 12944	Series	Paints and varnishes - Corrosion protection of steel structures by protective paint systems	-	-

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

POWER TRANSFORMERS –

Part 16: Transformers for wind turbine applications

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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International Standard IEC 60076-16 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
14/690/FDIS	14/698/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.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INTRODUCTION

This part of IEC 60076 is intended to specify the additional requirements for the transformers for installation in wind turbine applications.

Wind turbines use generator step-up transformers to connect the turbines to a network. These transformers can be installed in the nacelle or in the tower or outside close to the wind turbine.

This standard covers transformers for wind turbine applications or wind farms where the constraints on transformers exceed the requirement of the present IEC 60076 series. The constraints are not often known or recognized by the transformer manufacturers, wind turbine manufacturers and operators and as a result the level of reliability of these transformers can be lower than those used for conventional applications.

The transformers for wind turbine applications are not included in the present list of IEC 60076 standard series.

The purpose of this standard is help to obtain the same level of reliability as transformers for more common applications.

This standard deals particularly with the effects of repeated high frequency transient over-voltages, electrical, environmental, thermal, loading, installation and maintenance conditions that are specific for wind turbines or wind farms.

On site measurements, investigations and observations in wind turbines have detected risks for some different kind of installations:

– repeated high frequency transient over or under voltages in the range of kHz;
– over and under frequency due to turbine control;
– values of over voltage;
– over voltage or under voltage coming from LV side;
– high level of transient over voltages due to switching;
– presence of partial discharge around the transformer;
– harmonic contents current and voltage;
– overloading under ambient conditions;
– fast transient overload;
– clearances not in compliance with the minimum prescribed;
– installation conditions and connections;
– restricted conditions of cooling;
– water droplets;
– humidity levels that exceed the maximum permissible values;
– salt and dust pollution and extreme climatic conditions;
– high levels of vibration;
– mechanical stresses.

Therefore it is necessary to take into account in the design of the transformer the constraints of this application, or to define some protective devices to protect the transformer. Additional or improved routine, type or special tests for these transformers have to be specified to be in compliance with the constraints on the network.

POWER TRANSFORMERS –

Part 16: Transformers for wind turbine applications

1 Scope

This part of IEC 60076 applies to dry-type and liquid-immersed transformers for rated power 100 kVA up to 10 000 kVA for wind turbine applications having a winding with highest voltage for equipment up to and including 36 kV and at least one winding operating at a voltage greater than 1,1 kV.

Transformers covered by this standard comply with the relevant requirements prescribed in the IEC 60076 standards.

2 Normative references

The following referenced documents are indispensable for the application 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 60076-1:2011, *Power transformers – Part 1: General*

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

IEC 60076-3:2000, *Power transformers – Part 3: Insulation levels, dielectric tests and external clearances in air*

IEC 60076-5:2006, *Power transformers – Part 5: Ability to withstand short circuit*

IEC 60076-7:2005, *Power transformers – Part 7: Loading guide for oil-immersed power transformers*

IEC 60076-8:1997, *Power transformers – Application guide*

IEC 60076-11:2004, *Power transformers – Part 11: Dry-type transformers*

IEC 60076-12:2008, *Power transformers – Part 12: Loading guide for dry-type power transformers*

IEC 60076-13:2006, *Power transformers – Part 13: Self-protected liquid-filled transformers*

IEC 61100, *Classification of insulating liquids according to fire-point and net calorific value*

IEC 61378-1:2011, *Converter transformers – Part 1: Transformers for industrial applications*

IEC 61378-3:2006, *Converter transformers – Part 3: Application guide*

IEC 61400-1:2005, *Wind turbines – Part 1: Design requirements*

ISO 12944 (all parts), *Paints and varnishes – Corrosion protection of steel structures by protective paint systems*

3 Terms and definitions

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

3.1
wind turbine transformer
generator step up transformer connecting the wind turbine to the power collection network of the wind farm

3.2
tower
part of the supporting structure of wind turbine on top of which the nacelle with generator and other equipments are located

3.3
nacelle
housing that contains the drive-train and other elements on top of a horizontal-axis wind turbine tower

4 Service conditions

4.1 Normal service conditions

Unless otherwise stated in this standard, the service conditions in IEC 60076-11 and IEC 60076-1 apply.

4.2 Altitude

IEC 60076 series applies.

4.3 Temperature of cooling air

The installation of transformers inside an enclosure without active cooling systems increases the transformer temperature.

The purchaser shall specify the maximum cooling air temperatures if they are different from those stated in IEC 60076-2.

The transformer shall be designed according to real ambient temperatures and installation real conditions as described by the purchaser at enquiry stage.

Clause A.1 provides considerations for transformers installed in a naturally ventilated area like at the rear of the nacelle or in a separate enclosure installed outside the tower and equipped with air inlet and outlet.

In case of transformer installed in the tower or in an enclosure where natural ventilation is not provided the formula in A.1 is not applicable. For transformers operating under these conditions, the effects of air inlet and outlet, cooling conditions, efficiency of air cooling and ventilation shall be considered.

The purchaser shall prescribe the air ambient temperature and air flow inside the tower at the enquiry stage. If no temperature or air flow is specified, an internal ambient temperature inside the tower of 10 K higher than external temperature shall be assumed and not limited air circulation around the transformers.