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English Version

**Rotating electrical machines - Part 32: Measurement of stator
end-winding vibration at form-wound windings
(IEC/TS 60034-32:2016)**

Machines électriques tournantes - Partie 32: Mesurage des
vibrations des développantes de stator au niveau des
enroulements préformés
(IEC/TS 60034-32:2016)

Drehende elektrische Maschinen - Teil 32: Messung von
Wickelkopfschwingungen an Formspulen im Ständer
(IEC/TS 60034-32:2016)

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

IEC 60034-18-31	NOTE	Harmonized as EN 60034-18-31
IEC 60034-18-32	NOTE	Harmonized as EN 60034-18-32
IEC/TS 60034-18-33	NOTE	Harmonized as CLC/TS 60034-18-33
IEC 60034-18-34	NOTE	Harmonized as EN 60034-18-34

Annex ZA (normative)

Normative references to international publications with their corresponding European publications

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.

NOTE 1 When an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

NOTE 2 Up-to-date information on the latest versions of the European Standards listed in this annex is available here: www.cenelec.eu.

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 60034-1	-	Rotating electrical machines - Part 1: Rating and performance	EN 60034-1 ¹	-
IEC 60034-15	-	Rotating electrical machines - Part 15: Impulse voltage withstand levels of form-wound stator coils for rotating a.c. machines	EN 60034-15	-
IEC 60079	series	Explosive atmospheres	EN 60079	series
ISO 7626-5	1994	Vibration and shock - Experimental determination of mechanical mobility – Part 5: Measurements using impact excitation with an exciter which is not attached to the structure	-	-
ISO 18431-1	-	Mechanical vibration and shock - Signal processing - Part 1: General introduction	-	-
ISO 18431-2	-	Mechanical vibration and shock - Signal processing - Part 2: Time domain windows for Fourier Transform analysis	-	-

¹ A new edition and common modifications are currently under preparation. Stage of these documents at the time of publication: FprEN 60034-1 and FprEN 60034-1/prAA.

TECHNICAL SPECIFICATION



**Rotating electrical machines –
Part 32: Measurement of stator end-winding vibration at form-wound windings**



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TECHNICAL SPECIFICATION



**Rotating electrical machines –
Part 32: Measurement of stator end-winding vibration at form-wound windings**

INTERNATIONAL
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COMMISSION

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CONTENTS

FOREWORD.....	5
INTRODUCTION.....	7
1 Scope.....	10
2 Normative references	10
3 Terms, definitions and abbreviated terms	11
3.1 Terms and definitions.....	11
3.2 Abbreviated terms.....	13
4 Causes and effects of stator end-winding vibrations	14
5 Measurement of stator end-winding structural dynamics at standstill	15
5.1 General.....	15
5.2 Experimental modal analysis.....	15
5.2.1 General	15
5.2.2 Measurement equipment	16
5.2.3 Measurement procedure	17
5.2.4 Evaluation of measured frequency response functions, identification of modes	20
5.2.5 Elements of test report	20
5.2.6 Interpretation of results.....	21
5.3 Driving point analysis.....	22
5.3.1 General	22
5.3.2 Measurement equipment	23
5.3.3 Measurement procedure	23
5.3.4 Evaluation of measured FRFs, identification of modes	23
5.3.5 Elements of test report	24
5.3.6 Interpretation of results.....	24
6 Measurement of end-winding vibration during operation	25
6.1 General.....	25
6.2 Measurement equipment.....	25
6.2.1 General	25
6.2.2 Vibration transducers.....	26
6.2.3 Electro-optical converters for fiber optic systems	27
6.2.4 Penetrations for hydrogen-cooled machines	27
6.2.5 Data acquisition.....	27
6.3 Sensor installation	28
6.3.1 Sensor locations	28
6.3.2 Good installation practices.....	29
6.4 Most relevant dynamic characteristics to be retrieved	30
6.5 Identification of operational deflection shapes.....	31
6.6 Elements of test report.....	31
6.7 Interpretation of results	32
7 Repeated measurements for detection of structural changes	33
7.1 General.....	33
7.2 Reference measurements, operational parameters and their comparability	33
7.3 Choice of measurement actions	35
7.4 Aspects of machine's condition and its history	36
Annex A (informative) Background causes and effects of stator end-winding vibrations	37

A.1	Stator end-winding dynamics	37
A.1.1	Vibration modes and operating deflection shape	37
A.1.2	Excitation of stator end-winding vibrations	38
A.1.3	Relevant vibration characteristics of stator end-windings	38
A.1.4	Influence of operational parameter	41
A.2	Increased stator end-winding vibrations	41
A.2.1	General aspects of increased vibration	41
A.2.2	Increase of stator end-winding vibrations levels over time and potential remedial actions	42
A.2.3	Transient conditions as cause for structural changes	43
A.2.4	Special aspects of main insulation	44
A.3	Operational deflection shape of global stator end-winding vibrations	44
A.3.1	General	44
A.3.2	Force distributions relevant for global vibrational behaviour	44
A.3.3	Idealized global vibration behaviour while in operation	45
A.3.4	General vibration behaviour of stator end-windings	47
A.3.5	Positioning of sensors for the measurement of global vibration level	49
A.4	Operational deflection shape of local stator end-winding vibrations	51
Annex B (informative)	Data visualization	52
B.1	General	52
B.2	Standstill measurements	53
B.3	Measurements during operation	56
Bibliography	62
Figure 1	– Stator end-winding of a turbogenerator (left) and a large motor (right) at connection end with parallel rings	7
Figure 2	– Example for an end-winding structure of an indirect cooled machine	8
Figure 3	– Measurement structure with point numbering and indication of excitation	19
Figure 4	– Simplified cause effect chain of stator end-winding vibration and influencing operational parameters	35
Figure A.1	– Illustration of global vibration modes	40
Figure A.2	– Example of rotational force distribution for $p = 1$	45
Figure A.3	– Example of rotating operational vibration deflection wave for $p = 1$	46
Figure A.4	– Illustration of two vibration modes with different orientation in space (example for $p = 1$)	47
Figure A.5	– on-rotational operational vibration deflection wave (example for $p = 1$)	48
Figure A.6	– Amplitude and phase distribution for a general case.	49
Figure A.7	– Sensors for the measurement of global vibration level centred in the winding zones	50
Figure A.8	– Measurement of global vibration level with 6 equidistantly distributed sensors in the centre of winding zones	50
Figure A.9	– Example – Sensor positions for the measurement of local vibration level of the winding connection relative to global vibration level	51
Figure B.1	– Measurement structure with point numbering and indication of excitation	52
Figure B.2	– Example for linearity test – Force signal and variance of related FRFs	53
Figure B.3	– Example for reciprocity test – FRFs in comparison	53
Figure B.4	– Example – Two overlay-plots of the same transfer functions but different dimensions	54

Figure B.5 – Shapes of the 4, 6 and 8-node modes with natural frequencies, measurement in one plane.....	55
Figure B.6 – Mode shape of a typical 4-node mode with different viewing directions (stator end-winding and outer support ring).....	55
Figure B.7 – Example – Amplitude and phase of dynamic compliance and coherence.....	56
Figure B.8 – 2-pole, 60 Hz generator – Trend in displacement over time for 10 stator end-winding accelerometers, as well as one accelerometer mounted on the stator core.....	56
Figure B.9 – 2-pole, 60 Hz generator – End-winding vibration, winding temperature trends over time, constant stator current.....	57
Figure B.10 – 2-pole, 60 Hz generator – End-winding vibration, stator current trends over time, constant winding temperature.....	57
Figure B.11 – 2-pole, 60 Hz generator – Example of variation in vibration levels at comparable operating conditions.....	58
Figure B.12 – 2-pole, 60 Hz generator – Raw vibration signal, acceleration waveform	59
Figure B.13 – 2-pole, 60 Hz generator – FFT and double integrated vibration signal, displacement spectrum	59
Figure B.14 – 2-pole, 60 Hz generator – Displacement spectrum	60
Figure B.15 – 2-pole, 60 Hz generator – Velocity spectrum	60
Figure B.16 – 2-pole, 60 Hz generator – Acceleration spectrum	61
Table 1 – Node number of highest mode shape in relevant frequency range and minimum number of measurement locations	20
Table 2 – Possible measurement actions to gain insight into various aspects of the cause-effect chain.	36

INTERNATIONAL ELECTROTECHNICAL COMMISSION

ROTATING ELECTRICAL MACHINES –

**Part 32: Measurement of stator end-winding vibration
at form-wound windings**

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Technical Specifications are subject to review within three years of publication to decide whether they can be transformed into International Standards.

IEC TS 60034-32, which is a Technical Specification, has been prepared by IEC technical committee 2: Rotating machinery.

The text of this Technical Specification is based on the following documents:

Enquiry draft	Report on voting
2/1810/DTS	2/1849/RVC

Full information on the voting for the approval of this Technical Specification 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.

NOTE A table of cross-references of all IEC TC 2 publications can be found on the IEC TC 2 dashboard on the IEC website.

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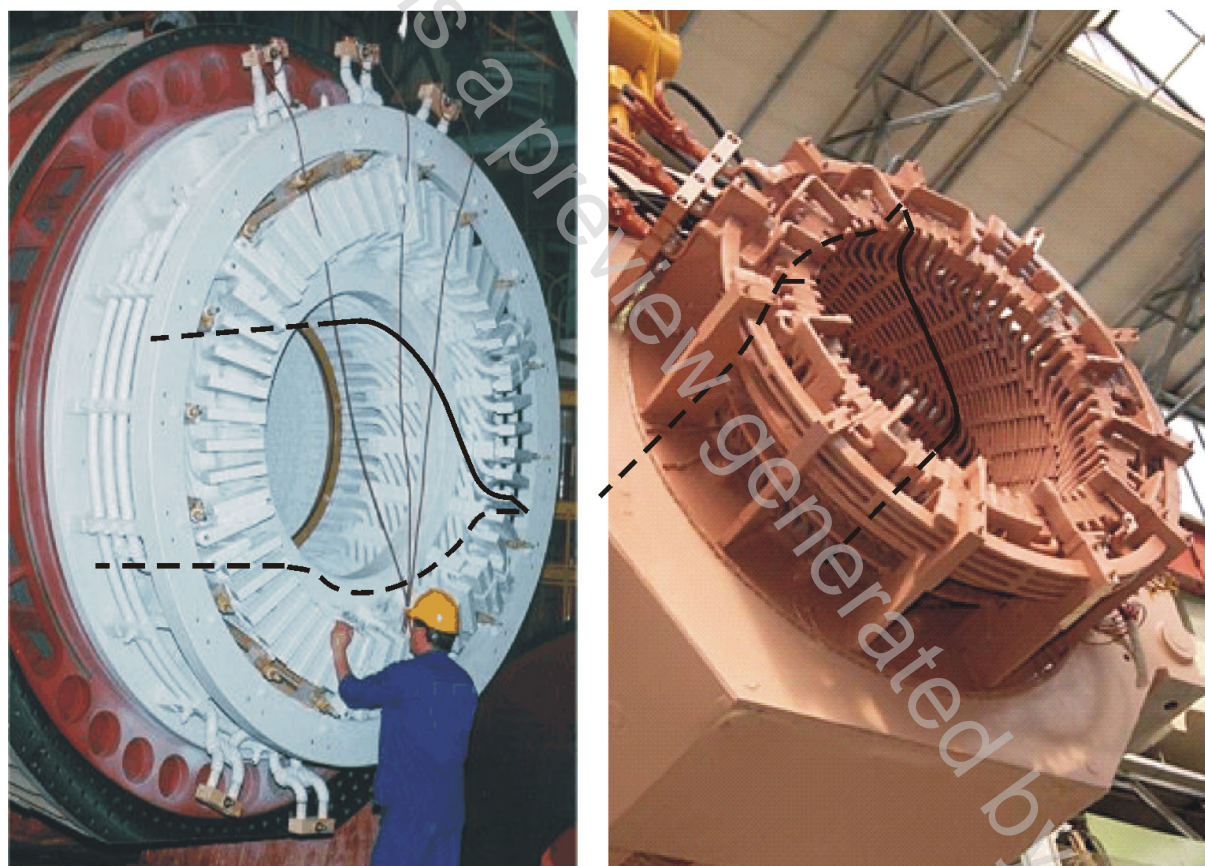
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INTRODUCTION

Large alternating current (AC) machines are equipped with multiphase stator windings. The information in this document is based on a dual-layer design. Such windings are connected to a multiphase voltage system (multiphase current system), which establishes a rotating magnetic field in the air gap between the rotor surface and stator bore. The voltage and current can vary during operation in order to adapt to varying mechanical load. Electrical machines are normally designed for motor or generator operating mode. The majority of AC machines are equipped with symmetrical three-phase windings, consisting of three, electrically isolated, spatially distributed winding parts that are intended for common operation.

Large AC rotating electrical machines are typically equipped with form-wound windings consisting of form wound coils (as defined in IEC 60034-15:2009, 2.3), single winding coils (single winding bars) which are given their shape before being assembled into the machine.

The winding overhang, or end-winding, is the portion of the stator winding that extends beyond the end of the magnetic core and is, in most cases, formed as a circular cone, see some examples in Figure 1 below.

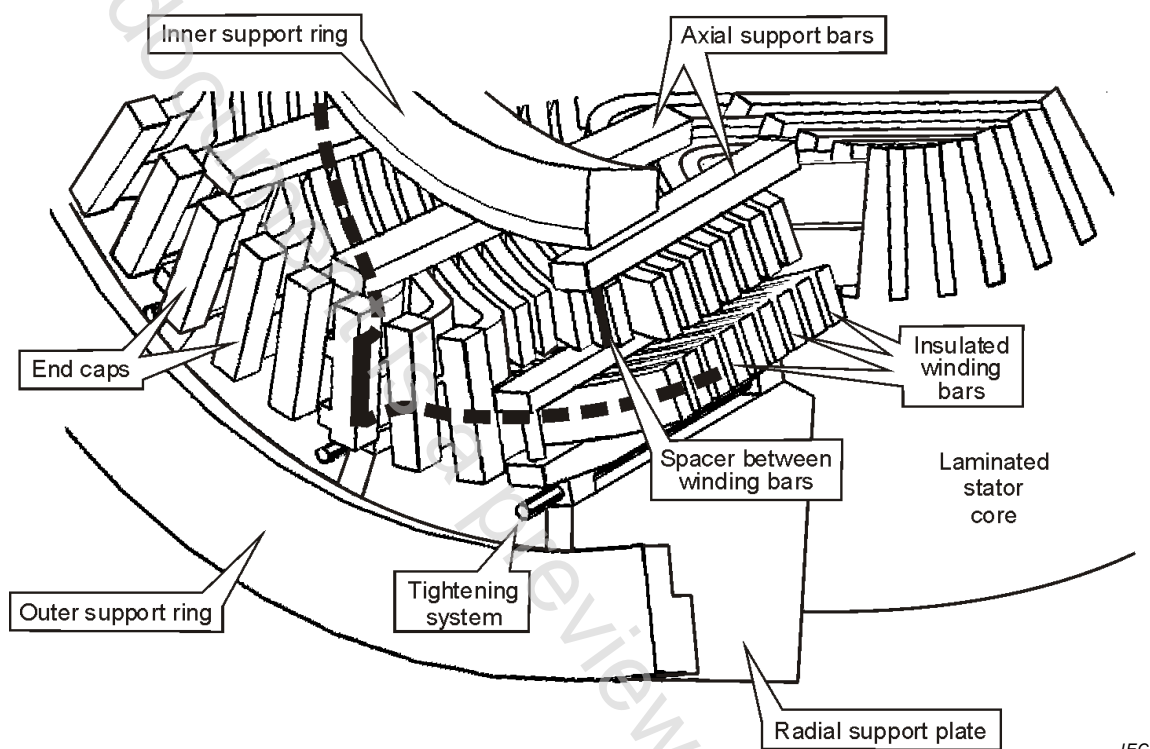


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NOTE Individual coil end marked with black line.

Figure 1 – Stator end-winding of a turbogenerator (left) and a large motor (right) at connection end with parallel rings

The majority of large AC machines with form-wound stator windings are equipped with a stator end-winding support structure. Among other functions it is expected to withstand the high electromagnetic force loading when the machine is exposed to an electrical fault in the electrical supply system. This includes a fault in the supply lines of an electrical grid or in an electronic supply device. In many cases the stator end-winding support structure is not only designed to increase the structural strength, but also provide appropriate structural stiffness and inertia to systematically influence structural dynamics and thus the vibration level during operation.



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Figure 2 – Example for an end-winding structure of an indirect cooled machine

Typical support elements are plates and rings, which support the end-winding cone as a whole. Moreover, the distance between coils (or bars) of the end-winding are defined by spacing elements and their positions are fixed by fastening components. The typical materials used for support elements, spacers and fasteners are composites containing glass fibre materials as well as resin impregnated felts, cords and bandings (see Figure 2). Also, high electrical fields surrounding metal parts could produce electrical discharges compromising long term electrical strength.

Until now there existed no general Technical Specification to get reliable and comparable results for the identification of natural frequencies during stand-still and for vibration behaviour of stator end-windings during operation.

The experimental modal analysis of stator end-windings is a well-established tool which has also been used for the verification of natural frequencies and mode shapes of large electrical machines worldwide. The goal is to avoid operation of the machine with increased end-winding vibration levels under the influence of natural frequencies. Measurement of transfer functions and identification of structural dynamic properties (e.g. natural frequencies, mode shapes and other modal parameters) with an impact test is a common testing procedure. It is applied to new machines by the manufacturer and also used as a maintenance tool by the user or contractor during a major overhaul of large rotating machines.

Operational measurement of vibrational behaviour of stator end-windings can be performed by the installation of special vibration transducers at selected end-winding locations for periodic measurements or permanent on-line monitoring.

Although measurements of natural frequencies and vibration levels of stator end-windings are well established techniques, the interpretation of results is still a matter of further improvement and development. Therefore this first edition is a Technical Specification and not an International Standard.