IEC 60034-4

Edition 3.0 2008-05

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Rotating electrical machines –
Part 4: Methods for determining synchronous machine quantities from tests

Machines électriques tournantes –
Partie 4: Méthodes pour la détermination, à partir d'essais, des grandeurs des machines synchrones

IEC 60034-4:2008

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INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

PRICE CODE
CODE PRIX XC

ICS 29.160

ISBN 2-8318-9706-8

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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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 60034-4 has been prepared by IEC technical committee 2: Rotating machinery.

This third edition cancels and replaces the second edition published in 1985 and its amendment 1 (1995). This edition constitutes a technical revision. The main changes with respect to the previous edition are listed below:

– Tests described in Supplement A of the previous edition were partly removed for lack of relevance in current practise.
– Provisions were made for tests on machines with brushless excitation.
– A table of test methods indicates preferred tests, and a test cross-reference is provided.
– The conventional two-axes salient-pole machine model description was added in an Annex.

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

FDIS	Report on voting
2/1488/FDIS	2/1495/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 IEC 60034 series, under the general title *Rotating electrical machines*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the maintenance result 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.

ROTATING ELECTRICAL MACHINES –

Part 4: Methods for determining synchronous machine quantities from tests

1 Scope

This part of IEC 60034 applies to three-phase synchronous machines of 1 kVA rating and larger with rated frequency of not greater than 500 Hz and not less than 10 Hz.

Most of the methods are intended to be used for machines having an excitation winding with slip-rings and brushes for their supply. Synchronous machines with brushless excitation require special effort for some of the tests. For machines with permanent magnet excitation, there is a limited applicability of the described tests, and special precautions have to be taken against irreversible demagnetization.

Excluded are axial-field machines and special synchronous machines such as inductor type machines and transversal flux machines.

It is not intended that this standard be interpreted as requiring any or all of the tests described therein on any given machine. The particular tests to be carried out shall be subject to agreement between manufacturer and customer.

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 60034-1:2004, *Rotating electrical machines – Part 1: Rating and performance*

IEC 60034-2-1, *Rotating electrical machines – Part 2-1: Standards methods for determining losses and efficiency from tests (excluding machines for traction vehicles)*

IEC 60034-2A, *Rotating electrical machines – Part 2: Methods for determining losses and efficiency from tests (excluding machines for traction vehicles) – First supplement: Measurement of losses by the calorimetric method*

IEC 60051 (all parts), *Direct acting indicating analogue electrical measuring instruments and their accessories*

3 Terms and definitions

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

3.1
initial starting impedance, synchronous motors
quotient of the applied armature voltage and the sustained average armature current, the machine being at standstill

3.2
direct-axis synchronous reactance
the quotient of the sustained value of that fundamental a.c. component of armature voltage, which is produced by the total direct-axis primary flux due to direct-axis armature current, and the value of the fundamental a.c. component of this current, the machine running at rated speed

[IEV 411-50-07]

3.3
direct-axis transient reactance
the quotient of the initial value of a sudden change in that fundamental a.c. component of armature voltage, which is produced by the total direct-axis primary flux, and the value of the simultaneous change in fundamental a.c. component of direct-axis armature current, the machine running at rated speed and the high decrement components during the first cycles being excluded

[IEV 411-50-09]

3.4
direct-axis sub-transient reactance
the quotient of the initial value of a sudden change in that fundamental a.c. component of armature voltage, which is produced by the total direct-axis armature flux, and the value of the simultaneous change in fundamental a.c. component of direct-axis armature current, the machine running at rated speed

[IEV 411-50-11]

3.5
quadrature-axis synchronous reactance
the quotient of the sustained value of that fundamental a.c. component of armature voltage, which is produced by the total quadrature-axis primary flux due to quadrature-axis armature current, and the value of the fundamental a.c. component of this current, the machine running at rated speed

[IEV 411-50-08]

3.6
quadrature-axis transient reactance
the quotient of the initial value of a sudden change in that fundamental a.c. component of armature voltage, which is produced by the total quadrature-axis armature winding flux, and the value of the simultaneous change in fundamental a.c. component of quadrature-axis armature current, the machine running at rated speed and the high decrement components during the first cycles being excluded

[IEV 411-50-10]

3.7
quadrature-axis sub-transient reactance
the quotient of the initial value of a sudden change in that fundamental a.c. component of armature voltage, which is produced by the total quadrature-axis primary flux and the value of the simultaneous change in fundamental a.c. component of quadrature-axis armature current, the machine running at rated speed

[IEV 411-50-12]

3.8
positive sequence reactance
the quotient of the reactive fundamental component of the positive sequence armature voltage, due to the sinusoidal positive sequence armature current at rated frequency, by the value of that component of current, the machine running at rated speed

[IEV 411-50-14]

3.9
negative sequence reactance
the quotient of the reactive fundamental component of negative sequence armature voltage, due to the sinusoidal negative sequence armature current at rated frequency, by the value of that component of current, the machine running at rated speed

[IEV 411-50-15]

3.10
zero sequence reactance
the quotient of the reactive fundamental component of zero sequence armature voltage, due to the presence of fundamental zero sequence armature current at rated frequency, by the value of that component of current, the machine running at rated speed

[IEV 411-50-16]

3.11
Potier reactance
a reactance taking into account the leakage of the field winding, on load and in the over-excited region, which is used in place of the armature leakage reactance to calculate the excitation on load by means of the Potier method

[IEV 411-50-13]

3.12
armature-leakage reactance
quotient of the reactive fundamental component of armature voltage due to the leakage flux of armature winding and the fundamental component of armature current, the machine running at rated speed

3.13
armature resistance
resistance measured by direct current between terminals of the armature winding, assigned to a certain winding temperature, expressed as per phase value

3.14
excitation winding resistance
resistance measured by direct current between terminals of the excitation winding, assigned to a certain winding temperature

3.15
positive sequence resistance
the quotient of the in-phase component of positive sequence armature voltage corresponding to losses in the armature winding and stray load losses due to the sinusoidal positive sequence armature current, by the value of that component of current, the machine running at rated speed

[IEV 411-50-18]

3.16
negative sequence resistance
the quotient of the in-phase fundamental component of negative sequence armature voltage, due to the sinusoidal negative sequence armature current at rated frequency, by the value of that component of current, the machine running at rated speed

[IEV 411-50-19]

3.17
zero sequence resistance
the quotient of the in-phase fundamental component of zero sequence armature voltage, due to the fundamental zero sequence armature current of rated frequency, by the value of that component of current, the machine running at rated speed

[IEV 411-50-20]

3.18
short-circuit ratio
the ratio of the field current for rated armature voltage on open-circuit to the field current for rated armature current on sustained symmetrical short-circuit, both with the machine running at rated speed

[IEV 411-50-21]

3.19
direct-axis transient open-circuit time constant
the time required, following a sudden change in operating conditions, for the slowly changing component of the open-circuit armature voltage, which is due to direct-axis flux, to decrease to 1/e , that is 0,368 of its initial value, the machine running at rated speed

[IEV 411-48-27]

3.20
direct-axis transient short-circuit time constant
the time required, following a sudden change in operating conditions, for the slowly changing component of direct-axis short-circuit armature current to decrease to 1/e, that is 0,368 of its initial value, the machine running at rated speed

[IEV 411-48-28]

3.21
direct-axis sub-transient open-circuit time constant

the time required, following a sudden change in operating conditions, for the rapidly changing component present during the first few cycles of the open-circuit armature winding voltage which is due to direct-axis flux, to decrease to 1/e, that is 0,368 of its initial value, the machine running at rated speed

[IEV 411-48-29]

3.22
direct-axis sub-transient short-circuit time constant
the time required, following a sudden change in operating conditions, for the rapidly changing component, present during the first few cycles in the direct-axis short-circuit armature current, to decrease to 1/e, that is 0,368 of its initial value, the machine running at rated speed

[IEV 411-48-30]

3.23
quadrature-axis transient open-circuit time constant
the time required, following a sudden change in operating conditions, for the slowly changing component of the open-circuit armature winding voltage which is due to quadrature-axis flux, to decrease to 1/e, that is 0,368 of its initial value, the machine running at rated speed

[IEV 411-48-32]

3.24
quadrature-axis transient short-circuit time constant
the time required, following a sudden change in operating conditions, for the slowly changing component of quadrature-axis short-circuit armature winding current, to decrease to 1/e, that is 0,368 of its initial value, the machine running at rated speed

[IEV 411-48-33]