IEC 60034-2-1

Edition 2.0 2014-06

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Rotating electrical machines –
Part 2-1: Standard methods for determining losses and efficiency from tests (excluding machines for traction vehicles)

Machines électriques tournantes –
Partie 2-1: Méthodes normalisées pour la détermination des pertes et du rendement à partir d'essais (à l'exclusion des machines pour véhicules de traction)

IEC 60034-2-1:2014-06(en-fr)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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FOREWORD

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International Standard IEC 60034-2-1 has been prepared by IEC technical committee 2: Rotating machinery.

This second edition cancels and replaces the first edition of IEC 60034-2-1, issued in 2007, as well as IEC 60034-2A, issued in 1974. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) The test methods are now grouped into preferred methods and methods for field or routine testing. Preferred methods have a low uncertainty and for a specific rating and type of machine only one preferred method is now defined.
b) The requirements regarding instrumentation have been detailed and refined.
c) The description of tests required for a specific method is now given in the same sequence as requested for the performance of the test. This will avoid misunderstandings and

improve the accuracy of the procedures. In addition, for each method a flowchart shows the sequence of tests graphically.

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

FDIS	Report on voting
2/1742/FDIS	2/1748/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.

NOTE A table of cross-references of all IEC TC 2 publications can be found in the IEC TC 2 dashboard 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- withdrawn,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.

ROTATING ELECTRICAL MACHINES –

Part 2-1: Standard methods for determining losses and efficiency from tests (excluding machines for traction vehicles)

1 Scope

This part of IEC 60034 is intended to establish methods of determining efficiencies from tests, and also to specify methods of obtaining specific losses.

This standard applies to d.c. machines and to a.c. synchronous and induction machines of all sizes within the scope of IEC 60034-1.

NOTE These methods may be applied to other types of machines such as rotary converters, a.c. commutator motors and single-phase induction motors.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60027-1, *Letter symbols to be used in electrical technology – Part 1: General*

IEC 60034-1:2010, *Rotating electrical machines – Part 1: Rating and performance*

IEC 60034-4:2008, *Rotating electrical machines – Part 4: Methods for determining synchronous machine quantities from tests*

IEC 60034-19, *Rotating electrical machines – Part 19:Specific test methods for d.c. machines on conventional and rectifier-fed supplies*

IEC 60034-29, *Rotating electrical machines – Part 29: Equivalent loading and superposition techniques – Indirect testing to determine temperature rise*

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

IEC 60051-1, *Direct acting indicating analogue electrical measuring instruments and their accessories – Part 1: Definitions and general requirements common to all parts*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60034-1, IEC 60051-1 and the following apply.

3.1
efficiency
ratio of output power to input power expressed in the same units and usually given as a percentage

3.2
direct efficiency determination
method by which the determination of efficiency is made by measuring directly the input power and the output power

3.3
dynamometer
device for measuring torque applied to the rotating part of the machine under test. It is equipped with means for measuring and indicating torque and speed, and is not limited to a cradle base construction. An in-line torque transducer may be used to provide a direct measurement of torque at the shaft of the machine under test.

3.4
dynamometer test
test in which the mechanical power output of a machine acting as a motor is determined by a dynamometer. Also a test in which the mechanical input power of a machine acting as a generator is determined by a dynamometer.

3.5
dual-supply back-to-back test
test in which two identical machines are mechanically coupled together, and the total losses of both machines are calculated from the difference between the electrical input to one machine and the electrical output of the other machine

3.6
indirect efficiency determination
method by which the determination of efficiency is made by measuring the input power or the output power and determining the total losses. Those losses are added to the output power, thus giving the input power, or subtracted from the input power, thus giving the output power.

3.7
single-supply back-to-back test
test in which two identical machines are mechanically coupled together, and are both connected electrically to the same power system. The total losses of both machines are taken as the input power drawn from the system.

3.8
no-load test
test in which a machine is run as a motor providing no useful mechanical output from the shaft, or when run as a generator with its terminals open-circuited

3.9
zero power factor test (synchronous machines)
no-load test on a synchronous machine, which is over-excited and operates at a power factor very close to zero

3.10
equivalent circuit method (induction machines)
test in which the losses are determined by help of an equivalent circuit model

3.11
test with rotor removed and reverse rotation test (induction machines)
combined test in which the additional load losses are determined from a test with rotor removed and a test with the rotor running in reverse direction to the rotating magnetic field of the stator

3.12
short-circuit test (synchronous machines)
test in which a machine is run as a generator with its terminals short-circuited

3.13
locked rotor test
test in which the rotor is locked to prevent rotation

3.14
eh-star test
test in which the motor is run in star connection on unbalanced voltage

3.15 Losses

3.15.1
total losses
P_T
difference between the input power and the output power, equivalent to the sum of the constant losses (see 3.15.2), the load losses (see 3.15.4), the additional load losses (see 3.15.5) and the excitation circuit losses (see 3.15.3)

3.15.2
constant losses
losses incorporating the sum of windage, friction and iron losses. Although these losses change with voltage and load, they are historically called “constant” losses and the name is retained in this standard.

3.15.2.1
constant losses
P_c
sum of the iron losses and the friction and windage losses

3.15.2.2
iron losses
P_{fe}
losses in active iron and additional no-load losses in other metal parts

3.15.2.3 Friction and windage losses P_{fw}

3.15.2.3.1
friction losses
losses due to friction (bearings and brushes, if not lifted at rated conditions) not including any losses in a separate lubricating system

3.15.2.3.2
windage losses
total losses due to aerodynamic friction in all parts of the machine, including power absorbed in shaft mounted fans, and in auxiliary machines forming an integral part of the machine

Note 1 to entry: Losses in a separate ventilating system should be listed separately.

Note 2 to entry: For machines indirectly or directly cooled by hydrogen, see IEC 60034-1.

3.15.3 Excitation circuit losses

3.15.3.1
excitation circuit losses
P_e
sum of the excitation winding losses (see 3.15.3.2), the exciter losses (see 3.15.3.3) and, for synchronous machines, electrical brush loss (see 3.15.3.5), if any