

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)**



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CONTENTS

FOREWORD.....	5
1 Scope.....	7
2 Normative references	7
3 Terms and definitions	7
4 Symbols and abbreviations.....	12
4.1 Symbols.....	12
4.2 Additional subscripts.....	13
5 Basic requirements.....	14
5.1 Direct and indirect efficiency determination	14
5.2 Uncertainty	15
5.3 Preferred methods and methods for customer-specific acceptance tests, field-tests or routine-tests	15
5.4 Power supply	15
5.4.1 Voltage.....	15
5.4.2 Frequency	15
5.5 Instrumentation	15
5.5.1 General	15
5.5.2 Measuring instruments for electrical quantities	16
5.5.3 Torque measurement.....	16
5.5.4 Speed and frequency measurement.....	16
5.5.5 Temperature measurement.....	17
5.6 Units.....	17
5.7 Resistance.....	17
5.7.1 Test resistance	17
5.7.2 Winding temperature	17
5.7.3 Correction to reference coolant temperature	18
5.8 State of the machine under test and test categories	18
5.9 Excitation circuit measurements.....	19
5.10 Ambient temperature during testing	19
6 Test methods for the determination of the efficiency of induction machines	19
6.1 Preferred testing methods.....	19
6.1.1 General	19
6.1.2 Method 2-1-1A – Direct measurement of input and output.....	20
6.1.3 Method 2-1-1B – Summation of losses, additional load losses according to the method of residual loss	21
6.1.4 Method 2-1-1C – Summation of losses with additional load losses from assigned allowance	28
6.2 Testing methods for field or routine-testing	32
6.2.1 General	32
6.2.2 Method 2-1-1D – Dual supply back-to-back-test.....	33
6.2.3 Method 2-1-1E – Single supply back-to-back-test	34
6.2.4 Method 2-1-1F – Summation of losses with additional load losses determined by test with rotor removed and reverse rotation test	35
6.2.5 Method 2-1-1G – Summation of losses with additional load losses determined by Eh-star method.....	39
6.2.6 Method 2-1-1H – Determination of efficiency by use of the equivalent circuit parameters.....	42

7	Test methods for the determination of the efficiency of synchronous machines	47
7.1	Preferred testing methods	47
7.1.1	General	47
7.1.2	Method 2-1-2A – Direct measurement of input and output.....	48
7.1.3	Method 2-1-2B – Summation of separate losses with a rated load temperature test and a short circuit test.....	50
7.1.4	Method 2-1-2C – Summation of separate losses without a full load test	55
7.2	Testing methods for field or routine testing	57
7.2.1	General	57
7.2.2	Method 2-1-2D – Dual supply back-to-back-test.....	57
7.2.3	Method 2-1-2E – Single supply back-to-back-test	58
7.2.4	Method 2-1-2F – Zero power factor test with excitation current from Potier-, ASA- or Swedish-diagram	60
7.2.5	Method 2-1-2G – Summation of separate losses with a load test without consideration of additional load losses	64
8	Test methods for the determination of the efficiency of d.c. machines.....	65
8.1	Testing methods for field or routine testing	65
8.1.1	General	65
8.1.2	Method 2-1-3A – Direct measurement of input and output.....	65
8.1.3	Method 2-1-3B – Summation of losses with a load test and d.c. component of additional load losses from test.....	67
8.1.4	Method 2-1-3C – Summation of losses with a load test and d.c. component of additional load losses from assigned value	73
8.1.5	Method 2-1-3D – Summation of losses without a load test	75
8.1.6	Method 2-1-3E – Single supply back-to-back test	77
	Annex A (normative) Calculation of values for the Eh-star method	80
	Annex B (informative) Types of excitation systems	83
	Annex C (informative) Induction machine slip measurement.....	84
	Annex D (informative) Test report template for method 2-1-1B.....	86
	Bibliography.....	87
	Figure 1 – Sketch for torque measurement test.....	20
	Figure 2 – Efficiency determination according to method 2-1-1A	21
	Figure 3 – Efficiency determination according to method 2-1-1B	22
	Figure 4 – Smoothing of the residual loss data.....	27
	Figure 5 – Efficiency determination according to method 2-1-1C	29
	Figure 6 – Vector diagram for obtaining current vector from reduced voltage test	30
	Figure 7 – Assigned allowance for additional load losses P_{LL}	31
	Figure 8 – Efficiency determination according to method 2-1-1D	33
	Figure 9 – Sketch for dual supply back-to-back test	33
	Figure 10 – Efficiency determination according to method 2-1-1E	34
	Figure 11 – Efficiency determination according to method 2-1-1F	36
	Figure 12 – Efficiency determination according to method 2-1-1G.....	39
	Figure 13 – Eh-star test circuit.....	40
	Figure 14 – Induction machine, T-model with equivalent iron loss resistor	42
	Figure 15 – Efficiency determination according to method 2-1-1H	43
	Figure 16 – Induction machines, reduced model for calculation.....	46

Figure 17 – Sketch for torque measurement test	49
Figure 18 – Efficiency determination according to method 2-1-2A	49
Figure 19 – Efficiency determination according to method 2-1-2B	50
Figure 20 – Efficiency determination according to method 2-1-2C	56
Figure 21 – Efficiency determination according to method 2-1-2D	57
Figure 22 – Sketch for dual supply back-to-back test ($I_M = I_G, f_M = f_G$)	58
Figure 23 – Efficiency determination according to method 2-1-2E	59
Figure 24 – Single supply back-to-back test for synchronous machines	59
Figure 25 – Efficiency determination according to method 2-1-2F	60
Figure 26 – Efficiency determination according to method 2-1-2G	64
Figure 27 – Sketch for torque measurement test	66
Figure 28 – Efficiency determination according to method 2-1-3A	66
Figure 29 – Efficiency determination according to method 2-1-3B	67
Figure 30 – Sketch for single supply back-to-back test for determination of d.c. component of additional load losses	71
Figure 31 – Efficiency determination according to method 2-1-3C	73
Figure 32 – Efficiency determination according to method 2-1-3D	76
Figure 33 – Efficiency determination according to method 2-1-3E	78
Figure 34 – Sketch for single supply back-to-back test	78
Figure C.1 – Slip measurement system block diagram	85
Table 1 – Reference temperature	17
Table 2 – Induction machines: preferred testing methods	20
Table 3 – Induction machines: other methods	32
Table 4 – Synchronous machines with electrical excitation: preferred testing methods	48
Table 5 – Synchronous machines with permanent magnets: preferred testing methods	48
Table 6 – Synchronous machines: other methods	57
Table 7 – DC machines: test methods	65
Table 8 – Multiplying factors for different speed ratios	74

INTERNATIONAL ELECTROTECHNICAL COMMISSION

ROTATING ELECTRICAL MACHINES –

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

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.

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- 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