

# INTERNATIONAL STANDARD

# NORME INTERNATIONALE

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**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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INTERNATIONAL  
ELECTROTECHNICAL  
COMMISSION

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ELECTROTECHNIQUE  
INTERNATIONALE

PRICE CODE  
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# 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 standard cancels and replaces IEC 60034-2 (1972), its amendment 1 (1995) and its amendment 2 (1996). IEC 60034-2A (1974) is retained for the time being.

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

FDIS	Report on voting
2/1443/FDIS	2/1460/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.

A list of all parts of IEC 60034 series, under the general title *Rotating electrical machines*, can be found on the IEC website.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

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- withdrawn,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.

## INTRODUCTION

During the revision phase for IEC 60034-2: 1972 and its amendments IEC 60034-2 A1: 1995 (defining IEC 60034-2A: 1974 as Clause 17) and IEC 60034-2 A2: 1996, WG 28 proposed and TC 2 agreed to separate the revised standard into three sections:

- the first part (IEC 60034-2-1) to cover machines within the scope of IEC 60034-1, which are normally tested under load;
- the second part (IEC 60034-2-2) to cover tests applicable mainly for large machines where the facility cost for other methods is not economical (especially the calibrated-machine test, the retardation test and the calorimetric method);
- the third part (IEC 60034-2-3) for tests on machines for converter supply..

To retain in IEC 60034-2-1 as normative the test methods that will eventually become IEC 60034-2-2, a temporary Annex D has been added. This annex contains elements from IEC 60034-2:1972 and its amendment 1:1995. It also makes reference to IEC 60034-2A:1974. Both will be incorporated in the future IEC 60034-2-2.



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

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

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

IEC 60034-4, *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 60044 (all parts), *Instrument transformers*

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

IEC 61986, *Rotating electrical machines – Equivalent loading and super-position techniques – Indirect testing to determine temperature rise*

NOTE A revision of IEC 61986 is under consideration; it will be published under reference IEC 60034-29.

### 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 definitions apply.

#### 3.1

##### **efficiency**

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

#### 3.2 Tests for direct efficiency determination

##### 3.2.1

##### **general**

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

##### 3.2.2

##### **torque meter test**

test in which the mechanical power output of a machine acting as a motor is determined by measurement of the shaft torque by means of a torque meter together with the rotational speed. Alternatively, a test performed on a machine acting as a generator, by means of a torque meter to determine the mechanical power input

##### 3.2.3

##### **dynamometer test**

test in accordance with 3.2.2 but measuring the shaft torque by means of a dynamometer

##### 3.2.4

##### **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

#### 3.3 Tests for indirect efficiency determination

##### 3.3.1

##### **general**

test in which the indirect 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

##### 3.3.2

##### **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

##### 3.3.3

##### **no-load test**

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

**3.3.4****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

**3.3.5****equivalent circuit method (induction machines)**

test in which the losses are determined by help of an equivalent circuit model

**3.3.6****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

**3.3.7****short-circuit test (synchronous machines)**

test in which a machine is run as a generator with its terminals short-circuited

**3.3.8****locked rotor test**

test in which the rotor is locked to prevent rotation

**3.3.9****eh-star test**

test in which the motor is run in star connection on unbalanced voltage.

**3.4 Losses****3.4.1****total losses  $P_T$** 

difference between the input power and the output power, equivalent to the sum of the constant losses (see 3.4.2), the load losses (see 3.4.4), the additional load losses (see 3.4.5) and the excitation circuit losses (see 3.4.3)

**3.4.2 Constant losses****3.4.2.1****constant losses  $P_k$** 

sum of the iron losses and the friction and windage losses

**3.4.2.2****iron losses  $P_{fe}$** 

losses in active iron and additional no-load losses in other metal parts

**3.4.2.3 Friction and windage losses  $P_{fw}$** **3.4.2.3.1****friction losses**

losses due to friction (bearings and brushes, if not lifted at rated conditions) not including any losses in a separate lubricating system. Losses in common bearings should be stated separately, whether or not such bearings are supplied with the machine. The bearing losses are based on the operating temperatures of the bearings, the type of oil and oil temperature.

NOTE 1 When the losses in a separate lubricating system are required these should be listed separately.