SLOVENSKI STANDARD
SIST EN 60034-2:1999/A2:1999

01-april-1999

Rotating electrical machines - Part 2: Methods for determining losses and efficiency of rotating electrical machinery from tests (excluding machines for traction vehicles) (IEC 60034-2:1972/A2:1996)

Rotating electrical machines -- Part 2: Methods for determining losses and efficiency of rotating electrical machinery from tests (excluding machines for traction vehicles)

Drehende elektrische Maschinen -- Teil 2: Verfahren zur Bestimmung der Verluste und des Wirkungsgrades von drehenden elektrischen Maschinen aus Prüfungen (ausgenommen Maschinen für Schienen- und Straßenfahrzeuge)

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

Ta slovenski standard je istoveten z: **EN 60034-2:1996/A2:1996**

ICS:

29.160.01	Rotacijski stroji na splošno	Rotating machinery in general

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EUROPEAN STANDARD

NORME EUROPÉENNE

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English version

Rotating electrical machines
Part 2: Methods for determining losses and efficiency of rotating electrical machinery from tests (excluding machines for traction vehicles)
(IEC 34-2:1972/A2:1996)

Machines électriques tournantes
Partie 2: Méthodes pour la détermination des pertes et du rendement des machines électriques tournantes à partir d'essais (à l'exclusion des machines pour véhicules de traction)
(CEI 34-2:1972/A2:1996)

Drehende elektrische Maschinen
Teil 2: Verfahren zur Bestimmung der Verluste und des Wirkungsgrades von drehenden elektrischen Maschinen aus Prüfungen (ausgenommen Maschinen für Schienen- und Straßenfahrzeuge)
(IEC 34-2:1972/A2:1996)

This amendment A2 modifies the European Standard EN 60034-2:1996; it was approved by CENELEC on 1996-10-01. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this amendment the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CENELEC member.

This amendment exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the Central Secretariat has the same status as the official versions.

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CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

Central Secretariat: rue de Stassart 35, B - 1050 Brussels

Foreword

The text of document 2/939/FDIS, prepared by IEC TC 2, Rotating machinery, was submitted to the formal vote and was approved by CENELEC as amendment A2 to EN 60034-2 on 1996-07-02.

The text of document 2G/73/FDIS, prepared by SC 2G, Test methods and procedures, of IEC TC 2, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC for inclusion into amendment A2 to EN 60034-2 on 1996-10-01.

NOTE: Amendment 2 to IEC 34-2, published in November 1996, contains both documents 2/939/FDIS and 2G/73/FDIS.

The following dates were fixed:

- latest date by which the amendment has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 1997-06-01
- latest date by which the national standards conflicting with the amendment have to be withdrawn (dow) 1997-06-01

For products which have complied with HD 53.2 S1:1974 (converted into EN 60034-2) before 1997-06-01, as shown by the manufacturer or by a certification body, this previous standard may continue to apply for production until 2002-06-01.

Endorsement notice

The text of amendment 2:1996 to the International Standard IEC 34-2:1972 was approved by CENELEC as an amendment to the European Standard without any modification.

NORME INTERNATIONALE
INTERNATIONAL STANDARD

CEI
IEC
34-2

1972

AMENDEMENT 2
AMENDMENT 2

1996-11

Amendement 2

Machines électriques tournantes –

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

Amendment 2

Rotating electrical machines –

Part 2:
Methods for determining losses and efficiency of rotating electrical machinery from tests (excluding machines for traction vehicles)

Bureau Central de la Commission Electrotechnique Internationale 3, rue de Varembé Genève, Suisse

Commission Electrotechnique Internationale
International Electrotechnical Commission
Международная Электротехническая Комиссия

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FOREWORD

This amendment has been prepared by sub-committee 2G: Test methods and procedures, of IEC technical committee 2: Rotating machinery.

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

FDIS	Reports on voting
2G/73/FDIS 2/939/FDIS	2G/81/RVD 2/951/RVD

Full information on the voting for the approval of this amendment can be found in the reports on voting indicated in the above table.

Page 3

CONTENTS

Add the title of annex A as follows:

Annex A – Provisional methods for determining losses and efficiency of converter-fed cage induction machines

Page 13

5 Reference temperature

Replace the existing text by the following:

Unless otherwise specified, all I^2R losses shall be corrected to the temperatures given below:

Thermal class of the insulation system	Reference temperature °C
A, E	75
B	95
F	115
H	130

If the rated temperature rise or the rated temperature is specified as that of a lower thermal class than that used in the construction, the reference temperature shall be that of the lower thermal class.

Page 55

Add annex A as follows:

Annex A
(informative)

Provisional methods for determining losses and efficiency of converter-fed cage induction machines

INTRODUCTION

This annex applies to cage induction machines with rated frequencies up to 120 Hz supplied by converters which have an intermediate circuit and are of the following types: I-converters and U-converters, typically Pulse Width Modulated (PWM).

The methods to determine losses and efficiency given in section 3 are partly no longer applicable and this annex indicates the test modifications that are necessary.

NOTE – The six-step converter is a special case of the pulsed converter.

In general, when fed from a converter, the motor losses are higher than during operation on a sinusoidal system. These additional losses depend on the harmonic spectrum of the impressed supply quantity (either current or voltage). Their magnitude is influenced by circuitry and control method of the converter. Consequently a simple factor to cover these additional losses cannot be found.

The determination of losses and efficiency will therefore preferably use procedures where the motor is operated together with the same converter with which it is going into service. It is also understood that suitable methods shall not require the knowledge of design data of the motor, such as the rotor bar geometry.

A.1 Determination of losses and efficiency of converter-fed motors

A.1.1 *Components of the additional losses*

In cage induction motors additional losses[1)] are produced due to the harmonics in either current or voltage; they are made up of the following components:

a) additional I^2R losses in primary windings;

b) additional I^2R losses in secondary windings;

c) additional losses in active iron.

NOTE – The physical effects giving rise to the additional losses are treated in chapter 5 of IEC 34-17, 1992: "Guide for the application of cage induction motors when fed from converters".

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1) These additional losses are due to harmonics of the supply and do not contain the additional losses described in 8.1a) and 8.3 which refer to sinusoidal supply of fundamental frequency only.

A.1.2 *Efficiency determination by input-output measurement*

The motor input-output measurement as indicated in clause 12 is a preferred method since all additional losses are incorporated in the result (see clause A.3); however, the measuring equipment must have sufficient accuracy for measuring power, torque and speed as well as an appropriate frequency range. Therefore, additional requirements for measuring instruments and accessories beyond the contents of clause 3 have to be specified (see clause A.2).

To keep within a required relative tolerance of the resulting motor efficiency, the maximum relative error $(\Delta P/P_{in})_{max}$ of the power measurement has to be decreased with increasing efficiency, as shown in figure A.1.

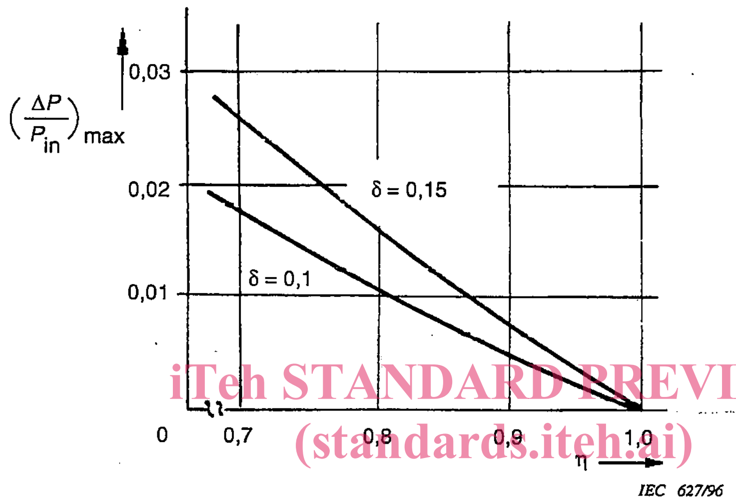

Figure A.1 – Maximum permissible relative error $(\Delta P/P_{in})_{max}$ of input as well as output measurement [2)]

There is also the possibility to determine the overall efficiency of the complete system consisting of converter and motor by input-output measurement, applicable on agreement between manufacturer and purchaser. In this case the motor efficiency cannot be determined separately.

A.1.3 *Efficiency determination by summation of losses*

A number of presumptions made in 9.1 are no longer valid for motors fed from converters. In the no-load test, the I^2R losses in the secondary winding (9.1.1.1) may not be neglected. Therefore the iron losses cannot be separated. The no-load test at variable voltage (i.e. at variable flux) according to 9.1.1.3 cannot be carried through with many commercial converters, due to the limited range of adjustment; consequently there will be no possibility to separate the friction and windage losses (8.1b) and c)) from the other losses by a no-load test.

2) δ = tolerance as described in IEC 34-1, table VIII, items 1 and 2. The curves are based on a simplified error consideration, assuming errors ΔP of equal magnitude in P_{in} and P_{out}. Figure A.1 is a graph of the equation $(\Delta P/P_{in})_{max} = \delta \cdot (1-\eta) / (1+\eta)$.

Concerning the load test, the statement in 9.1.2.1 that "the secondary winding losses are taken to be equal to the product of the slip and the total power transmitted to the secondary winding" is only valid for a machine operated with a sinusoidal current of fundamental frequency. Moreover, to calculate the I^2R losses of the primary winding by means of the resistance measured using direct current (9.1.2.1) will produce an error due to eddy currents.

Hence when using the method of summation of losses certain assumptions have to be made (see clause A.4).

A.1.4 *Efficiency determination by the calorimetric method*

The calorimetric method is especially useful for application to converter-fed motors since the losses are measured independently of the waveforms of voltages and currents.

The calorimetric calibration method according to clause 3 of IEC 34-2A has been found of advantage since it does not require measurement of the mass rate of flow; hence the density of the cooling medium, being functions of humidity and temperature, need not be known. Moreover, the variation of specific heat capacity can usually be disregarded.

In a set-up according to figure A.2 the power absorbed in the dissipation resistor can be measured without difficulty, so that the motor losses may be calculated from the proportion:

$$P_v = P_d (T_2 - T_1) / (T_3 - T_2)$$

where

P_v represents the motor losses;

P_d represents the power absorbed in the dissipation resistor;

T_1, T_2, T_3 represents the measured temperatures at the points indicated in figure A.2.

The measuring accuracy depends mainly on the magnitude of temperature rise values $(T_2 - T_1)$ and $(T_3 - T_2)$. The measurement has to be made in accordance with clause 13 of IEC 34-2A, to enable an accuracy of measurement as indicated in clause 15 and table II.

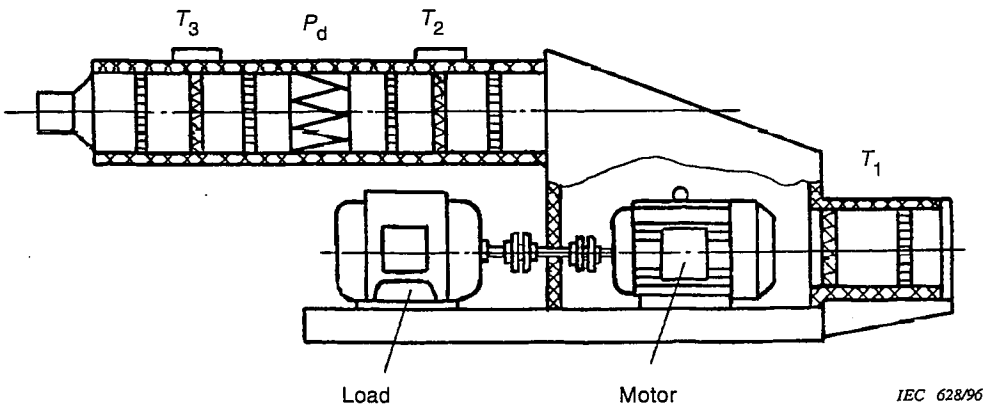

Figure A.2 – Schematic diagram of a test set-up for the calorimetric calibration method