SLOVENSKI STANDARD
SIST EN 60349-2:2002

01-julij-2002

Železniške naprave - Rotacijski električni stroji za železniška in cestna vozila - 2. del: Elektronsko napajani izmenični motorji (IEC 60349-2:1993, spremenjen)

Railway applications - Rotating electrical machines for rail and road vehicles -- Part 2: Electronic converter-fed alternating current motors

Bahnanwendungen - Drehende elektrische Maschinen für Bahn- und Straßenfahrzeuge -- Teil 2: Umrichtergespeiste Wechselstrommotoren

Applications ferroviaires - Machines électriques tournantes des véhicules ferroviaires et routiers -- Partie 2: Moteurs à courant alternatif alimentés par convertisseur électronique

Ta slovenski standard je istoveten z: **EN 60349-2:2001**

ICS:

29.160.30	Motorji	Motors
29.280	Električna vleča oprema	Electric traction equipment

SIST EN 60349-2:2002 **en**

EUROPEAN STANDARD **EN 60349-2**

NORME EUROPÉENNE

EUROPÄISCHE NORM October 2001

ICS 29.280

English version

Railway applications - Rotating electrical machines for rail and road vehicles Part 2: Electronic converter-fed alternating current motors

(IEC 60349-2:1993, modified)

Traction électrique -
Machines électriques tournantes des véhicules ferroviaires et routiers
Partie 2: Moteurs à courant alternatif alimentés par convertisseur électronique
(CEI 60349-2:1993, modifiée)

Bahnanwendungen -
Drehende elektrische Maschinen für Bahn- und Straßenfahrzeuge
Teil 2: Umrichtergespeiste Wechselstrommotoren
(IEC 60349-2:1993, modifiziert)

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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 European Standard 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

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Ref. No. EN 60349-2:2001 E

Foreword

The text of the International Standard IEC 60349-2:1999, prepared by IEC TC 9, Electric traction equipment, together with the common modifications prepared by SC 9XB, Electromechanical material on board rolling stock, of the Technical Committee CENELEC TC 9X, Electrical and electronic applications for railways, was submitted to the Unique Acceptance Procedure and was approved by CENELEC as EN 60349-2 on 2000-08-01.

This European Standard supersedes ENV 60439-2:1993.

- latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2002-04-01
- latest date by which the national standards conflicting with the EN have to be withdrawn (dow) 2003-08-01

In this European Standard the common modifications to the International Standard are indicated by a vertical line in the left margin of the text.

Annexes designated „normative" are part of the body of the standard.
Annexes designated „informative" are given for information only.
In this standard, Annexes A, B, D and E are normative and Annex C is informative.

Contents

Introduction

This document supplements or modifies IEC 60349 Part 2. The changes are considered necessary to make it acceptable as a European Standard following the issue of EN 61377 "Combined testing of inverter-fed alternating current motors and their control", and re-issue of EN 60349 Part 1 "Rotating electrical machines for rail and road vehicles – Machines other than electronic converter-fed alternating current motors".

The main changes are summarised below.

- EN 61377 and IEC 60349 Part 2 both call up type tests for motors on converter supplies. The modifications endeavour to rationalise the interface between these two documents so as to avoid the duplication of tests unless specifically required. A new thermal test on a sinusoidal supply has been introduced to remove the need of using a converter for repeat type tests.

The re-issue of EN 60349 Part 1 modifies the requirements to provide a test specification and a test report including a quantitative vibration test (type test).

1 General

1.1 Scope and object

1.1.1 This European Standard applies to convertor-fed alternating current motors forming part of the equipment of electrically propelled rail and road vehicles.

The object of this part 2 of EN 60349 is to enable the performance of a motor to be confirmed by tests and to provide a basis for assessment of its suitability for a specified duty and for comparison with other motors.

Where further testing is to be undertaken to EN 61377 "Combined testing of inverter-fed alternating current motors and their control", it may be preferable, to avoid duplication, that some type and investigation tests be carried out on the combined test bed.

Particular attention is drawn to the need for collaboration between the designers of the motor and its associated convertor as detailed in clause 3.1.

NOTE 1 This part also applies to motors installed on trailers hauled by powered vehicles.

NOTE 2 The basic requirements of this part may be applied to motors for special purpose vehicles such as mine locomotives but this part does not cover flameproof or other special features that may be required.

NOTE 3 It is not intended that this part should apply to motors on small road vehicles, such as battery-fed delivery vehicles, factory trucks, etc. This part also does not apply to minor machines such as windscreen wiper motors, etc. that may be used on all types of vehicles.

NOTE 4 Industrial type motors complying with EN 60034 may be suitable for some auxiliary drives, providing that it is demonstrated that operation on a convertor supply will meet the requirements of the particular application.

1.1.2 The rating of traction motors fed in parallel by a common convertor has to take account of the effect on load-sharing of differences of wheel diameter and of motor characteristics and also of weight transfer when operating at high coefficients of adhesion. The user is to be informed of the maximum permissible difference in wheel diameter for the particular application.

1.1.3 The electrical input to motors covered by this part has to be from an electronic convertor.

NOTE At the time of drafting this part only the following combinations of motors and convertors had been used for traction applications, but it may also apply to other combinations which may be used in the future:
- asynchronous motors fed by voltage source convertors;
- asynchronous motors fed by current source convertors;
- synchronous motors fed by current source convertors.

The motors covered by this part are classified as follows:

- Traction motors
  Motors for propelling rail or road vehicles.

- Auxiliary motors not covered by EN 60034
  Motors for driving compressors, fans, auxiliary generators or other auxiliary machines.

1.2 Normative references

This European Standard incorporates by dated or undated references, provisions from other publications. These normative references are cited at the appropriate place in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

EN 50163	Railway applications - Supply voltages of traction systems
EN 50207	Railway applications - Electronic power convertors for rolling stock
EN 60034-2	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 + IEC 60034-2A)
EN 60034-9	Rotating electrical machines - Part 9 - Noise limits (IEC 60034-9)
EN 60034-14	Rotating electrical machines – Part 14: Mechanical vibration of certain machines with shaft heights 56 mm and higher – Measurement, evaluation and limits of the vibration severity (IEC 60034-14)
EN 60651	Sound level meters (IEC 60651)
EN 61260	Electroacoustics - Octave-band and fractional-octave-band filters (IEC 61260)
EN 61373	Railway applications - Rolling stock equipment - Shock and vibration tests (IEC 61373)
EN 61377	Electric traction - Rolling stock - Combined testing of inverter-fed alternating current motors and their control (IEC 61377)
HD 53.8	Rotating electrical machines – Part 8: Terminal markings and direction of rotation of rotating machines (IEC 60034-8 + A1 + A2)
HD 566 S1	Thermal evaluation and classification of electrical insulation (IEC 60085)
IEC 60050-131	International Electrotechnical Vocabulary – Chapter 131: Electric and magnetic circuits
IEC 60050-151	International Electrotechnical Vocabulary – Chapter 151: Electrical and magnetic devices

IEC 60050-411 International Electrotechnical Vocabulary – Chapter 411: Rotating machines

IEC 60050-811 International Electrotechnical Vocabulary – Chapter 811: Electric traction

1.3 Environmental conditions

Unless otherwise specified by the user, the following environmental conditions are assumed:

a) Altitude

Height above sea level not exceeding 1 200 m.

b) Temperature

Air temperature in the shade not exceeding 40 °C.

Whenever motors are intended to operate where one or both of these limits will be exceeded, special requirements may be agreed between user and manufacturer.

Furthermore, the user shall inform the manufacturer of any particularly severe environmental condition such as dust, humidity, temperature, snow, dynamic effects, etc. to which the motors will be subjected.

2 Definitions

2.1 General

For definition of general terms used in this part reference should be made to IEC 60050-131, IEC 60050-151, IEC 60050-411 and IEC 60050-811.

For the purpose of this part of EN 60349, the following definitions apply:

2.2
rating of a motor
combination of simultaneous values of electrical and mechanical quantities, with their duration and sequence, assigned to the motor by the manufacturer

2.2.1
rated value
numerical value of any quantity included in a rating

2.2.2
continuous rating
mechanical output that the motor can deliver on the test bed for an unlimited time under the conditions specified in clause 6.1 without exceeding the limits of temperature rise given in table 2, all other appropriate requirements in this part also being satisfied

NOTE Several continuous ratings may be specified.

2.2.3
short-time rating (for example, one hour)
mechanical output that the motor can deliver on the test bed for the stated time without exceeding the limits of temperature rise given in table 2, the test being carried out as specified in 6.1 starting with the motor cold, all other appropriate requirements in this part being also satisfied

2.2.4
short-time overload rating
mechanical output that the motor can deliver on the test bed for the stated time without exceeding the limits of temperature rise given in table 3, the test being started and carried out as specified in 6.1.6

NOTE Short-time overload ratings are of value in determining the suitability of motors for duties which involve relatively long periods of operation below the continuous rating followed by a period above it. These are most likely to occur in locomotive applications. They are not relevant to the repeated short load cycles of rapid transit and similar duties, and should not be specified for such applications.

2.2.5
intermittent duty rating
duty cycle on which the motor may be operated without the temperature rises at any point exceeding the limits given in table 2

2.2.6
equivalent rating
continuous rating with constant values of voltage, current and speed that, as far as temperature rise is concerned, is equivalent to the intermittent duty cycle which the motor has to withstand in service

NOTE This rating should be agreed between user and manufacturer.

2.2.7
guaranteed rating
rating assigned by the manufacturer for test purposes

2.2.7.1
guaranteed rating of a traction motor
normally the continuous rating but in special cases the user and manufacturer may agree that it be a short-time or intermittent rating

2.2.7.2
guaranteed rating of an auxiliary motor
continuous rating unless otherwise specified

2.3
rated voltage
root-mean-square value of the fundamental component of the line-to-line voltage applied to a motor when it is operating at a guaranteed rating. For motors fed directly or indirectly from a contact system it is normally the highest voltage (excluding transients) which can be applied to the motor when it is drawing the rated current, with the contact system at its nominal voltage as defined in Annex D

2.4
rated speed
speed at a guaranteed rating

2.5
maximum voltage
highest root-mean-square value of the fundamental component of the line-to-line supply voltage which can be applied to the motor in service

2.6
repetitive peak voltage
peak value of the waveform of the convertor output voltage, any random transient peaks arising from line voltage transients or other causes being disregarded

2.7
maximum current
maximum current shown on the specified characteristic as defined in 3.3

2.8
maximum working speed

2.8.1
maximum working speed of a traction motor
highest rotational speed assigned to the motor by the manufacturer

NOTE When the characteristics of the vehicle for which a motor is intended are specified, this speed is not less than that corresponding to the maximum service speed of the vehicle assuming fully worn metallic wheels or the minimum rolling diameter of rubber tyres.

2.8.2
maximum working speed of an auxiliary motor
highest rotational speed assigned to the motor by the manufacturer

NOTE For specific applications account should be taken, when assigning this speed, of the most unfavourable conditions of voltage, frequency, loading, etc., that can occur in service.

3 Characteristics

3.1 Exchange of information

The motor and convertor designers shall collaborate to produce all the technical information necessary to ensure that the combined unit will meet the requirements of this part of EN 60349.

To fulfil this requirement, the motor designer shall provide the convertor designer with all the information necessary to fully evaluate the interaction between the motor and the convertor.

The convertor designer shall also provide the motor designer with a characteristic showing, for example, the convertor line-to-line output voltage (including the repetitive voltage peaks), current, fundamental frequency, harmonics and power over the whole range of the application, including operation at the maximum and minimum values of the contact-system voltage.

The documents recording this exchange of information shall form an integral part of the specification of the motor and of the convertor.

NOTE This requirement for the exchange of information is also included in EN 50207.

3.2 Reference temperature

All characteristics, irrespective of the class of insulation used on the motor to which they apply, shall be drawn for a winding reference temperature of 150°C which shall be stated on the characteristic.

3.3 Specified characteristics

Motor specifications shall, as a general rule, include characteristic curves in accordance with the relevant clauses of this part. These curves, defined as the "specified characteristics", shall be plotted to the designed operating limits of each variable. Unless otherwise agreed between user and manufacturer the characteristics shall show the machine performance at the nominal voltage of the supply system as defined in Annex D, and shall be submitted to the user before the order for the motors is placed.

3.4 Declared characteristics

Declared characteristics are derived from the results of type tests carried out in accordance with 6.2.1 and shall meet the requirements of 6.2.2.

Unless previously agreed, the declared characteristics of motors electromagnetically identical with any previously manufactured for the same user or application shall be those of the existing motors. In which case compliance with the characteristics shall be demonstrated by routine tests only.

3.5 Efficiency characteristics

Efficiency characteristics shall take account of losses arising from the harmonics in the supply from the convertor. Power used for excitation of synchronous motors shall also be included in the losses unless otherwise accounted for, (e.g. as an auxiliary load), in which case the omission shall be stated on the characteristic.

3.6 Traction motor characteristics

The specified and declared characteristics of a traction motor shall be the convertor-fed variable frequency characteristics, which shall show motor line-to-line voltage, current, frequency, mean torque and efficiency as a function of speed over the whole range of application of the motor. Characteristics of asynchronous motors shall show slip and those of synchronous motors shall show the excitation current. Voltage curves shall show the root-mean-square value of the fundamental component. Current curves shall show the root-mean-square value of the fundamental component and the total root-mean-square value. For motors used in the braking mode, similar characteristics shall be produced showing the torque input and the electrical output as a function of motor speed.

NOTE 1 Subclause 3.1 refers to the need for the exchange of information between the designers of the motor and of the convertor.

As an alternative to motor torque and speed the characteristics may show tractive effort at the rail and vehicle speed, in which case the gear ratio, wheel diameter and transmission losses shall be stated. If conventional values are used for the latter they shall be in accordance with figure B.1.

NOTE 2 Subclause 1.1.2 refers to the need to consider the effect on parallel-fed motors of differing wheel diameters and of weight transfer between axles.

3.7 Auxiliary motor characteristics

The specified and declared characteristics of auxiliary motors shall be the convertor-fed characteristics, which shall show the motor line-to-line voltage, current, speed and mean torque as a function of motor output for each operating frequency over the whole range of application of the motor. The characteristics of motors which operate at continuously variable frequency shall be plotted for the maximum and minimum frequencies only.

Characteristics of asynchronous motors shall show slip and those of synchronous motors shall show the excitation current. Voltage curves shall show the root-mean-square value of the fundamental component. Current curves shall show the root-mean-square value of the fundamental component and the total root-mean-square value. The characteristics shall take account of the additional losses arising from the supply harmonics and the efficiency at the guaranteed rating shall be stated.

Alternatively, the characteristics may be plotted as a function of speed.

NOTE Subclause 3.1 refers to the need for the exchange of information between the designers of the motor and of the convertor.

4 Marking

4.1 Nameplate

All motors covered by this part of EN 60349 shall carry a nameplate including at least the following information:

1) Manufacturer's name.
2) Motor type designation.
3) Motor serial number.
4) Year of manufacture.

Furthermore, a serial number shall be punched on both the stator and rotor of every motor, and motors designed for unidirectional rotation shall carry an arrow indicating the direction of rotation.

NOTE The motor serial number and rotation arrow should be easily readable when the motor is installed in the vehicle.

4.2 Terminal and lead marking

Terminal and lead markings shall be in accordance with HD 53.8 unless otherwise agreed.

5 Test categories

5.1 Test categories

5.1.1 General

There are three categories of tests:

- type tests;
- routine tests;
- investigation tests.

NOTE See 1.1 on duplication of tests.

5.1.2 Type tests

Type tests are intended to prove the ratings, characteristics and performance of new types of motor. They shall be carried out on one motor of every new design. Unless otherwise agreed, the motor shall be one of the first ten manufactured. Where there is a change in place and/or method of manufacture refer to 5.1.2.3.

Before testing commences the manufacturer shall provide the user with a test specification outlining the tests to be undertaken to demonstrate compliance with this standard. Following completion of the type tests the manufacturer shall supply the user with a full test report.

5.1.2.1 Type tests on convertor supply

If each motor is fed by its own convertor the type test shall preferably be carried out using the convertor to be employed in service, but, as an alternative, a supply closely resembling in waveform and harmonics the supply from the vehicle convertor may be employed.