AS 60034.26—2009
IEC 60034-26, Ed. 1 (2006)

AS 60034.26—2009

Australian Standard®

Rotating electrical machines

Part 26: Effects of unbalanced voltages on the performance of three-phase induction motors

STANDARDS Australia

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The following are represented on Committee EL-009:

- Airconditioning and Refrigeration Equipment Manufacturers Association of Australia
- Australian Chamber of Commerce and Industry
- Australian Electrical and Electronic Manufacturers Association
- Australian Greenhouse Office, Department of the Environment and Water Resources
- Australian Industry Group
- Bureau of Steel Manufacturers of Australia
- Department of Defence (Australia)
- Electrical Apparatus Service Association
- Energy Efficiency and Conservation Authority of New Zealand
- Engineers Australia
- Ministry of Economic Development (New Zealand)
- Registered Master Builders

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PREFACE

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee EL-009, Rotating Electrical Machinery.

This Standard was prepared by the Australian members of the Joint Standards Australia/Standards New Zealand Committee EL-009. After consultation with stakeholders in both countries, Standards Australia and Standards New Zealand decided to develop this Standard as an Australian Standard rather than an Australian/New Zealand Standard.

The objective of this Standard is to highlight the effects of unbalanced voltages on the performance of cage induction motors.

This Standard is identical with, and has been reproduced from IEC 60034-26, Ed. 1 (2006), *Rotating electrical machines – Part 26: Effects of unbalanced voltages on the performance of three-phase induction motors*.

This Standard is Part 26 of a Series dealing with rotating electrical machinery. Additional parts will be added from time to time. This Series when complete will consist of the following parts:

AS	
1359.102.2	Rotating electrical machines—Methods for determining losses and efficiency of rotating electrical machinery from tests—Measurement of losses by the calorimetric method
60034	Rotating electrical machines
60034.1	Part 1: Rating and performance
60034.2.1	Part 2.1: Methods for determining losses and efficiency from tests (excluding machines for traction vehicles)
60034.3	Part 3: Specific requirements for synchronous generators driven by steam turbines or combustion gas turbines
60034.4	Part 4: Methods for determining synchronous machine quantities from tests
60034.5	Part 5: Degrees of protection provided by the integral design of rotating electrical machines (IP code)—Classification
60034.6	Part 6: Method of cooling (IC code)
60034.7	Part 7: Classification of types of construction, mounting arrangements and terminal box position (IM code)
60034.8	Part 8: Terminal markings and direction of rotation
60034.9	Part 9: Noise limits
60034.11	Part 11: Thermal protection
60034.12	Part 12: Starting performance of single-speed three-phase cage induction motors
60034.14	Part 14: Mechanical vibration of certain machines with shaft heights 56 mm and higher—Measurement, evaluation and limits of vibration severity
60034.15	Part 15: Impulse voltage withstand levels of rotating a.c. machines with form-wound stator coils
60034.16	Part 16: Excitation systems for synchronous machines (all parts)
60034.17	Part 17: Cage induction motors when fed from converters—Application guide
60034.18	Part 18: Functional evaluation of insulation systems (all parts)
60034.19	Part 19: Specific test methods for d.c. machines on conventional and rectifier-fed supplies
60034.20.1	Part 20.1: Control motors—Stepping motors
60034.22	Part 22: AC generators for reciprocating internal combustion (RIC) engine driven generating sets
60034.23	Part 23: Specification for the refurbishing of rotating electrical machines
60034.25	Part 25: Guidance for the design and performance of a.c. motors specifically designed for converter supply

AS	
60034.26	Part 26: Effects of unbalanced voltages on the performance of three-phase cage induction motors(this Standard)
60034.27	Part 27: Off-line partial discharge measurements on the stator winding insulation of rotating electrical machines
60034.28	Part 28: Test methods for determining quantities of equivalent circuit diagrams for the three-phase low voltage cage induction motors
60034.29	Part 29: Equivalent loading and superposition techniques—Indirect testing to determine temperature rise.

As this Standard is reproduced from an International Standard, the following applies:

(a) Its number does not appear on each page of text and its identity is shown only on the cover and title page.

(b) In the source text ‘IEC 60034-26’ should read ‘AS 60034.26’.

(c) A full point should be substituted for a comma when referring to a decimal marker.

The terms ‘normative’ and ‘informative’ are used to define the application of the annex to which they apply. A normative annex is an integral part of a standard, whereas an informative annex is only for information and guidance.

CONTENTS

INTRODUCTION

When the line voltages applied to a three-phase cage induction motor are not equal, the currents in the stator windings will also be unequal. A small percentage voltage unbalance will result in a much larger percentage current unbalance.

The application of unbalanced voltages to a three-phase induction motor introduces a negative sequence voltage, and this produces in the air gap, a flux rotating against the rotation of the rotor, thus tending to produce high currents. A small negative sequence voltage may produce currents in the windings considerably in excess of those present under balanced voltage conditions. Consequently, the temperature rise of the motor operating at a particular load and percentage of voltage unbalance will be greater than for the motor operating under the same conditions with balanced voltages.

The analytical and graphical methods used to calculate the symmetrical components from the voltage readings of the three phases are well-known and can be taken from textbooks. Thus, the calculation schemes are not incorporated in this standard, but shown in the informative Annex A. Besides, the evaluation of the symmetrical components can be done automatically by modern instrumentation.

An approximate evaluation of imbalance is given in the informative Annex B.

STANDARDS AUSTRALIA

Australian Standard

Rotating electrical machines
Part 26: Effects of unbalanced voltages on the performance of three-phase induction motors

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1 Scope

This part of IEC 60034 describes the effects of unbalanced voltages on the performance of three-phase cage 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.

References to international standards that are struck through in this clause are replaced by references to Australian Standards that are listed immediately thereafter and identified by shading. Any Australian Standard that is identical to the International Standard it replaces is identified as such.

~~IEC 60034-12, *Rotating electrical machines – Part 12: Starting performance of single-speed three-phase cage induction motors*~~

AS 60034.12, *Rotating electrical machines*, Part 12: *Starting performance of single-speed three-phase cage induction motors* (identical to IEC 60034-12)

3 Effects of unbalanced voltages on performance

The effects of unbalanced voltages on motor performance are as described in 3.1 to 3.3.

3.1 Currents

The negative sequence components of the voltage produce in the air gap a flux rotating against the rotation of the rotor. A small negative-sequence component of the voltage may produce currents in the windings considerably in excess of those present under balanced voltage conditions. The frequency of the current in the cage is almost twice rated frequency, thus in the case of cages with current displacement the increase of the rotor winding losses is substantially higher than the increase of the stator winding losses.

The currents at normal operating speed will be greatly unbalanced in the order of approximately 6 to 10 times the voltage unbalance.

The locked-rotor current will be unbalanced to the same degree that the voltages are unbalanced, but the locked-rotor apparent power will increase only slightly.

3.2 Heating

The temperature rise of the stator winding is always higher than in operation at balanced supply voltages due to the increase of the losses produced by the negative-sequence components of the currents and voltages.

