



NSAI
Standards

Irish Standard
I.S. EN 60034-28:2013

Rotating electrical machines -- Part 28:
Test methods for determining
quantities of equivalent circuit
diagrams for three-phase low-voltage
cage induction motors (IEC 60034
-28:2012 (EQV))

I.S. EN 60034-28:2013

Incorporating amendments/corrigenda issued since publication:

The National Standards Authority of Ireland (NSAI) produces the following categories of formal documents:

I.S. xxx: Irish Standard – national specification based on the consensus of an expert panel and subject to public consultation.

S.R. xxx: Standard Recommendation - recommendation based on the consensus of an expert panel and subject to public consultation.

SWiFT xxx: A rapidly developed recommendatory document based on the consensus of the participants of an NSAI workshop.

<i>This document replaces:</i> EN 60034-28:2007	<i>This document is based on:</i> EN 60034-28:2013 EN 60034-28:2007	<i>Published:</i> 14 June, 2013 16 May, 2007
This document was published under the authority of the NSAI and comes into effect on: 21 June, 2013		ICS number: 29.160
NSAI 1 Swift Square, Northwood, Santry Dublin 9	T +353 1 807 3800 F +353 1 807 3838 E standards@nsai.ie W NSAI.ie	Sales: T +353 1 857 6730 F +353 1 857 6729 W standards.ie
Údarás um Chaighdeáin Náisiúnta na hÉireann		

EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

EN 60034-28

June 2013

ICS 29.160

Supersedes EN 60034-28:2007

English version

**Rotating electrical machines -
Part 28: Test methods for determining quantities of equivalent circuit
diagrams for three-phase low-voltage cage induction motors
(IEC 60034-28:2012)**

Machines électriques tournantes -
Partie 28: Méthodes d'essai pour la
détermination des grandeurs des
schémas d'équivalence des circuits pour
moteurs à induction à cage basse tension
triphasés
(CEI 60034-28:2012)

Drehende elektrische Maschinen -
Teil 28: Prüfverfahren zur Bestimmung der
Ersatzschaltbildgrößen dreiphasiger
Niederspannungs-Käfigläufer-
Asynchronmotoren
(IEC 60034-28:2012)

This European Standard was approved by CENELEC on 2013-01-17. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard 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 CEN-CENELEC Management Centre 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 CEN-CENELEC Management Centre has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

CENELEC

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

Management Centre: Avenue Marnix 17, B - 1000 Brussels

Foreword

The text of document 2/1685/FDIS, future edition 2 of IEC 60034-28, prepared by IEC/TC 2 "Rotating machinery" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN 60034-28:2013.

The following dates are fixed:

- latest date by which the document has to be (dop) 2013-12-14
implemented at national level by
publication of an identical national
standard or by endorsement
- latest date by which the national (dow) 2016-01-17
standards conflicting with the
document have to be withdrawn

This document supersedes EN 60034-28:2007.

EN 60034-28:2013 includes the following significant technical changes with respect to EN 60034-28:2007:

- a) the formulae are now all given for equivalent star-connection equivalent circuit diagrams. They are applied even in the case of delta connected windings. All formulae for delta connected equivalent circuit diagrams have been moved to notes;
- b) procedures for the determination of equivalent circuit parameters from a load curve test as an alternative to the reverse rotation and locked rotor tests have been added.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC [and/or CEN] shall not be held responsible for identifying any or all such patent rights.

Endorsement notice

The text of the International Standard IEC 60034-28:2012 was approved by CENELEC as a European Standard without any modification.

Annex ZA (normative)

Normative references to international publications with their corresponding European publications

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.

NOTE When an international publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 60034-1 (mod)	2010	Rotating electrical machines - Part 1: Rating and performance	EN 60034-1 + corr. October	2010 2010
IEC 60034-2-1	-	Rotating electrical machines - Part 2-1: Standard methods for determining losses and efficiency from tests (excluding machines for traction vehicles)	EN 60034-2-1	-
IEC 60034-2-2	-	Rotating electrical machines - Part 2-2: Specific methods for determining separate losses of large machines from tests - Supplement to IEC 60034-2-1	EN 60034-2-2	-
IEC/TS 60034-2-3 ¹⁾	-	Rotating electrical machines - Part 2-3: Specific test methods for determining losses and efficiency of converter-fed AC motors	-	-
IEC/TS 60034-25	-	Rotating electrical machines - Part 25: Guidance for the design and performance of a.c. motors specifically designed for converter supply	CLC/TS 60034-25	-
IEC 60044	Series	Instrument transformers	EN 60044	Series
IEC 60051-1	-	Direct acting indicating analogue electrical measuring instruments and their accessories - Part 1: Definitions and general requirements common to all parts	EN 60051-1	-
IEC 60072-1	-	Dimensions and output series for rotating electrical machines - Part 1: Frame numbers 56 to 400 and flange numbers 55 to 1 080	-	-

¹⁾ To be published.

This page is intentionally left BLANK.

CONTENTS

FOREWORD	4
INTRODUCTION	6
1 Scope	7
2 Normative references	7
3 Terms, definitions, symbols and conventions	7
3.1 Terms and definitions	7
3.2 Symbols	8
3.3 Subscripts	9
3.4 Winding connection	9
4 Test requirements	10
4.1 General	10
4.2 Frequency and voltage	10
4.3 Instrumentation	10
4.3.1 Measuring instruments for electrical quantities, speed and frequency	10
4.3.2 Instrument transformers	10
4.3.3 Temperature measurement	10
5 Approximations and uncertainties	10
6 Test procedures	11
6.1 General	11
6.2 Stator d.c. line-to-line resistance measurement	11
6.3 Load-test at rated load	11
6.4 Load curve test	12
6.5 No-load test	12
6.6 Reverse rotation and locked rotor tests	13
6.6.1 General	13
6.6.2 Reverse rotation test	13
6.6.3 Locked rotor test	13
7 Determination of motor quantities	13
7.1 General	13
7.2 Resistance of stator winding R_S	15
7.3 Total stator inductance $L_{ts} = L_m + L_{\sigma s}$	15
7.3.1 General	15
7.3.2 Determination procedure	15
7.4 Equivalent resistance of iron losses $R_{fe\Gamma}$	16
7.4.1 Constant losses	16
7.4.2 Friction and windage losses	17
7.4.3 Iron losses	17
7.5 Total leakage inductance $L_{t\sigma}$	18
7.5.1 General	18
7.5.2 Distribution of leakage inductances between stator and rotor	18
7.5.3 Determination of total leakage inductance from a reverse rotation or locked rotor test (6.6)	18
7.5.4 Determination of total leakage inductance from a load curve test (6.4)	20
7.6 Magnetizing inductance L_m and voltage U_m	21
7.6.1 From a reverse rotation or locked rotor test (6.6)	21
7.6.2 From a load curve test (6.4)	21

I.S. EN 60034-28:2013

60034-28 © IEC:2012

– 3 –

7.7	Stator and rotor leakage inductances $L_{\sigma S}$ and $L_{\sigma r}'$	22
7.7.1	From a reverse rotation or locked rotor test (6.6).....	22
7.7.2	From a load curve test (6.4).....	22
7.8	Inductances for calculations at constant flux (rated load).....	22
7.9	Resistance of rotor cage R_r' referred to the stator winding and frequency.....	23
7.10	Equivalent resistance of iron losses R_{fe}	25
Annex A	(informative) Sample calculation	26
Figure 1	– Type-T equivalent circuit diagram	14
Figure 2	– Type-T equivalent circuit diagram (iron losses disregarded).....	14
Figure 3	– Type-L equivalent circuit diagram (iron losses disregarded)	14
Figure 4	– Type-Γ equivalent circuit diagram.....	15
Figure 5	– Typical characteristics of inductance L over current I	16

INTERNATIONAL ELECTROTECHNICAL COMMISSION

ROTATING ELECTRICAL MACHINES –

Part 28: Test methods for determining quantities of equivalent circuit diagrams for three-phase low-voltage cage induction motors

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 60034-28 has been prepared by IEC technical committee 2: Rotating machinery.

This second edition cancels and replaces the first edition published in 2007. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition.

- a) The formulae are now all given for equivalent star-connection equivalent circuit diagrams. They are applied even in the case of delta connected windings. All formulae for delta-connected equivalent circuit diagrams have been moved to notes.
- b) Procedures for the determination of equivalent circuit parameters from a load curve test as an alternative to the reverse rotation and locked rotor tests have been added.

I.S. EN 60034-28:2013

60034-28 © IEC:2012

– 5 –

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

FDIS	Report on voting
2/1685/FDIS	2/1688/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.

The committee has decided that the contents of this publication will remain unchanged until the stability 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.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INTRODUCTION

Equivalent circuits are widely used in the control of adjustable speed drives with induction motors supplied by frequency inverters. The motor parameters are required for the realisation of flux oriented control or other model-based control algorithms. Their knowledge is required by suppliers and system engineers, especially when motors and frequency inverters from different suppliers are combined.

This standard provides a standardized test procedure to determine the electric motor parameters. At the same time the draft offers an improved understanding of the equivalent circuit method. The procedures can be carried out in laboratories equipped for standard electric machinery tests.

NOTE This standard's main purpose is for assistance in modelling frequency controlled motors. Due to the simplifications the results cannot be used to determine motor performance or efficiency accurately.

A related technical specification is IEC/TS 60034-25 where required motor parameters are listed, but their definition and methods of determination are not included.

ROTATING ELECTRICAL MACHINES –

Part 28: Test methods for determining quantities of equivalent circuit diagrams for three-phase low-voltage cage induction motors

1 Scope

This part of the IEC 60034 series applies to three-phase low-voltage cage induction motors of frame numbers 56 to 400 as specified in IEC 60072-1.

This standard establishes procedures to obtain values for elements of single phase equivalent circuit diagrams from tests and defines standard elements of these diagrams.

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 60034-1:2010, *Rotating electrical machines – Part 1: Rating and performance*

IEC 60034-2-1, *Rotating electrical machines – Part 2-1: Standard methods for determining losses and efficiency from tests (excluding machines for traction vehicles)*

IEC 60034-2-2, *Rotating electrical machines – Part 2-2: Specific methods for determining separate losses of large machines from tests – Supplement to IEC 60034-2-1*

IEC 60034-2-3¹, *Rotating electrical machines – Part 2-3: Specific test methods for determining losses and efficiency of converter-fed AC motors*

IEC/TS 60034-252, *Rotating electrical machines – Part 25: A.C. Motors when used in power drive systems - Application guide*

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 60072-1, *Dimensions and output series for rotating electrical machines – Part 1: Frame numbers 56 to 400 and flange numbers 55 to 1080*

3 Terms, definitions, symbols and conventions

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60034-1:2010 apply.

¹ To be published.

² A revision of this publication is currently under preparation.

This is a free preview. Purchase the entire publication at the link below:

[Product Page](#)

-
- Looking for additional Standards? Visit Intertek Inform Infostore
 - Learn about LexConnect, All Jurisdictions, Standards referenced in Australian legislation
-