

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)

EVS

EESTI STANDARDI EESSÕNA

NATIONAL FOREWORD

<p>S E EVS-EN 60034-28:2013 E EN 60034-28:2013</p> <p>S</p> <p>EVS</p> <p>E E</p> <p>14 06 2013</p> <p>S E S</p>	<p>E EVS-EN 60034-28:2013 E EN 60034-28:2013</p> <p>S</p> <p>E</p> <p>14 06 2013</p> <p>S E</p>
--	---

EVS-

S 2 160

Standardite reprodutseerimise ja levitamise õigus kuulub Eesti Standardikeskusele

E S
10 1031 E _____ 60 0 0 - _____ E S :

The right to reproduce and distribute standards belongs to the Estonian Centre for Standardisation

N
10 1031 E _____ 60 0 0 - _____ S :

EVS

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- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2016-01-17

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.

EVS

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.

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

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

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.