

© Copyright SEK Svensk Elstandard. Reproduction in any form without permission is prohibited.

Fasta isolermaterial – Temperaturbeständighet – Provning –

Del 6: Bestämning av temperaturindex (TI och RTI) för isolermaterial med hjälp av metoden med fast tidsram

Electrical insulating materials –

Thermal endurance properties –

*Part 6: Determination of thermal endurance indices (TI and RTI) of
an insulating material using the fixed time frame method*

Som svensk standard gäller europastandarden EN IEC 60216-6:2023. Den svenska standarden innehåller den officiella engelska språkversionen av EN IEC 60216-6:2023.

Nationellt förord

Europastandarden EN IEC 60216-6:2023

består av:

- **europastandardens ikraftsättningsdokument**, utarbetat inom CENELEC
- **IEC 60216-6, Third edition, 2022 - Electrical insulating materials - Thermal endurance properties - Part 6: Determination of thermal endurance indices (TI and RTI) of an insulating material using the fixed time frame method**

utarbetad inom International Electrotechnical Commission, IEC.

Tidigare fastställd svensk standard SS-EN 60216-6, utg 2:2006 med eventuella tillägg, ändringar och rättelser, gäller ej fr o m 2026-01-02.

Standarder underlättar utvecklingen och höjer elsäkerheten

Det finns många fördelar med att ha gemensamma tekniska regler för bl a mätning, säkerhet och provning och för utförande, skötsel och dokumentation av elprodukter och elanläggningar.

Genom att utforma sådana standarder blir säkerhetsfordringar tydliga och utvecklingskostnaderna rimliga samtidigt som marknadens acceptans för produkten eller tjänsten ökar.

Många standarder inom elområdet beskriver tekniska lösningar och metoder som åstadkommer den elsäkerhet som föreskrivs av svenska myndigheter och av EU.

SEK är Sveriges röst i standardiseringsarbetet inom elområdet

SEK Svensk Elstandard svarar för standardiseringen inom elområdet i Sverige och samordnar svensk medverkan i internationell och europeisk standardisering. SEK är en ideell organisation med frivilligt deltagande från svenska myndigheter, företag och organisationer som vill medverka till och påverka utformningen av tekniska regler inom elektrotekniken.

SEK samordnar svenska intressenters medverkan i SEKs tekniska kommittéer och stödjer svenska experters medverkan i internationella och europeiska projekt.

Stora delar av arbetet sker internationellt

Utformningen av standarder sker i allt väsentligt i internationellt och europeiskt samarbete. SEK är svensk nationalkommitté av International Electrotechnical Commission (IEC) och Comité Européen de Normalisation Electrotechnique (CENELEC).

Standardiseringsarbetet inom SEK är organiserat i referensgrupper bestående av ett antal tekniska kommittéer som speglar hur arbetet inom IEC och CENELEC är organiserat.

Arbetet i de tekniska kommittéerna är öppet för alla svenska organisationer, företag, institutioner, myndigheter och statliga verk. Den årliga avgiften för deltagandet och intäkter från försäljning finansierar SEKs standardiseringsverksamhet och medlemsavgift till IEC och CENELEC.

Var med och påverka!

Den som deltar i SEKs tekniska kommittéarbete har möjlighet att påverka framtida standarder och får tidig tillgång till information och dokumentation om utvecklingen inom sitt teknikområde. Arbetet och kontakterna med kollegor, kunder och konkurrenter kan gynnsamt påverka enskilda företags affärsutveckling och bidrar till deltagarnas egen kompetensutveckling.

Du som vill dra nytta av dessa möjligheter är välkommen att kontakta SEKs kansli för mer information.

SEK Svensk Elstandard

Box 1284
164 29 Kista
Tel 08-444 14 00
www.elstandard.se

English Version

Electrical insulating materials - Thermal endurance properties -
Part 6: Determination of thermal endurance indices (TI and RTI)
of an insulating material using the fixed time frame method
(IEC 60216-6:2022)

Matériaux isolants électriques - Propriétés d'endurance
thermique - Partie 6: Détermination des indices
d'endurance thermique (IT et ITR) d'un matériau isolant en
utilisant la méthode de trame de durées fixes
(IEC 60216-6:2022)

Elektroisolerstoffe - Eigenschaften hinsichtlich des
thermischen Langzeitverhaltens - Teil 6: Bestimmung der
thermischen Langzeitkennwerte (TI und RTI) eines
Isolierstoffes unter Anwendung des
Festzeitraumenverfahrens
(IEC 60216-6:2022)

This European Standard was approved by CENELEC on 2023-01-02. 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, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Türkiye and the United Kingdom.



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

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

European foreword

The text of document 112/583/FDIS, future edition 3 of IEC 60216-6, prepared by IEC/TC 112 "Evaluation and qualification of electrical insulating materials and systems" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN IEC 60216-6:2023.

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) 2023-10-02
- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2026-01-02

This document supersedes EN 60216-6:2006 and all of its amendments and corrigenda (if any).

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

Any feedback and questions on this document should be directed to the users' national committee. A complete listing of these bodies can be found on the CENELEC website.

Endorsement notice

The text of the International Standard IEC 60216-6:2022 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 are referred to in the text in such a way that some or all of their content constitutes requirements 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.

NOTE 1 Where an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

NOTE 2 Up-to-date information on the latest versions of the European Standards listed in this annex is available here: www.cenelec.eu.

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 60212	-	Standard conditions for use prior to and during the testing of solid electrical insulating materials	EN 60212	-
IEC 60216-1	2013	Electrical insulating materials - Thermal endurance properties - Part 1: Ageing procedures and evaluation of test results	EN 60216-1	2013
IEC 60216-2	-	Electrical insulating materials - Thermal endurance properties - Part 2: Determination of thermal endurance properties of electrical insulating materials - Choice of test criteria	EN 60216-2	-
IEC 60216-3	2021	Electrical insulating materials - Thermal endurance properties - Part 3: Instructions for calculating thermal endurance characteristics	EN IEC 60216-3	2021
IEC 60216-4-1	-	Electrical insulating materials - Thermal endurance properties - Part 4-1: Ageing ovens - Single-chamber ovens	EN 60216-4-1	-
IEC 60216-4-2	-	Electrical insulating materials - Thermal endurance properties - Part 4-2: Ageing ovens - Precision ovens for use up to 300 °C	EN 60216-4-2	-
IEC 60216-4-3	-	Electrical insulating materials - Thermal endurance properties - Part 4-3: Ageing ovens - Multi-chamber ovens	EN 60216-4-3	-
IEC 60216-5	2022	Electrical insulating materials - Thermal endurance properties - Part 5: Determination of relative temperature index (RTI) of an insulating material	EN 60216-5	2022
IEC 60493-1	-	Guide for the statistical analysis of ageing - test data - Part 1: Methods based on mean values of normally distributed test results		-

INTERNATIONAL STANDARD

NORME INTERNATIONALE



**Electrical insulating materials – Thermal endurance properties –
Part 6: Determination of thermal endurance indices (TI and RTI) of an insulating
material using the fixed time frame method**

**Matériaux isolants électriques – Propriétés d'endurance thermique –
Partie 6: Détermination des indices d'endurance thermique (IT et ITR) d'un
matériau isolant en utilisant la méthode de trame de durées fixes**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

ICS 17.220.99; 29.035.01

ISBN 978-2-8322-6022-7

Warning! Make sure that you obtained this publication from an authorized distributor. Attention! Veuillez vous assurer que vous avez obtenu cette publication via un distributeur agréé.
--

CONTENTS

FOREWORD	5
1 Scope	7
2 Normative references	7
3 Terms, definitions, symbols and abbreviated terms	8
3.1 Terms and definitions	8
3.2 Symbols and abbreviated terms	11
4 FTFM protocol	12
4.1 Principles of FTFM protocol	12
4.2 Objective of FTFM protocol	12
5 TI determination	13
5.1 Ageing procedures	13
5.2 Ageing times and temperatures	13
5.3 Test specimens	13
5.3.1 Preparation	13
5.3.2 Number of specimens	14
5.4 Diagnostic tests	14
5.5 Selection of end-points	15
5.6 Establishment of initial property value	15
5.7 Ageing conditions	15
5.7.1 Ageing ovens	15
5.7.2 Environmental conditions	15
5.7.3 Conditions for property measurement	16
5.8 Procedure for ageing	16
6 Calculation procedures	16
6.1 General principles	16
6.1.1 Thermal endurance calculation	16
6.1.2 Property value – equivalent temperature transform (Calculation of hypothetical ageing temperature derived from the value of a property)	17
6.2 Precision of calculations	17
6.3 Derivation of temperatures equivalent to property values	17
6.3.1 General	17
6.3.2 Preliminary calculations	17
6.3.3 Regression calculations (property on temperature)	18
6.3.4 Linearity test	20
6.3.5 Estimation of end-point temperatures equivalent to property values	21
6.4 Regression analysis (temperature on time)	21
6.4.1 General	21
6.4.2 Group means and variances	21
6.4.3 General means and variances	21
6.4.4 Regression	22
6.5 Statistical tests	23
6.5.1 Variance equality test	23
6.5.2 Linearity test (<i>F</i> -test)	24
6.5.3 Estimates of <i>x</i> and <i>y</i> and their confidence limits	24
6.6 Thermal endurance graph	26
7 Calculation and requirements for results	26

7.1	Calculation of thermal endurance characteristics	26
7.2	Reporting of results.....	27
7.2.1	Summary of statistical tests and reporting	27
7.2.2	Report format	27
8	Report	27
9	RTI determination	28
10	Additional symbols.....	28
11	Experimental procedures	29
11.1	Selection of reference EIM	29
11.2	Selection of diagnostic test for extent of ageing	29
11.3	Ageing procedures	29
12	Calculation procedures	29
12.1	General principles	29
12.2	Input data	29
12.3	RTI	30
12.4	Confidence limits	31
12.5	Extrapolation.....	32
13	Results and report	33
13.1	Results of statistical and numerical tests.....	33
13.2	Result	33
13.3	Report.....	33
Annex A (normative)	Decision flow chart.....	34
Annex B (normative)	Decision table	36
Annex C (informative)	Statistical tables.....	37
Annex D (informative)	Suggested ageing times and temperatures.....	41
D.1	TI determination.....	41
D.1.1	Correlation time (TI) = 20 000 h	41
D.1.2	Other correlation times for TI calculation (see 12.3).....	41
D.2	RTI determination	42
Annex E (informative)	Figures.....	43
Annex F (normative)	Statistical significance of the difference between two regression estimates	46
Annex G (informative)	Computer program	47
G.1	General.....	47
G.1.1	Overview	47
G.1.2	Convenience program execution	48
G.2.1	Content of file Control6.ftd.....	50
G.2.2	Report	52
G.2.3	Thermal endurance graph.....	54
Figure A.1	– Decision flow chart	35
Figure E.1	– Property-temperature graph with regression line	43
Figure E.2	– Thermal endurance graph	43
Figure E.3	– Ageing times and temperatures in relation to thermal endurance graph.....	44
Figure E.4	– Ageing times and temperatures in relation to thermal endurance graph.....	44
Figure E.5	– Ageing times and temperatures in relation to thermal endurance graph.....	45

Figure G.1 – Shortcut property dialog for program launch	49
Figure G.2 – Thermal endurance graph.....	54
Table 1 – Intermediate data values	30
Table B.1 – Decision table	36
Table C.1 – χ^2 -function.....	37
Table C.2 – t -function	37
Table C.3 – F -function, $P = 0,05$	38
Table C.4 – F -function, $P = 0,005$	39
Table D.1 – Ageing temperatures and times.....	41

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**ELECTRICAL INSULATING MATERIALS –
THERMAL ENDURANCE PROPERTIES –****Part 6: Determination of thermal endurance indices (TI and RTI)
of an insulating material using the fixed time frame method**

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.

IEC 60216-6 has been prepared by IEC technical committee 112: Evaluation and qualification of electrical insulating materials and systems. It is an International Standard.

This second edition cancels and replaces the first edition published in 2003. This edition constitutes a technical revision.

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

- a) clarification of definition of index properties vs. endurance properties;
- b) complete rework of Annex G and the corresponding program.

The text of this International Standard is based on the following documents:

Draft	Report on voting
112/583/FDIS	112/589/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications.

A list of all parts in the IEC 60216 series, published under the general title *Electrical insulating materials – Thermal endurance properties*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

IMPORTANT – The "colour inside" logo on the cover page of this document 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.

ELECTRICAL INSULATING MATERIALS – THERMAL ENDURANCE PROPERTIES –

Part 6: Determination of thermal endurance indices (TI and RTI) of an insulating material using the fixed time frame method

1 Scope

This part of IEC 60216 specifies the experimental and calculation procedures for deriving the thermal endurance characteristics, temperature index (TI) and relative temperature index (RTI) of an electrical insulating material (EIM) using the “fixed time frame method (FTFM)”.

In this protocol, the ageing takes place for a small number of fixed times, using the appropriate number of ageing temperatures throughout each time, the properties of the specimens being measured at the end of the relevant time interval. This differs from the procedure of IEC 60216-1, where ageing is conducted at a small number of fixed temperatures, property measurement taking place after ageing times dependent on the progress of ageing.

The diagnostic tests employed in the fixed time frame method are restricted to destructive tests. The method has not yet been applied to non-destructive or proof test procedures.

Both the TI and the RTI determined according to the FTFM protocol are derived from experimental data obtained in accordance with the instructions of IEC 60216-1 and IEC 60216-2 as modified in this part of IEC 60216. The calculation procedures and statistical tests are modified from those of IEC 60216-3 and IEC 60216-5.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

IEC 60212, *Standard conditions for use prior to and during the testing of solid electrical insulating materials*

IEC 60216-1:2013, *Electrical insulating materials – Thermal endurance properties – Part 1: Ageing procedures and evaluation of test results*

IEC 60216-2, *Electrical insulating materials – Thermal endurance properties – Part 2: Determination of thermal endurance properties of electrical insulating materials – Choice of test criteria*

IEC 60216-3:2021, *Electrical insulating materials – Thermal endurance properties – Part 3: Instructions for calculating thermal endurance characteristics*

IEC 60216-4-1, *Electrical insulating materials – Thermal endurance properties – Part 4-1: Ageing ovens – Single-chamber ovens*

IEC 60216-4-2, *Electrical insulating materials – Thermal endurance properties – Part 4-2: Ageing ovens – Precision ovens for use up to 300 °C*

IEC 60216-4-3, *Electrical insulating materials – Thermal endurance properties – Part 4-3: Ageing ovens – Multi-chamber ovens*

IEC 60216-5:2022, *Electrical insulating materials – Thermal endurance properties – Part 5: Determination of relative temperature index (RTI) of an insulating material*

IEC 60493-1, *Guide for the statistical analysis of ageing test data – Part 1: Methods based on mean values of normally distributed test results*