

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

Krafttransformatorer – Del 57-1202: Vätskeisolerade fasskiftande transformatorer

Power transformers –

Part 57-1202: Liquid immersed phase-shifting transformers

Som svensk standard gäller europastandarden EN IEC/IEEE 60076-57-1202:2025.
Den svenska standarden innehåller de officiella engelska språkversionerna av
EN IEC/IEEE 60076-57-1202:2025 och EN IEC/IEEE 60076-57-1202:2025/A11:2025.

Nationellt förord

Europastandarden EN IEC/IEEE 60076-57-1202:2025

består av:

- **europastandardens ikraftsättningsdokument**, utarbetat inom CENELEC
- **IEC/IEEE 60076-57-1202, First edition, 2017 - Power transformers – Part 57-1202: Liquid immersed phase-shifting transformers**

utarbetad inom International Electrotechnical Commission, IEC.

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 1042
172 21 Sundbyberg
Tel 08-444 14 00
elstandard.se

English Version

Power transformers - Part 57-1202: Liquid immersed phase-shifting transformers
(IEC/IEEE 60076-57-1202:2017)

Transformateurs de puissance - Partie 57-1202:
Transformateurs déphaseurs immergés dans un liquide
(IEC/IEEE 60076-57-1202:2017)

Leistungstransformatoren - Teil 57-1202: Ölgefüllte
Phasenschieber
(IEC/IEEE 60076-57-1202:2017)

This European Standard was approved by CENELEC on 2025-03-26. 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

This document (EN IEC/IEEE 60076-57-1202:2025) consists of the text of document IEC/IEEE 60076-57-1202:2017, prepared by IEC/TC 14 "Power Transformers".

The following dates are fixed:

- latest date by which this document has to be (dop) 2026-04-30
implemented at national level by publication of an
identical national standard or by endorsement
- latest date by which the national standards (dow) 2028-04-30
conflicting with this document have to be withdrawn

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/IEEE 60076-57-1202:2017 was approved by CENELEC as a European Standard without any modification.



IEEE

IEC/IEEE 60076-57-1202

Edition 1.0 2017-05

INTERNATIONAL STANDARD

NORME INTERNATIONALE



**Power transformers –
Part 57-1202: Liquid immersed phase-shifting transformers**

**Transformateurs de puissance –
Partie 57-1202: Transformateurs déphaseurs immergés dans un liquide**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

ICS 29.180

ISBN 978-2-8322-4258-2

**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
2.1 IEC references.....	7
2.2 IEEE references.....	7
3 Terms and definitions	8
4 Use of normative references	11
5 Service conditions	11
5.1 General.....	11
5.2 Usual service conditions	11
5.2.1 Switching arrangement	11
5.2.2 Power flow.....	11
5.2.3 Operation with two or more PSTs in series or parallel.....	11
5.2.4 Phase unbalance	12
5.2.5 Surge protection	12
6 Rating and general requirements	12
6.1 Rated power	12
6.2 Loading at other than rated conditions	12
6.3 Specification of buck capability	12
6.4 Cooling modes.....	13
6.5 Short circuit impedance and load phase angle capability.....	13
6.5.1 Specification.....	13
6.5.2 Short circuit impedance for asymmetric designs	13
6.6 Neutral earthing (grounding)	13
6.7 Rated voltage	13
6.8 Voltage variation and asymmetric design	13
6.9 Rated frequency	14
6.10 Operation at higher than rated voltage and/or at other than rated frequency	14
6.11 Highest voltage for equipment and dielectric test levels	14
6.12 Taps	14
6.13 Sound level.....	14
6.14 Transport	14
7 Construction	14
7.1 General.....	14
7.2 Liquid-filled connections between tanks	15
7.3 Liquid insulation and preservation system.....	15
7.4 Alignment between tanks	15
7.5 Core and core frame earthing arrangements	16
7.6 Test connections.....	16
8 Short circuit capability	16
9 Connection phase displacement symbols.....	16
9.1 General.....	16
9.2 Special symbols for PSTs	16
9.3 Clock number notation	17
9.4 Examples.....	17
9.4.1 Single core phase shifting transformers	17

9.4.2	Two core phase shifting transformers	19
9.4.3	Transformers incorporating a phase shifting element	21
10	Rating plates (nameplates)	22
11	Terminal markings and phase rotation	23
12	Information to be provided by the manufacturer	23
13	Tests	24
13.1	General	24
13.2	Routine tests	24
13.3	Type (design) tests	24
13.4	Special tests	24
13.5	Winding resistance	25
13.6	Measurement of voltage ratio, phase angle and check of phase displacement	25
13.7	Measurement of short-circuit impedance and load loss	25
13.8	Temperature-rise test	26
13.9	Measurement of no-load loss and current	26
13.10	Determination of sound level	26
13.10.1	General	26
13.10.2	For PSTs with one combined cooling system	26
13.10.3	For PSTs with separate exciting and series unit cooling systems	27
13.11	Measurement of zero sequence impedance	27
13.12	Dielectric tests	27
13.12.1	General	27
13.12.2	Induced voltage test with partial discharge measurement (IVPD)	28
13.12.3	Switching impulse test (SI)	28
13.12.4	Lightning impulse test	28
13.12.5	Lightning impulses applied to multiple line terminals simultaneously (LIMT)	29
13.13	Tests on on-load tap-changers – operation test	29
13.14	Leak testing with pressure	30
13.15	Vacuum deflection test	30
13.16	Pressure deflection test	30
14	Tolerances	30
14.1	General	30
14.2	Tolerance for impedance and phase angle	30
Annex A	(informative) Check list of information to be provided with enquiry and order	32
A.1	Rating and general data	32
A.1.1	Normal information	32
A.1.2	Special information	33
A.2	Parallel operation	34
Annex B	(informative) Behaviour of a phase shifting transformer with non-symmetrical fault currents	35
Annex C	(informative) Example specification of buck capability	37
Annex D	(informative) Additional noise measurements	38
Annex E	(informative) Calculation of phase angle under load	40
Annex F	(informative) Additional information on advance-retard switch	44
F.1	Principle	44
F.2	Classification within the international standardization system	44

F.3 Requirements according to IEC 60214-1 and IEEE Std C57.131	44
Bibliography.....	45
Figure 1 – Example A: DS0-3/9.....	18
Figure 2 – Example B: PS0-3/9.....	18
Figure 3 – Example C: DA0-3	19
Figure 4 – Example D: YNyn/IIIId S0-3/9.....	20
Figure 5 – Example E: YNyn+d/IIIId A0-3/9	20
Figure 6 – Example F: YNa0yn/dIII A0-3/9	21
Figure 7 – Example G: V A0-2/8.....	22
Figure B.1 – PST with single phase fault and surge protection	36
Figure E.1 – Phase angle diagram for a PST under load where $\alpha_0 > 0$ and $\varphi_L < 0$	40
Figure E.2 – Phase angle diagram for a PST under load where $\alpha_0 < 0$ and $\varphi_L < 0$	40
Figure E.3 – Phase angle diagram for a PST under load where $\alpha_0 > 0$ and $\varphi_L > 0$	41
Figure E.4 – Phase angle diagram for a PST under load where $\alpha_0 < 0$ and $\varphi_L > 0$	41
Table C.1 – Required PST capability in buck operation	37
Table D.1 – Combinations of sound level measurements needed to represent different loading conditions.....	39

POWER TRANSFORMERS –

Part 57-1202: Liquid immersed phase-shifting transformers

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.

IEEE Standards documents are developed within IEEE Societies and Standards Coordinating Committees of the IEEE Standards Association (IEEE-SA) Standards Board. IEEE develops its standards through a consensus development process, approved by the American National Standards Institute, which brings together volunteers representing varied viewpoints and interests to achieve the final product. Volunteers are not necessarily members of IEEE and serve without compensation. While IEEE administers the process and establishes rules to promote fairness in the consensus development process, IEEE does not independently evaluate, test, or verify the accuracy of any of the information contained in its standards. Use of IEEE Standards documents is wholly voluntary. *IEEE documents are made available for use subject to important notices and legal disclaimers (see <http://standards.ieee.org/IPR/disclaimers.html> for more information).*

IEC collaborates closely with IEEE in accordance with conditions determined by agreement between the two organizations. This Dual Logo International Standard was jointly developed by the IEC and IEEE under the terms of that agreement.

- 2) The formal decisions 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. The formal decisions of IEEE on technical matters, once consensus within IEEE Societies and Standards Coordinating Committees has been reached, is determined by a balanced ballot of materially interested parties who indicate interest in reviewing the proposed standard. Final approval of the IEEE standards document is given by the IEEE Standards Association (IEEE-SA) Standards Board.
- 3) IEC/IEEE Publications have the form of recommendations for international use and are accepted by IEC National Committees/IEEE Societies in that sense. While all reasonable efforts are made to ensure that the technical content of IEC/IEEE Publications is accurate, IEC or IEEE 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 (including IEC/IEEE Publications) transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC/IEEE Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC and IEEE do not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC and IEEE are 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 IEEE or their directors, employees, servants or agents including individual experts and members of technical committees and IEC National Committees, or volunteers of IEEE Societies and the Standards Coordinating Committees of the IEEE Standards Association (IEEE-SA) Standards Board, 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/IEEE Publication or any other IEC or IEEE 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 implementation of this IEC/IEEE Publication may require use of material covered by patent rights. By publication of this standard, no position is taken with respect to the existence or validity of any patent rights in connection therewith. IEC or IEEE shall not be held responsible for identifying Essential Patent Claims for which a license may be required, for conducting inquiries into the legal validity or scope of Patent Claims or determining whether any licensing terms or conditions provided in connection with submission of a Letter of Assurance, if any, or in any licensing agreements are reasonable or non-discriminatory. Users of this standard are expressly advised that determination of the validity of any patent rights, and the risk of infringement of such rights, is entirely their own responsibility.

International Standard IEC/IEEE 60076-57-1202 has been prepared by IEC technical committee 14: Power transformers, in cooperation with the Transformers Committee of the IEEE Power & Energy Society¹, under the IEC/IEEE Dual Logo Agreement.

This publication is published as an IEC/IEEE Dual Logo standard.

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

FDIS	Report on voting
14/892/FDIS	14/902/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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The IEC Technical Committee and IEEE Technical Committee have decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC website 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.

¹ A list of IEEE participants can be found at the following URL: http://standards.ieee.org/downloads/60076/60076-57-1202-2017/60076-57-1202-2017_wg-participants.pdf

POWER TRANSFORMERS –

Part 57-1202: Liquid immersed phase-shifting transformers

1 Scope

This part of IEC 60076 covers the requirements for phase-shifting transformers of all types. The scope excludes transformers with an unregulated phase shift.

This document is limited to matters particular to phase-shifting transformers and does not include matters relating to general requirements for power transformers covered in existing standards in the IEC 60076 series or IEEE Std C57.12.00™ and IEEE Std C57.12.10™.

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.

2.1 IEC references

IEC 60050-421, *International Electrotechnical Vocabulary – Chapter 421: Power transformers and reactors* (available at: www.electropedia.org)

IEC 60076-1, *Power transformers – Part 1: General*

IEC 60076-2, *Power transformers – Part 2: Temperature rise for liquid-immersed transformers*

IEC 60076-3, *Power transformers – Part 3: Insulation levels, dielectric tests and external clearances in air*

IEC 60076-5, *Power transformers – Part 5: Ability to withstand short circuit*

IEC 60076-10, *Power transformers – Part 10: Determination of sound levels*

IEC 60076-18, *Power transformers – Part 18: Measurement of frequency response*

ISO 2178, *Non-magnetic coatings on magnetic substrates – Measurement of coating thickness – Magnetic method*

ISO 2409, *Paints and varnishes – Cross-cut test*

2.2 IEEE references

IEEE Std C57.12.00™, *IEEE Standard for General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers*

IEEE Std C57.12.10™, *IEEE Standard Requirements for Liquid-Immersed Power Transformers*

IEEE Std C57.12.70™, *IEEE Standard for Standard Terminal Markings and Connections for Distribution and Power Transformers*

IEEE Std C57.12.80™, *IEEE Standard Terminology for Power and Distribution Transformers*

IEEE Std C57.12.90™, *IEEE Standard Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers*