

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

**Fordringar på generatoranläggningar för
anslutning i parallelldrift med elnät –
Del 10: Test för bedömning om överensstämmelse för generande enheter**
*Requirements for generating plants to be connected in parallel with distribution networks –
Part 10: Tests for conformity assessment of generating units*

Som svensk standard gäller europastandarden EN 50549-10:2022. Den svenska standarden innehåller den officiella engelska språkversionen av EN 50549-10:2022.

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

**Requirements for generating plants to be connected in parallel
with distribution networks - Part 10: Tests for conformity
assessment of generating units**

Exigences relatives aux centrales électriques destinées à
être raccordées en parallèle à des réseaux de distribution -
Partie 10: Essais d'évaluation de la conformité des unités
de production

Anforderungen für zum Parallelbetrieb mit einem Verteilnetz
vorgesehene Erzeugungsanlagen - Teil 10:
Prüfanforderungen für die Konformitätsbeurteilung von
Erzeugungseinheiten

This European Standard was approved by CENELEC on 2022-08-09. 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

Contents

Page

European foreword.....	5
1 Scope	6
2 Normative references	6
3 Terms, definitions, symbols and abbreviations	8
3.1 Terms and definitions	8
3.1.1 General.....	8
3.1.2 Plant, module and unit	9
3.1.3 Power	10
3.1.4 Voltage	11
3.1.5 Circuit theory	12
3.1.6 Protection	12
3.1.7 Control	13
3.1.8 Power quality	13
3.2 Symbols and abbreviations	14
3.2.1 Abbreviations	14
3.2.2 Symbols	14
4 Assessment methods and test equipment	15
4.1 General.....	15
4.2 Assessment methods.....	16
4.2.1 Test on complete generating unit	16
4.2.2 Test on the electrical generation system	16
4.2.3 Test on the nacelle of a wind turbine	17
4.2.4 Test on the primary energy converter	18
4.2.5 Test at limited power	18
4.2.6 Test on stopped generating unit.....	18
4.2.7 Test on an independent component.....	18
4.2.8 Simulated input test	19
4.2.9 Test by changing a control parameter	19
4.2.10 Field measurements	20
4.2.11 Test by calculation and numerical simulation for generating units of synchronous generating technology	21
4.2.12 Test of the real generating unit control unit in a simulated environment (“Controller-Hardware-in-the-loop” (HIL) test).....	21
4.2.13 Evaluation by inspection and test of dependent components	21
4.3 Requirements for the measuring equipment.....	22
4.4 Configuration range and parameter sets	24
4.4.1 General.....	24
4.4.2 Documentation.....	26
4.5 EUT Software change requirements.....	26
5 Testing	27
5.1 General.....	27
5.2 Normal operating range	27
5.2.1 Frequency operating range	27
5.2.2 Voltage operating range.....	30
5.3 Immunity to disturbances	33
5.3.1 Rate of change of frequency (ROCOF).....	33
5.3.2 Phase jump.....	37
5.3.3 Fault ride through, over-voltage (OVRT) and under-voltage (UVRT)	40
5.4 Active response to frequency deviation	50
5.4.1 General.....	50
5.4.2 Test application and verification methodology	50

5.4.3	Verification procedure	53
5.4.4	Assessment criteria	64
5.4.5	Documentation	64
5.5	Power specification and response to voltage variations	65
5.5.1	Power capabilities assessment - voltage support by reactive power	65
5.5.2	Voltage support by reactive power - test to determine the reactive power control modes	72
5.6	Voltage related active power reduction - P(U)	87
5.6.1	General	87
5.6.2	Test application and verification	88
5.6.3	Test procedure for steady-state behaviour	88
5.6.4	Test procedure for dynamic behaviour	88
5.6.5	Assessment criteria	89
5.6.6	Documentation	89
5.7	EMC and power quality	90
5.7.1	EMC	90
5.7.2	Power Quality	90
5.8	Interface protection	95
5.8.1	General	95
5.8.2	Test application and verification methodology	96
5.8.3	Verification procedure for generating plants to be connected to a LV distribution network with Interface protection as internal device	96
5.8.4	Verification procedure for generating plants to be connected to a LV distribution network with Interface protection as dedicated device	118
5.8.5	Verification procedure for generating plants to be connected to a MV distribution network	118
5.8.6	Islanding detection	119
5.9	Connection and starting	119
5.9.1	General	119
5.9.2	Test application and verification methodology	121
5.9.3	Automatic reconnection after tripping	121
5.9.4	Starting to generate electrical power	123
5.9.5	Assessment criteria	123
5.9.6	Documentation	124
5.9.7	Synchronisation	124
5.10	Active power reduction on set point	125
5.10.1	General	125
5.10.2	Test application and verification methodology	125
5.10.3	Verification procedure	126
5.11	Remote information exchange	129
5.12	Requirements regarding single fault tolerance of interface protection system and interface switch	130
5.12.1	General	130
5.12.2	Single fault tolerance of the interface protection system	130
5.12.3	Single fault tolerance of the interface switch	131
5.13	Model definition and model validation for generating units of synchronous generating technology	131
5.13.1	General	131
5.13.2	Model definition	132
5.13.3	Verification environment	133
5.13.4	Verification process	136
Annex A (normative)	Fault ride through test setup	153
A.1	Example UVRT test setup	153
A.2	Example OVRT test setup	153
A.3	AC Grid simulator converter system	154
Annex B (normative)	Template for statements of conformity and parameters	157
B.1	General	157

B.2 Templates for statements of conformity157

Annex C (informative) Table 8 of EN 61000-4-13:2002 and Table 26 of EN IEC 60255-181:2019.166

C.1 Table 26 of EN IEC 60255-181:2019166

C.2 Table 8 of EN 61000-4-13:2002167

Bibliography168

European foreword

This document (EN 50549-10:2022) has been prepared by CLC/TC 8X “System aspects of electrical energy supply”.

The following dates are fixed:

- latest date by which this document has to be (dop) 2023-08-09
implemented at national level by publication of
an identical national standard or by
endorsement
- latest date by which the national standards (dow) 2025-08-09
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.

EN 50438:2013 has been superseded by EN 50549-1:2019. However, Annex D of EN 50438:2013 provided requirements on compliance type testing, which is out of the scope of EN 50549-1:2019 resulting in a gap regarding type testing. This document provides requirements for compliance type testing for generating units and closes this gap.

This document has been prepared under a Standardization Request given to CENELEC by the European Commission and the European Free Trade Association.

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.

1 Scope

The purpose of this document is to provide technical guidance for tests on generating units and interface protection to evaluate their electrical characteristics.

NOTE 1 Mechanical issues are taken into account as far as they influence the electrical characteristics.

The evaluation results are intended to be used to demonstrate conformity of generating units to technical requirements for grid connection. In this context the evaluation results can also be used as part of a certification programme.

NOTE 2 Besides the type test results of the generating unit all additional elements for connection to the grid (e.g. transformer, cabling, multiple units) are considered in the evaluation of the final installation of a generating plant.

The requirements to be evaluated are covered in the following standardization documents:

- EN 50549-1:2019: Requirements for generating plants to be connected in parallel with distribution networks
- Part 1: connection to a LV distribution network - Generating plants up to and including Type B
- EN 50549-2:2019: Requirements for generating plants to be connected in parallel with distribution networks
- Part 2: Connection to a MV distribution network - Generating plants up to and including Type B

If grid connection requirements are dealt with in other documents or for other generating module types, where no specific testing procedure is provided, testing methods of this document can be used if applicable.

This document provides evaluation criteria for the conformity assessment of generating units with respect to the abovementioned standardization documents, based on type testing. However, some requirements are applicable on the generating plant level. The assessment of the conformity to these plant requirements are out of the scope of this document. Nevertheless, this document may be used to show the capabilities of a generating unit to be used in a plant.

As a consequence, it is possible that the conformity assessment of a generating unit does not cover all aspects of the above-mentioned standardization documents, typically when a requirement is evaluated on a plant level. Therefore, the conformity assessment report indicates clearly which clauses of this document are covered and which clauses are not covered.

This document recognizes the existence of specific technical test requirements within several member states that must be complied with.

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.

EN 50549-1:2019, *Requirements for generating plants to be connected in parallel with distribution networks - Part 1: Connection to a LV distribution network - Generating plants up to and including Type B*

EN 50549-2:2019, *Requirements for generating plants to be connected in parallel with distribution networks - Part 2: Connection to a MV distribution network - Generating plants up to and including Type B*

EN IEC 60034 (all parts), *Rotating electrical machines*

EN IEC 60034-4-1, *Rotating electrical machines - Part 4-1: Methods for determining electrically excited synchronous machine quantities from tests*

EN 50524, *Data sheet for photovoltaic inverters*

EN 60255-1, *Measuring relays and protection equipment - Part 1: Common requirements*

- EN 60255-26, *Measuring relays and protection equipment - Part 26: Electromagnetic compatibility requirements*
- EN 60255-27, *Measuring relays and protection equipment - Part 27: Product safety requirements*
- EN 60255-127, *Measuring relays and protection equipment - Part 127: Functional requirements for over/under voltage protection*
- EN IEC 60255-181:2019, *Measuring relays and protection equipment - Part 181: Functional requirements for frequency protection*
- EN 60730-1:2016¹, *Automatic electrical controls - Part 1: General requirements*
- EN 61000-3-2, *Electromagnetic compatibility (EMC) - Part 3-2: Limits - Limits for harmonic current emissions (equipment input current ≤16 A per phase)*
- EN 61000-3-3, *Electromagnetic compatibility (EMC) - Part 3-3: Limits - Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems, for equipment with rated current ≤ 16 A per phase and not subject to conditional connection*
- EN 61508-3:2010, *Functional safety of electrical/electronic/programmable electronic safety-related systems - Part 3: Software requirements*
- EN IEC 61000-3-11, *Electromagnetic compatibility (EMC) - Part 3-11: Limits - Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems - Equipment with rated current ≤ 75 A and subject to conditional connection*
- EN 61000-3-12, *Electromagnetic compatibility (EMC) - Part 3-12: Limits - Limits for harmonic currents produced by equipment connected to public low-voltage systems with input current >16 A and ≤ 75 A per phase*
- EN 61000-4-7:2002,² *Electromagnetic compatibility (EMC) – Part 4-7: Testing and measurement techniques - General guide on harmonics and interharmonics measurements and instrumentation, for power supply systems and equipment connected thereto*
- EN 61000-4-13:2002,³ *Electromagnetic compatibility (EMC) - Part 4-13: Testing and measurement techniques - Harmonics and interharmonics including mains signalling at a.c. power port, low frequency immunity tests*
- EN 61869-2, *Instrument transformers - Part 2: Additional requirements for current transformers*
- EN 61869-3, *Instrument transformers – Part 3: Additional requirements for inductive voltage transformers*
- EN 62116, *Utility-interconnected photovoltaic inverters - Test procedure of islanding prevention measures*
- EN 62109-2, *Safety of power converters for use in photovoltaic power systems - Part 2: Particular requirements for inverters*
- EN IEC 61010 (all parts), *Safety requirements for electrical equipment for measurement, control, and laboratory use*
- EN IEC 61326 (all parts), *Electrical equipment for measurement, control and laboratory use - EMC requirements*
- UL 1998:2013, *Standard for Software in Programmable Components*

¹ As amended by EN 60730-1:2016/A1:2019 and EN 60730-1:2016/A2:2022.

² As amended by EN 61000-4-7:2002/A1:2009.

³ As amended by EN 61000-4-13:2002/A1:2009 and EN 61000-4-13:2002/A2:2016.