



BSI Standards Publication

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

National foreword

This British Standard is the UK implementation of EN 50549-1:2019+A1:2023, incorporating corrigendum April 2019. It supersedes BS EN 50549-1:2019, which will be withdrawn on 12 December 2024.

The start and finish of text introduced or altered by amendment is indicated in the text by tags. Tags indicating changes to CENELEC text carry the number of the CENELEC amendment. For example, text altered by CENELEC amendment A1 is indicated by A1 A1.

The UK participation in its preparation was entrusted to Technical Committee GEL/8, Systems Aspects for Electrical Energy Supply.

A list of organizations represented on this committee can be obtained on request to its committee manager.

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English Version

**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**

Exigences relatives aux centrales électriques destinées à
être raccordées en parallèle à des réseaux de distribution -
Partie 1: Raccordement à un réseau de distribution BT -
Centrales électriques jusqu'au Type B inclus

Anforderungen für zum Parallelbetrieb mit einem Verteilnetz
vorgesehene Erzeugungsanlagen - Teil 1: Anschluss an
das Niederspannungsverteilstromnetz bis einschließlich Typ B

This European Standard was approved by CENELEC on 2018-08-09. 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.

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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.

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

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Contents

Page

European foreword	4
Introduction.....	5
1 Scope.....	8
2 Normative references	9
3 Terms and definitions	9
3.1 General	9
3.2 Plant, module and unit.....	11
3.3 Power.....	14
3.4 Voltage.....	15
3.5 Circuit theory.....	16
3.6 Protection.....	18
3.7 Control	22
4 Requirements on generating plants	23
4.1 General	23
4.2 Connection scheme	24
4.3 Choice of switchgear	25
4.3.1 General	25
4.3.2 Interface switch	25
4.4 Normal operating range	25
4.4.1 General	25
4.4.2 Operating frequency range	25
4.4.3 Minimal requirement for active power delivery at underfrequency	26
4.4.4 Continuous operating voltage range	27
4.5 Immunity to disturbances.....	27
4.5.1 General	27
4.5.2 Rate of change of frequency (ROCOF) immunity	27
4.5.3 Under-voltage ride through (UVRT)	28
4.5.4 Over-voltage ride through (OVRT)	29
4.5.5 Phase jump immunity	30
4.6 Active response to frequency deviation	30
4.6.1 Power response to overfrequency.....	30
4.6.2 Power response to underfrequency.....	33
4.7 Power response to voltage changes	36
4.7.1 General	36
4.7.2 Voltage support by reactive power	36
4.7.3 Voltage related active power reduction	41
4.7.4 Short circuit current requirements on generating plants	41
4.8 EMC and power quality	42
4.9 Interface protection	43
4.9.1 General	43
4.9.2 Void.....	44
4.9.3 Requirements on voltage and frequency protection.....	45
4.9.4 Means to detect island situation	47



4.9.5	Digital input to the interface protection	48
4.10	Connection and starting to generate electrical power.....	48
4.10.1	General	48
4.10.2	Automatic reconnection after tripping.....	48
4.10.3	Starting to generate electrical power	48
4.10.4	Synchronization	49
4.11	Ceasing and reduction of active power on set point	49
4.11.1	Ceasing active power	49
4.11.2	Reduction of active power on set point	49
4.12	Remote information exchange	49
4.13	Requirements regarding single fault tolerance of interface protection system and interface switch	50
Annex A (informative)	Interconnection guidance	51
A.1	General	51
A.2	Network integration	51
A.3	Clusters of single-phase generating units	52
Annex B (informative)	Void	53
Annex C (informative)	Parameter Table	54
Annex D (informative)	List of national requirements applicable for generating plants	59
Annex E (informative)	Loss of Mains and overall power system security	61
Annex F (informative)	Examples of protection strategies	62
F.1	Introduction	62
F.1.1	General	62
F.1.2	Generalities	62
F.1.3	Detection of unwanted islands	62
F.1.4	Problems with uncontrolled islanding in MV networks	63
F.1.4.1	Safety	63
F.1.4.2	Grid parameters	63
F.1.4.3	Reclosing operations	63
F.1.4.4	Protection of islands against overcurrents	63
F.1.4.5	Protection against phase to earth faults	63
F.2	Example strategy 1	64
F.3	Example strategy 2	67
Annex G (normative)	Abbreviations	69
Annex H (informative)	Relationship between this European standard and the COMMISSION REGULATION (EU) 2016/631	70
Bibliography		71

European foreword

This document (EN 50549-1:2019) has been prepared by CLC/TC 8X “System aspects of electrical energy supply”.

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conflicting with this document have to
be withdrawn

This document supersedes EN 50438:2013 and CLC/TS 50549-1:2015.

This European Standard relates to both the RfG European Network Code and current technical market needs. Its purpose is to give detailed description of functions to be implemented in products.

This European Standard is also intended to serve as a technical reference for the definition of national requirements where the RfG European Network Code requirements allow flexible implementation. The specified requirements are solely technical requirements; economic issues regarding, e.g. the bearing of cost are not in the scope of this document.

CLC/TC 8X plans future standardization work in order to ensure the compatibility of this European Standard (EN) with the evolution of the legal framework.

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.

European foreword to amendment A1

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- latest date by which the national standards (dow) 2026-09-21
conflicting with this document have to be
withdrawn

This document amends EN 50549-1:2019.

This amendment includes the following significant technical changes:

- Introduction of a phase jump immunity requirement.
- Harmonizing the ROCOF immunity requirement for synchronous and non-synchronous generating technology.
- Modifying FRT for type A from recommendation to requirement.
- Providing additional detail for EESS in case of overfrequency.

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.

Introduction

Rationale for the content and structure of this document.

1. Foreword

This Explanatory Note explains the rationale behind the content and structure of prEN 50549-1 and prEN 50549-2. Due to the unique relationship between COMMISSION REGULATION 2016/631 (RfG) and the EN 50549 Series, and based on the comments received at the enquiry stage of prEN 50549-1 and prEN 50549-2, TC8X WG03 decided to draft this explanatory note in order to provide national committees and the wider public with an understanding of these rationale.

2. Increased Scope of EN 50549 in relation to RfG

In the tradition of EN 50438, TC8X WG03 intended, in writing of prEN50549, to include all capabilities of generating plants that are needed to operate these in parallel to distribution networks. This includes issues necessary for a stable distribution network management as well as the management of the interconnected system. As RfG is focused on the interconnected system, it is logical that, taking into account further needs for distribution network management, further aspects are included.

3. Introduction of “Responsible party”

During the national implementation process of COMMISSION REGULATION (EU) 2016/631, different types of responsible parties play a role in the refinement of the non-exhaustive requirements. In each member country, the National Regulatory Authority approves this national implementation. Depending on the national regulatory framework, this might result in a variety of documents: national laws, decrees or regulations, technical specifications, or requirements of transmission and distribution system operators. Therefore, as explained in the scope, EN 50549-1 and EN 50549-2 refer to the “responsible party” where requirements have to be defined by an actor other than the DSO. However when a generating plant is built and connected to the distribution network, typically the distribution system operator provides the plant developer all the technical requirements to be fulfilled.

4. Use of terms

Terms and definitions are selected to achieve consistency with EN 60050, IECV (cf. www.electropedia.org) and CENELEC terminology, recognizing that terms in COMMISSION REGULATION (EU) 2016/631 may deviate.

5. Additional requirements for distribution system management

The following requirements are stated in EN 50549 for distribution system management reasons, which might not be required in RfG or if required in RfG, are not required for type A. As Directive 714/2009 8(7) limits the scope of RfG to issues effecting the cross border trade of electricity, requirements included solely for the need of distribution system management are considered beyond the scope of RfG.

- Connection scheme and Coordination of switch gear,
- Voltage operating range,
- Reactive power capability and control modes,
- Voltage related active power reduction,
- Interface protection including the detection of island situations,
- Connection and reconnection to the grid,
- Generation curtailment,
- Remote information exchange,

6. Additional requirements for stability of the interconnected system

Additionally, requirements relevant for the stability of the interconnected systems are included in case of over voltage ride through (OVRT) as this is not dealt with in RfG. Due to the long duration of RfG development and the fast development of decentralised generation in Europe robustness to voltage swells is considered to be of high importance, but apparently could not be included into RfG.

As electrical energy storage system (EESS), are excluded from the scope of RfG, but are included in the scope of the EN 50549 Series, EN 50549 also includes the further requirement of active power frequency response to under frequency (LFSM-U) to electrical energy storage systems. This requirement is considered of great importance in view of the expected fast increase of electrical energy storage for the next years and is considered not to affect the cost of electrical energy storage systems if considered during their design.

7. Details on the operation of the LFSM-O

During the enquiry stage, some comments reported that certain details in the chapter regarding the operation of the LFSM-O (e.g. intentional delay, operation with deactivation threshold) were violating the RfG. These topics have been further evaluated consulting the European Stakeholder Committee (ESC-GC) and TC8X WG03 could not conclude in the same way. The fact that these operations are not foreseen in the RfG is considered not sufficient to state any violation. Therefore these details are kept with additional information on their use.

8. Implementation of UVRT and LFSM-U to avoid legal conflict with RfG

A1 Under Voltage Ride Through (UVRT) requirements are defined in RfG for modules type B, type C and type D. There is no mentioning of this topic for type A modules.

Nevertheless, UVRT is seen as an important requirement in some member states even for small generation modules like type A.

NOTE At the time of writing, LVRT requirements for type A modules have been implemented in the following countries: Austria, Czech Republic, Germany, Portugal (for PGM of 15 kW and higher), Switzerland.

From a legal point of view there are two contradicting opinions on whether it is allowed or forbidden to require UVRT for type A modules.

— Opinion 1: It can be required because the topic is not dealt with for type A modules.

— Option 2: It cannot be required because the topic UVRT is dealt within the RfG. Not mentioning UVRT for type A in RfG therefore means that it cannot be required for type A modules.

TC8X WG03 adopts the view of ACER as expressed in “ACER Monitoring of the Implementation of the Grid Connection Network Codes” 11 November 2021 Item 3.3.4 #D where it states the German UVRT requirement for Type A as compliant with NC RfG.

This same explanation can be applied to the requirements regarding Limited Frequency Sensitive Mode - Underfrequency (LFSM-U). In RfG, this LFSM-U is solely defined for type C and type D modules. In EN 50549, LFSM-U is defined as a recommendation (should) for generating modules of type A and type B. The sole exception is electrical energy storage systems having a requirement (shall). These systems are currently not within the scope of the RfG. **A1**

9. Annex H - Relationship between this European standard and the COMMISSION REGULATION (EU) 2016/631.

Manufacturers of generating units and plants shall comply with all relevant EU Directives and Regulations. For the specific function of connecting the generating plant with the electric system the reference regulation is COMMISSION REGULATION (EU) 2016/631 (NC RfG).

Since the EN 50549-1 and -2 are covering all technical requirements for type A and type B generating units, modules and plants, it is considered helpful to provide the information which clause of the standard supports which article of the RfG in a structured informative annex within the standard.

For other EU Directives and Regulations (e.g. LVD, MD or GAR) it is a formal task given to CCMC to include such an informative Annex ZZ based on a standardization request from the EU. It is finally reviewed by the new approach consultant (NAC) for the relevant Directive or Regulation and the listing of the standard in the official journal of the EU (OJEU) providing the “presumption of

conformity". This means that if a product is compliant with the standard, the Directive or Regulations is fulfilled too.

CLC TC 8X is fully aware, that this official procedure is not included in the RfG. Therefore CLC TC 8X WG3 drafted Annex H. In Annex H the relationship between the clauses and the articles is shown. It is considered, that generating plants compliant with the clauses of the standards are also compliant with the articles in the RfG. Of course, this does not provide "presumption of conformity" as a listed standard in the OJEU would provide. Nevertheless it will be helpful for the industry when performing the conformity assessment against RfG.

1 Scope

This document specifies the technical requirements for the protection functions and the operational capabilities for generating plants, intended to operate in parallel with LV distribution networks.

For practical reasons this document refers to the responsible party where requirements have to be defined by an actor other than the DSO e.g. TSO, member state, regulatory authorities according to the legal framework. Typically the DSO will inform the producer about these requirements.

NOTE 1 This includes European network codes and their national implementation, as well as additional national regulations.

NOTE 2 Additional national requirements especially for the connection to the distribution network and the operation of the generating plant may apply.

The requirements of this European Standard apply, irrespective of the kind of energy source and irrespective of the presence of loads in the producer's network, to generating plants, generating modules, electrical machinery and electronic equipment that meet all of the following conditions:

- converting any energy source into AC electricity;
- generating modules capacity of type B or smaller according to COMMISSION REGULATION (EU) 2016/631 while considering national implementation for the decision regarding power limits between A and B types and B and C types;
- connected to and operated in parallel with an AC LV distribution network.

NOTE 3 Generating plants connected to a MV distribution network fall into the scope of EN 50549-2.

NOTE 4 Electrical energy storage systems (EESS) in meeting the conditions above are included

If generating modules of different type (A or B) are combined in one plant, different requirements apply for the different modules based on the type of each module.

EXAMPLE: If a generating plant consists of multiple generating modules (see 3.2.1), according to COMMISSION REGULATION (EU) 2016/631 the situation might occur, that some generating modules are of type A and some are of type B.

Unless specified otherwise by the DSO and the responsible party, generating plants connected to a medium voltage distribution network with a maximum apparent power up to 150 kVA can comply with this European Standard as alternative to the requirements of EN 50549-2. A different threshold may be defined by the DSO and the responsible party.

This document recognizes the existence of specific technical requirements (e.g. grid codes) of the DSO or another responsible party within a member state and these must be complied with.

Excluded from the scope are:

- the selection and evaluation of the point of connection;
- power system impact assessment e.g. assessment of effects on power quality, local voltage increase, impact on line protections operation;
- connection assessment, the set of technical verifications made as part of the planning of the connection;
- island operation of generating plants, both intentional and unintentional, where no part of the distribution network is involved;
- four-quadrant rectifier of drives feeding braking energy back into the distribution network for limited duration with no internal source of primary energy;
- uninterruptible power supply with duration of parallel operation limited to 100 ms;

NOTE 5 Parallel operation due to maintenance of uninterruptible power supply units is not seen as part of normal UPS operation and therefore not considered in this document.

- requirements for the safety of personnel as they are already adequately covered by existing European Standards.
- the connection of a generating unit, module or plant into a DC network

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 50549-2, *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*

Ⓐ₁ EN 50549-10, *Requirements for generating plants to be connected in parallel with distribution networks - Part 10: Tests for conformity assessment of generating units* Ⓐ₁

Ⓐ₁ Text deleted Ⓐ₁

EN 61000-4-30, *Electromagnetic compatibility (EMC) — Part 4-30: Testing and measurement techniques — Power quality measurement methods (IEC 61000-4-30)*

HD 60364-1, *Low-voltage electrical installations — Part 1: Fundamental principles, assessment of general characteristics, definitions (IEC 60364-1)*

HD 60364-5-551, *Low-voltage electrical installations — Part 5-55: Selection and erection of electrical equipment — Other equipment — Clause 551: Low-voltage generating sets (IEC 60364-5-551)*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

Note Terms and definitions are selected to achieve consistency with IEV (cf. www.electropedia.org) and CENELEC terminology, recognizing that terms in COMMISSION REGULATION (EU) 2016/631 may deviate.

3.1 General

3.1.1

distribution network

AC electrical network, including closed distribution networks, for the distribution of electrical power from and to third parties connected to it, to and from a transmission or another distribution network, for which a DSO is responsible

Note 1 to entry: A distribution network does not include the producer's network.

3.1.2

closed distribution network

system which distributes electricity within an industrial, commercial or shared services site, that is geographically confined, and does not supply households customers (without excluding the option of a small number of households served by the system that have an employment or similar associations with the owner of the system)

Note 1 to entry: A closed distribution network will either be used to integrate the production processes of the network users for specific or technical reasons or distribute electricity primarily to the operator of the closed distribution network or his related undertakings.

[SOURCE: Directive 2009/72/EC, article 28, modified]

3.1.3

distribution system operator

DSO

natural or legal person responsible for the distribution of electrical power to final customers and for operating, ensuring the maintenance of and, if necessary, developing the distribution network in a given area

Note 1 to entry: As this document is applicable to distribution grids, DSO is used for relevant system operator according to article 2 (13) of COMMISSION REGULATION 2016/631.

Note 2 to entry: In some countries, the distribution network operator (DNO) fulfils the role of the DSO.

3.1.4

transmission system operator

natural or legal person responsible for operating, ensuring the maintenance of and, if necessary, developing the transmission system in a given area and, where applicable, its interconnections with other power systems, and for ensuring the long-term ability of the power system to meet reasonable demands for the transmission of electricity

3.1.5

responsible party

party, that according to the legal framework is responsible to define requirements or parameters according to COMMISSION REGULATION 2016/631 e.g. TSO, member state, regulatory authority

3.1.6

low voltage (LV) distribution network

electric distribution network with a voltage whose nominal r.m.s. value is $U_n \leq 1 \text{ kV}$

3.1.7

medium voltage (MV) distribution network

electric distribution network with a voltage whose nominal r.m.s. value is $1 \text{ kV} < U_n \leq 36 \text{ kV}$

Note 1 to entry: Because of existing network structures, the upper boundary of MV can be different in some countries.

3.1.8

power system stability

capability of a power system to regain a steady state, characterized by the synchronous operation of the generating plants after a disturbance

[SOURCE: IEC 603-03-01]

3.1.9

producer

natural or legal person who already has connected or is planning to connect an electricity generating plant to a distribution network

3.1.10**producer's network**

AC electrical installations downstream from the point of connection operated by the producer for internal distribution of electricity

Note 1 to entry: When the internal distribution network is identical to an electrical network of a customer having his own generating plant, where one or more generating units are connected to this internal distribution network behind a point of connection, then this network may be also referred as prosumer's network.

3.1.11**downstream**

direction in which the active power would flow if no generating units, connected to the distribution network, were running

3.1.12**point of connection****POC**

reference point on the electric power system where the user's electrical facility is connected

Note 1 to entry: For the purpose of this standard, the electric power system is the distribution network.

[SOURCE: IEC 617-04-01 modified]

3.1.13**operating in parallel with the distribution network**

situation where the generating plant is connected to a distribution network and operating

3.1.14**temporary operation in parallel with the distribution network**

conditions in which the generating plant is connected during defined short periods to a distribution network to maintain the continuity of the supply and to facilitate testing

3.1.15**nominal value**

value of a quantity used to designate and identify a component, device, equipment, or system

Note to entry: The nominal value is generally a rounded value.

[SOURCE: IEC 151-16-09]

3.2 Plant, module and unit**3.2.1****generating module**

either a generating unit of synchronous generating technology or the sum of all generating units of non-synchronous generating technology connected to a common point of connection including all elements needed to feed electric power to the distribution grid

Note 1 to entry: In some documents this can mean a power-generating module.

Note 2 to entry: Generating modules in the context of this document can be of type A or type B according to the definition of COMMISSION REGULATION 2016/631, article 5.

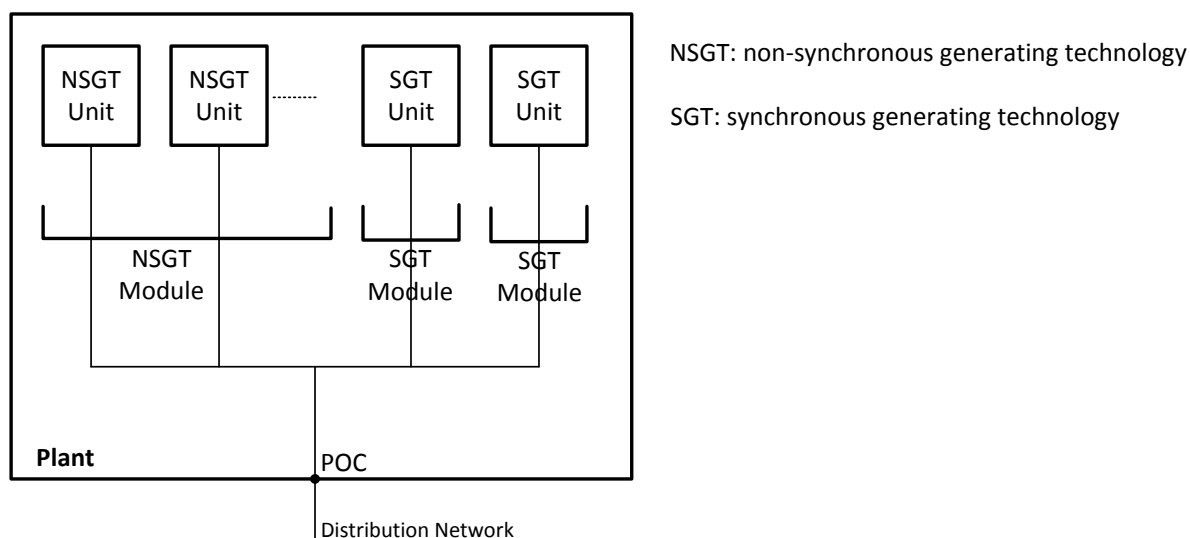


Figure 1 — Generating module at a common POC

3.2.2

generating plant

sum of generating modules connected at one point of connection, including auxiliaries and all connection equipment

Note 1 to entry: In some documents this can mean a power-generating plant.

Note 2 to entry: This definition is intended to be used for verification of compliance to the technical requirements of this standard. It may be different to the legal definition of a plant.

3.2.3

generating unit

smallest set of installations which can generate electrical energy running independently and which can feed this energy into a distribution network

Note 1 to entry: In some documents this can mean a power-generating unit.

Note 2 to entry: For example, a combined cycle gas turbine (CCGT) consisting of a gas turbine and a steam turbine or an installation of an internal combustion engine (ICE) followed by an organic rankine cycle (ORC) machine are considered both as a single generating unit.

Note 3 to entry: If a generating unit is a combination of technologies leading to different requirements, this has to be resolved case by case.

Note 4 to entry: A electrical energy storage EES operating in electricity generation mode and AC connected to the distribution network is considered to be a generating unit.

3.2.4

micro-generating plant

generating plant with generating units having nominal currents in sum not exceeding 16 A per phase

3.2.5

micro-generating unit

generating unit with nominal currents up to and including 16 A per phase

3.2.6

synchronous generating technology

technology where a generating unit is based on a synchronous machine which is directly coupled to an electric power system

3.2.7**non-synchronous generating technology**

technology where a generating unit is connected non-synchronously to an electric power system

EXAMPLE induction machine (non-synchronously connected in COMMISSION REGULATION 2016/631), converter based technology (connected through power electronics in COMMISSION REGULATION 2016/631)

3.2.8**cogeneration****combined heat and power****CHP**

combined generation of electricity and heat by an energy conversion system and the concurrent use of the electric and thermal energy from the conversion system

3.2.9**Linear Stirling engines**

a Stirling engine whose prime mover performs a cyclic linear up and down movement through a magnetic field to generate AC electric power

3.2.10**electrical energy storage system****EES system****EESS**

grid-integrated installation with defined electrical boundaries, comprising of at least one EES, whose purpose is to extract electrical energy from an electric power system, store this energy internally in some manner and inject electrical energy into an electrical power system and which includes civil engineering works, energy conversion equipment and related ancillary equipment.

Note 1 to entry: The EES system is controlled and coordinated to provide services to the electric power system operators or to the electric power system users.

Note 2 to entry: In some cases, an EES system may require an additional energy source during its discharge, providing more energy to the electric power system than the energy it stored.

 Note 3 to entry: Electric vehicle charging stations intended to feed power back to the grid are considered an EESS while a vehicle is connected. 

[SOURCE: IEC 62933-1 ED1]

3.2.11**electrical energy storage****EES**

installation able to absorb electrical energy, to store it for a certain amount of time and to release electrical energy during which energy conversion processes may be included

EXAMPLE A device that absorbs AC electrical energy to produce hydrogen by electrolysis, stores the hydrogen, and uses that gas to produce AC electrical energy is an EES.

Note 1 to entry: EES may be used also to indicate the activity of an apparatus described in the definition during performing its own functionality.

 Note 2 to entry: Electric vehicle charging stations intended to feed power back to the grid are considered an EES while a vehicle is connected. 

[SOURCE: IEC 62933-1 ED1]

3.3 Power

3.3.1

P

active power

under periodic conditions, mean value, taken over one period T , of the instantaneous power p

$$P = \frac{1}{T} \int_0^T p dt$$

Note 1 to entry: Under sinusoidal conditions, the active power is the real part of the complex power S , thus $P = \text{Re } S$.

Note 2 to entry: The coherent SI unit for active power is watt, W.

[SOURCE: IEC 60050-111-42]

3.3.2

P_D

design active power

maximum AC active power output at an active factor of 0,9 or the active factor specified by the DSO or the responsible party for a certain generating plant or generating technology

3.3.3

P_{max}

maximum active power

maximum continuous active power, measured in a 10 min average, which a generating unit or the sum of all the generating units in a generating plant can produce, minus any loads associated solely with facilitating the operation of that generating plant and not fed into the network as specified in the connection agreement or as agreed between the DSO and the generating plant operator

3.3.5

P_M

momentary active power

actual AC active power output at a certain instant

3.3.6

P_A

available active power

maximum AC active power available from the primary energy source after power conversion subject to the availability and magnitude of that primary energy source at the relevant time

Note 1 to entry: The available active power considers all constraints regarding e.g. the primary energy source or the availability of a heat sink for CHP.

3.3.7

rated current

maximum continuous AC output current which a generating unit or generating plant is designed to achieve under normal operating conditions

3.3.8

S_{max}

maximum apparent power

maximum AC apparent power output, measured in a 10 min average, that the generating unit or the sum of all the generating units in a generating plant is designed to achieve under normal operating conditions

3.3.9

primary energy source

non-electric energy source supplying an electric generating unit

Note 1 to entry: Examples of primary energy sources include natural gas, wind and solar energy. These sources can be utilized, e.g. by gas turbines, wind turbines and photovoltaic cells.

3.3.10**apparent power**

product of the rms voltage U between the terminals of a two-terminal element or two-terminal circuit and the rms electric current I in the element or circuit

$$S = UI$$

Note 1 to entry: Under sinusoidal conditions, the apparent power is the modulus of the complex power S , thus $S = |\underline{S}|$.

Note 2 to entry: The coherent SI unit for apparent power is voltampere, VA.

[SOURCE: IEC 131-11-41]

3.3.11**reactive power**

for a linear two-terminal element or two-terminal circuit, under sinusoidal conditions, quantity equal to the mean value of the product of the instantaneous voltage u and the instantaneous current i' which is equal to i but leading it by $\pi / 2$:

$$Q = \overline{ui'} = \frac{1}{T} \int_0^T ui' dt$$

where T denotes half the period of u , Q being equivalent to the product of the apparent power S and the sine of the displacement angle φ

$$Q = S \sin \varphi$$

Note 1 to entry: The reactive power is the imaginary part of the complex power $\underline{S}$, thus $Q = \text{Im } \underline{S}$. Its absolute value is equal to the non-active power, thus $|\underline{Q}| = Q_{\sim}$.

Note 2 to entry: The coherent SI unit for reactive power is voltampere, VA. The special name var and its symbol var are also used.

[SOURCE: IEC 131-11-44] **A1**

3.4 Voltage**3.4.1**

U_n

nominal voltage

voltage by which a supply network is designated or identified and to which certain operating characteristics are referred

3.4.2

f_n

nominal frequency

frequency used to designate and identify equipment or a power system

Note 1 to entry: For the purpose of this standard, the nominal frequency f_n is 50 Hz.

[SOURCE: IEC 151-16-09, modified]

3.4.3

(Void)

3.4.4**reference voltage**

value specified as the base on which residual voltage, thresholds and other values are expressed in per unit or percentage terms

Note 1 to entry: For the purpose of this standard, the reference voltage is the nominal voltage of the distribution network.

[SOURCE: EN 50160:2010, 3.18, modified]

3.4.5**voltage change**

variation of the r.m.s. value of a voltage between two consecutive levels sustained for definite but unspecified durations

[SOURCE: IEC 161-08-01, modified]

EN 50549-1:2019+A1:2023 (E)

3.4.6

under-voltage ride through

UVRT

ability of a generating unit or generating plant to stay connected during voltage dips

Note 1 to entry: In some documents the expression low voltage ride through (LVRT) is used for the same concept.

3.4.7

over-voltage ride through

OVRT

ability of a generating unit or generating plant to stay connected during voltage swells

Note 1 to entry: In some documents the expression high voltage ride through (HVRT) is used for the same concept.

3.4.9

phase

instantaneous phase

ϑ

argument of the cosine function in the representation of a sinusoidal quantity

Note 1 to entry: The term "instantaneous phase" is only used when the independent variable is time.

Note 2 to entry: For the quantity $a(t) = \hat{a} \cos(\omega t + \vartheta)$, the phase is $\omega t + \vartheta$.

[SOURCE: IEC 60050-101:2004]

3.4.10

instantaneous frequency

first derivative of instantaneous phase

3.4.11

rate of change of frequency

ROCOF

first derivative of instantaneous frequency or second derivative of instantaneous phase

3.4.12

phase jump

abrupt change in the phase of the voltage of an AC electrical network 

3.5 Circuit theory

3.5.1

active factor

ratio of the active power to the apparent power for a two-terminal element or a two-terminal circuit under sinusoidal conditions

Note 1 to entry: In a three phase system, this is referring to the positive sequence component of the fundamental.

Note 2 to entry: The active factor is equal to the cosine of the displacement angle.

[SOURCE: IEC 60050-101:2004, modified]

3.5.2

displacement angle

φ

under sinusoidal conditions, phase difference between the voltage applied to a linear two-terminal element or two-terminal circuit and the electric current in the element or circuit

Note 1 to entry: In a three phase system, this is referring to the positive sequence component of the fundamental.

Note 2 to entry: The cosine of the displacement angle is the active factor.

[SOURCE: IEC 60050-101:2004, modified]

3.5.3

power factor

under periodic conditions, ratio of the absolute value of the active power P to the apparent power S

$$\lambda = \frac{|P|}{S}$$

Note 1 to entry: Under sinusoidal conditions, the power factor is the absolute value of the active factor.

[SOURCE: IEC 131-11-46]

3.5.4 fundamental components of a three-phase system

3.5.4.1

phasor

representation of a sinusoidal integral quantity by a complex quantity whose argument is equal to the initial phase and whose modulus is equal to the root-mean-square value

Note 1 to entry: For a quantity $a(t) = A \sqrt{2} \cos(\omega t + \Theta_0)$ the phasor is $A \exp j\Theta_0$.

Note 2 to entry: The similar representation with the modulus equal to the amplitude is called "amplitude phasor".

Note 3 to entry: A phasor can also be represented graphically.

[SOURCE: IEC 131-11-26, modified]

3.5.4.2

positive sequence component of the fundamental

for a three-phase system with phases L1, L2 and L3, the symmetrical sinusoidal three-phase set of voltages or currents having frequency equal to the fundamental frequency and which is defined by the following complex mathematical expression:

$$\underline{X}_1 = \frac{1}{3} (\underline{X}_{L1} + \underline{a} \underline{X}_{L2} + \underline{a}^2 \underline{X}_{L3})$$

where

$\underline{a} = e^{j2\pi/3}$ is the 120 degree operator,

X_{L1} , X_{L2} and X_{L3} are the complex expressions of the fundamental frequency phase quantities concerned, that is, current or voltage phasors

Note 1 to entry: In a balanced harmonic-free system, only positive sequence component of the fundamental exists. For example, if phase voltage phasors are symmetrical $\underline{U}_{L1} = Ue^{j\theta}$, $\underline{U}_{L2} = Ue^{j(\theta+4\pi/3)}$ and $\underline{U}_{L3} = Ue^{j(\theta+2\pi/3)}$ then $\underline{U}_1 = (Ue^{j\theta} + e^{j2\pi/3} Ue^{j(\theta+4\pi/3)} + e^{j4\pi/3} Ue^{j(\theta+2\pi/3)})/3 = (Ue^{j\theta} + Ue^{j\theta} + Ue^{j\theta})/3 = Ue^{j\theta}$

[SOURCE: IEC 448-11-27]

3.5.4.3

negative sequence component of the fundamental

for a three-phase system with phases L1, L2 and L3, the symmetrical sinusoidal three-phase set of voltages or currents having frequency equal to the fundamental frequency and which is defined by the following complex mathematical expression:

$$\underline{X}_2 = \frac{1}{3} (\underline{X}_{L1} + \underline{a}^2 \underline{X}_{L2} + \underline{a} \underline{X}_{L3})$$

where

$\underline{a} = e^{j2\pi/3}$ is the 120 degree operator

$\underline{X}_{L1}$, $\underline{X}_{L2}$ and $\underline{X}_{L3}$ are the complex expressions of the fundamental frequency phase quantities concerned, that is, current or voltage phasors

Note 1 to entry: Negative sequence voltage or current components may be significant only when the voltages or currents, respectively, are unbalanced. For example, if phase voltage phasors are symmetrical $\underline{U}_{L1} = Ue^{j\theta}$, $\underline{U}_{L2} = Ue^{j(\theta+4\pi/3)}$ and $\underline{U}_{L3} = Ue^{j(\theta+2\pi/3)}$ then the negative sequence component $\underline{U}_2 = (Ue^{j\theta} + e^{j4\pi/3} Ue^{j(\theta+4\pi/3)} + e^{j2\pi/3} Ue^{j(\theta+2\pi/3)})/3 = Ue^{j\theta} (1 + e^{j2\pi/3} + e^{j4\pi/3})/3 = 0$.

[SOURCE: IEC 448-11-28]

3.5.4.4

zero sequence component of the fundamental

for a three-phase system with phases L1, L2 and L3, the in-phase sinusoidal voltage or current component having the fundamental frequency and equal amplitude in each of the phases and which is defined by the following complex mathematical expression:

$$\underline{X}_0 = \frac{1}{3}(\underline{X}_{L1} + \underline{X}_{L2} + \underline{X}_{L3})$$

where

$\underline{X}_{L1}$, $\underline{X}_{L2}$ and $\underline{X}_{L3}$ are the complex expressions of the fundamental frequency phase quantities concerned, that is, current or voltage phasors

[SOURCE: IEC 448-11-29]

3.6 Protection

3.6.1

protection system

arrangement of one or more protection equipment, and other devices intended to perform one or more specified protection functions

Note 1 to entry: A protection system includes one or more protection equipment, instrument transformer(s), wiring, tripping circuit(s), auxiliary supply(s) and, where provided, communication system(s). Depending upon the principle(s) of the protection system, it may include one end or all ends of the protected section and, possibly, automatic reclosing equipment.

Note 2 to entry: The circuit-breaker(s) are excluded.

[SOURCE: IEC 448-11-04]

3.6.2

protection relay

measuring relay which detects faults or other abnormal conditions in a power system or of a power equipment

Note 1 to entry: A protection relay is a component part of a protection system.

Note 2 to entry: An interface protection relay is a protection relay acting on the interface switch.

[SOURCE: IEC 447-01-14]

3.6.3

circuit-breaker

mechanical switching device, capable of making, carrying and breaking currents under normal circuit conditions and also making, carrying for a specified duration and breaking currents under specified abnormal circuit conditions such as those of short circuit

[SOURCE: IEC 441-14-20]

3.6.4

interface protection system

protection system that acts on the interface switch

3.6.5

interface protection relay

combination of different protection relay functions which opens the interface switch of a generating unit and prevents its closure, whichever is appropriate in case of:

- a fault on the distribution network (with reference to POC voltage level);
- an islanding situation;
- the presence of voltage and frequency values outside the corresponding regulation values

3.6.6**basic protection**

protection against electric shock under fault-free conditions

[SOURCE: IEC 195-06-01]

3.6.7**basic insulation**

insulation of hazardous-live-parts which provides basic protection

Note 1 to entry: This concept does not apply to insulation used exclusively for functional purposes.

[SOURCE: IEC 195-06-06]

3.6.8**disconnection**

separation of the active parts of the main circuit of the generating unit or plant from the network with mechanical contacts providing at least the equivalent of basic insulation

Note 1 to entry: Passive components like filters, auxiliary power supply to the generating unit and sense circuits can remain connected.

Note 2 to entry: For the design of basic insulation all voltage sources should be considered.

3.6.9**switch**

device for changing the electric connections among its terminals

[SOURCE: IEC 151-12-22]

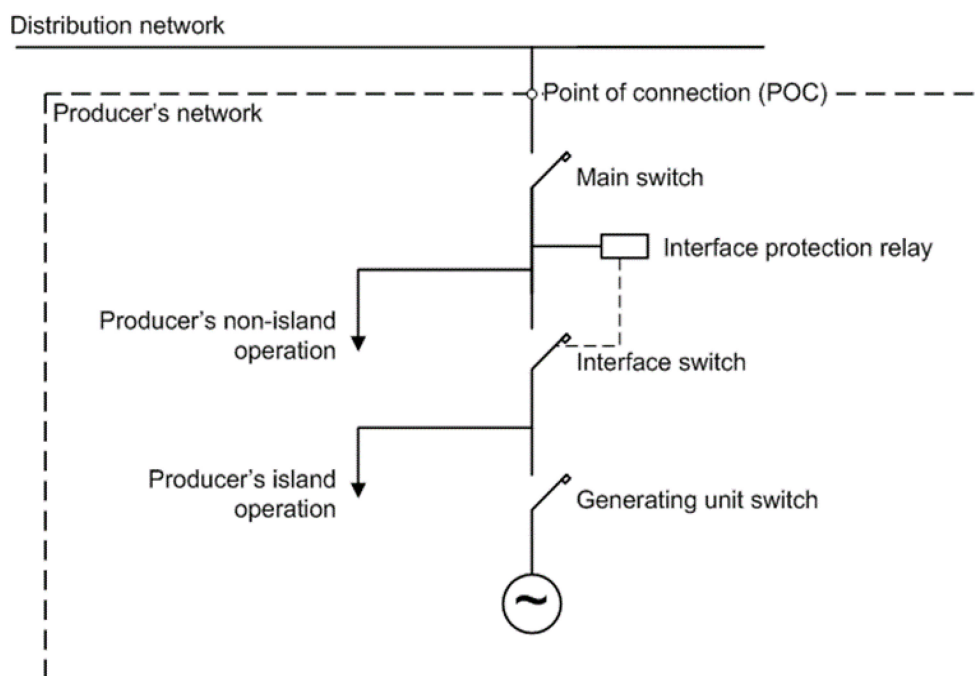


Figure 2 — Example of an generating plant connected to a distribution network (schematic view of switches)

3.6.9.1**main switch**

switch installed as close as possible to the point of connection, for protection against internal faults and disconnection of the whole plant from the distribution network

Note 1 to entry: See also Figure 2.

3.6.9.2

interface switch

switch (circuit breaker, switch or contactor) installed in the producer's network, for separating the part(s) of the producer's network containing at least one generating unit from the distribution network

Note 1 to entry: See also Figure 2.

Note 2 to entry: In some situations, the interface switch may be used to enable island operation of part of the producer's network, if technically feasible.

3.6.9.3

generating unit switch

switch installed electrically close to the terminals of each generating unit of the generating plant, for protection and disconnection of that generating unit

Note 1 to entry: See also Figure 2.

3.6.10

observation time

time during which all the voltage and the frequency values are observed to be within a specified range prior to a generating plant connection to the distribution network or start to generate electric power

3.6.11

Interface protection system timing

3.6.11.1

energizing quantity

input value by which the protection function is activated when it is applied under specified conditions

Note 1 to entry: See also Figure 3.

[SOURCE: IEC 442-05-58 modified]

3.6.11.2

start time

duration of the time interval between the instant when the energizing quantity of the measuring relay in reset condition is changed, under specified conditions, and the instant when the start signal asserts

Note 1 to entry: See also Figure 3.

[SOURCE: EN 60255-151, modified]

3.6.11.3

time delay setting

intentional delay that might be adjustable by the user

Note 1 to entry: See also Figure 3.

3.6.11.4

operate time

duration of the time interval between the instant when the energizing quantity of a measuring relay in reset condition is changed, under specified conditions, and the instant when the relay operates

Note 1 to entry: See also Figure 3.

Note 2 to entry: Operate time is start time plus time delay setting.

[SOURCE: IEC 447-05-05, modified]

3.6.11.5**disconnection time**

sum of operate time of the protection system and the opening time of the interface switch

Note 1 to entry: See also Figure 3 where the CB opening time indicates the opening time.

3.6.11.6**reset time**

duration of the time interval between the instant when the energizing quantity of a measuring relay in operate condition is changed, under specified conditions, and the instant when the relay resets

Note 1 to entry: See also Figure 3.

[SOURCE: IEC 447-05-06, modified]

3.6.11.7**disengaging time**

duration of the time interval between the instant a specified change is made in the value of the input energizing quantity which will cause the relay to disengage and instant it disengages

Note 1 to entry: See also Figure 3.

[SOURCE: IEC 447-05-10]

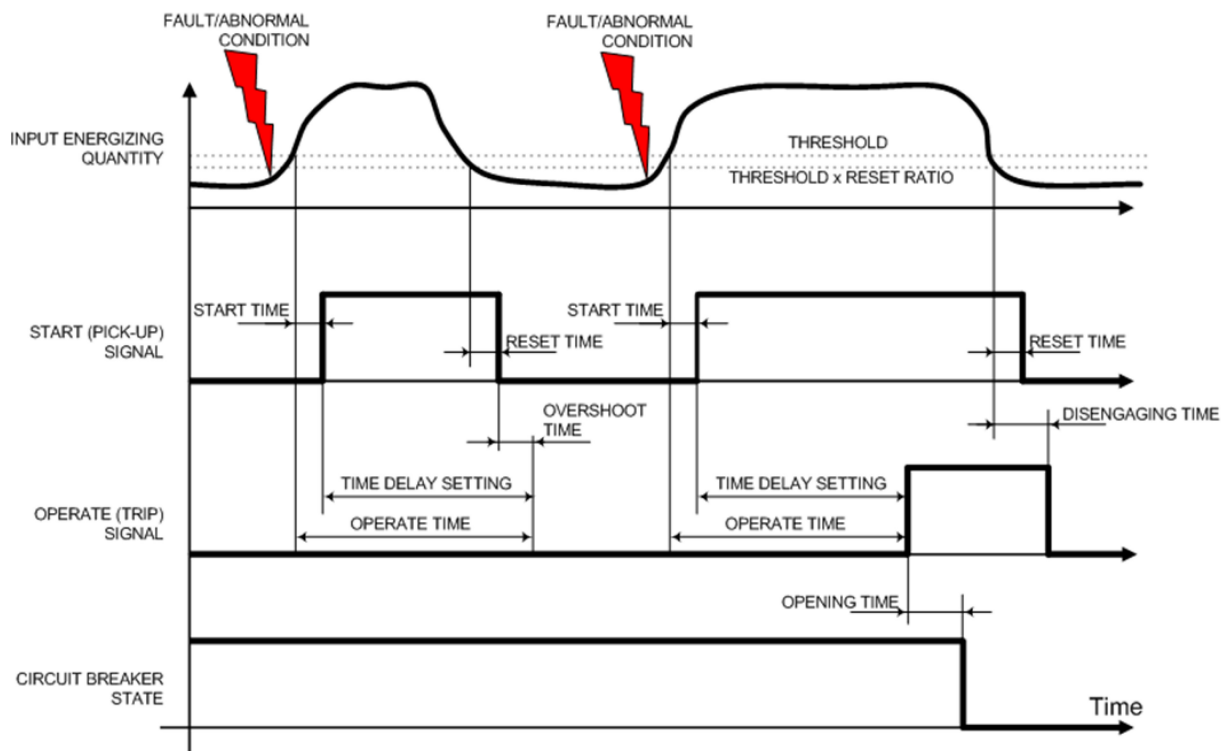


Figure 3 — Main times defining the interface protection performance

3.6.12**islanding**

situation where a section of the distribution network, containing generating plants, becomes physically disconnected from the rest of distribution network and one or more generating units maintain a supply of electrical energy to the isolated section of the distribution network