



SLOVENSKI STANDARD
SIST-TS CLC/TS 50549-2:2015
01-april-2015

Zahteve za priklop generatorjev za toke nad 16 A na fazo - 2. del: Priklop na srednjenapetostni distribucijski sistem

Requirements for the connection of generators above 16 A per phase - Part 2:
Connection to the MV distribution system

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Prescriptions relatives au raccordement de générateurs de plus de 16A par phase -
Partie 2: Connexion au réseau de distribution MT

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ICS:

29.160.20	Generatorji	Generators
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SPÉCIFICATION TECHNIQUE
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ICS 29.160.20

English Version

**Requirements for generating plants to be connected in parallel
with distribution networks - Part 2: Connection to a MV
distribution network**

Prescriptions relatives au raccordement de générateurs de plus de 16A par phase - Partie 2: Connexion au réseau de distribution MT

Anforderungen für den Anschluss von Stromerzeugungsanlagen über 16 A je Phase - Teil 2: Anschluss an das Mittelspannungsverteilungsnetz

This Technical Specification was approved by CENELEC on 2014-09-15.

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

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Foreword

This document (CLC/TS 50549-2:2015) has been prepared by CLC/TC 8X "System aspects of electrical energy supply".

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

This Technical Specification relates to both future European Network Codes and current technical market needs. Its purpose is to give detailed description of functions to be implemented in products.

This Technical Specification is also intended to serve as a technical reference for the definition of national requirements where European Network Codes requirements allow flexible implementation. The stated 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 Technical Specification with the evolution of the legal framework.

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1 Scope

The purpose of this Technical Specification is to provide technical guidance on the requirements for generating plants which can be operated in parallel with a distribution network.

For practical reasons, this Technical Specification refers to the distribution system operator in case settings have to be defined and/or provided, even when these settings are to be defined and/or provided by another actor according to national and European legal framework.

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

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

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

- converting any primary energy source into AC electricity;
- connected to a MV distribution network;
- intended to operate in parallel with this distribution network under normal network operating conditions.

NOTE 3 Generating plants connected to a LV distribution network fall into the scope of EN 50438 (up to 16 A) and CLC/TS 50549-1 (above 16 A).

Unless stated differently by the DSO, a generating plant with a maximum apparent power up to 100 kVA can, as alternative to the requirements of this Technical Specification, comply with CLC/TS 50549-1. A different threshold may be defined by the DSO.

This Technical Specification defines connection requirements.

This Technical Specification recognizes the existence of National Standards, Network Codes, and specific technical requirements of the DSOs. These should be complied with.

Excluded from the scope are:

- the selection and evaluation of the point of connection;
- power system impact assessment;
- connection assessment;
- island operation of generating plants, both intentional and unintentional, where no part of the distribution network is involved;
- active front ends of drives feeding energy back into the distribution network for short duration;
- requirements for the safety of personnel as they are already adequately covered by existing European Standards.

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.

EN 60044-2, *Instrument transformers — Part 2: Inductive voltage transformers (IEC 60044-2)*

EN 60044-7, *Instrument transformers — Part 7: Electronic voltage transformers (IEC 60044-7)*

EN 60255-127, *Measuring relays and protection equipment — Part 127: Functional requirements for over/under voltage protection (IEC 60255-127)*

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

EN 61869-3, *Instrument transformers — Part 3: Additional requirements for inductive voltage transformers (IEC 61869-3)*

IEC 60050, *International Electrotechnical Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050 and the following apply.

3.1

active factor

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

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: IEV 131-11-49, modified]

3.2

available active power

P_A

maximum AC active power available from the prime mover subject to the availability and magnitude of the primary energy source at the relevant time

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

3.3

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: IEV 195-06-06]

3.4

basic protection

protection against electric shock under fault-free conditions

[SOURCE: IEV 195-06-01]

3.5

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

3.6

converter connected generating technology

technology where a generating unit is connected to a distribution grid through a converter including doubly fed induction machine based technology (DFIG)

3.7**declared supply voltage** U_c supply voltage U_c agreed by the power system operator and the network user

Note 1 to entry: Generally declared supply voltage U_c is the nominal voltage U_n but it may be different according to the agreement between the power system operator and the network user.

[SOURCE: EN 50160]

3.8**design active power** P_D

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

3.9**directly coupled generating technology**

technology where a generating unit is connected to a distribution grid without any converter

Note 1 to entry: Soft starters are not considered as converter in this definition.

3.10**disconnection**

separation of the active parts of the main circuit of the generating plant or unit 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 lines can remain connected.

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

3.11**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 60034-11:2004 MOD]

3.12**distribution network**

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

3.13**distribution system operator****DSO**

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

Note 1 to entry: In some countries, the distribution network operator (DNO) fulfils the role of the DSO.

3.14**downstream**

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

3.15**droop**

the ratio of the per-unit change in frequency $(\Delta f)/f_n$ (where f_n is the nominal frequency) to the per-unit change in power $(\Delta P)/P_{ref}$ (where P_{ref} is the reference power at the instance when the frequency reaches a frequency threshold):

$$s = - (\Delta f/f_n) / (\Delta P/P_{ref})$$

[SOURCE: IEC 603-04-08]

3.16**voltage dead band**

amplitude of the voltage step ΔU within which a specific behaviour is not required

3.17**fundamental components of a three-phase system****3.17.1****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, MOD]

3.17.2**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, and \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: 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].

3.17.3**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, and \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 $U_{L3} = Ue^{j(\theta+2\pi/3)}$ 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]

3.17.4

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]

3.18

generating plant

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

Note 1 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.

3.19

generating plant controller

functional controller which ensures the fulfillment of performance requirements at the point of connection (POC) towards a generating plant, usually by utilizing external measurement signals from the POC to generate reference to a sub structure, e.g. the generating units

3.20

generating plant class threshold

power threshold to be defined by the DSO to discriminate between class I and class II generating plants

Note 1 to entry: This threshold is intended to allow for an easier connection process for smaller plants. Class I generating plants may only be evaluated on generating unit level.

Note 2 to entry: This threshold can be defined generally or case by case for specific generating plants.

3.21

generating plant of class I

generating plant with maximum power equal or below the generating plant class threshold

3.22

generating plant of class II

generating plant with maximum power above the generating plant class threshold

3.23

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: For example, a combined cycle gas turbine (CCGT) or an organic rankine cycle (ORC) after a combustion engine is considered as a single generating unit.

Note 2 to entry: If a generating unit is a combination of technologies leading to different requirements, this has to be settled case by case.

Note 3 to entry: A storage device operating in electricity generation mode and AC connected to the distribution network is considered to be a generating unit.

3.24

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

3.25

interface protection system

protection system that acts on the interface switch

3.26 Interface protection system timing

3.26.1

energizing quantity

energizing quantity by which the protection function is activated when it is applied under specified conditions

Note 1 to entry: See also Figure 1.

[SOURCE: IEV 442-05-58 modified]

3.26.2

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 1.

[SOURCE: EN 60255-151, modified]

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3.26.3

time delay setting

intentional delay that might be adjustable by the user

Note 1 to entry: See also Figure 1.

3.26.4

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 1.

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

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

3.26.5

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 1 where the CB opening time indicates the opening time.

3.26.6

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 1.

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

3.26.7 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 1 .

[SOURCE: IEC 447-05-10]

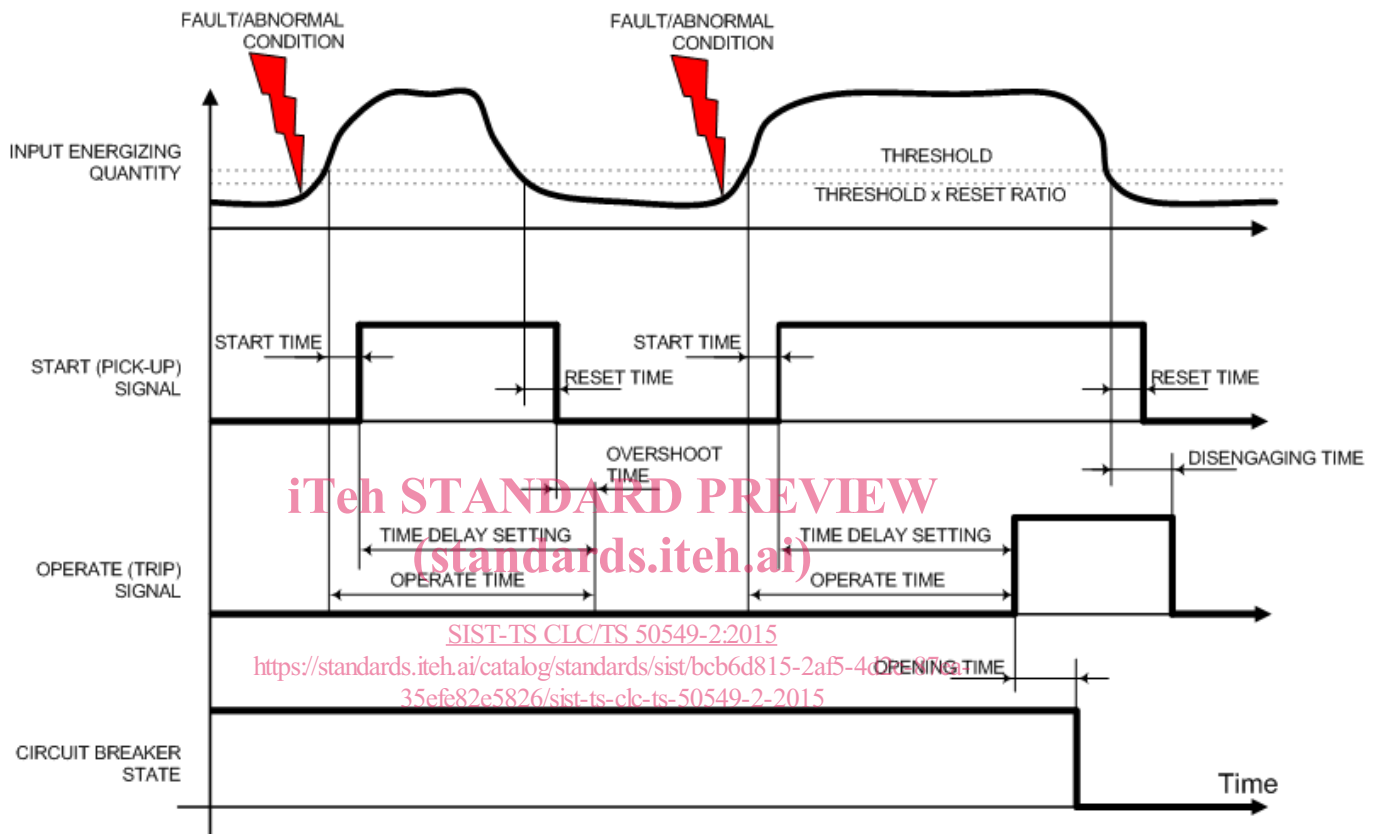


Figure 1 — Main times defining the interface protection performance

3.27 islanding

situation where a section of the distribution network, containing generation, 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

3.28 maximum active power

P_{max}

maximum AC active power output that the generating unit or the sum of all the generating units in a generating plant is designed to achieve under normal operating conditions

Note 1 to entry: This maximum power is defined by a measurement with 10 min averaging.

3.29 maximum apparent power

S_{max}

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

Note 1 to entry: This maximum power is defined by a measurement with 10 min averaging.

3.30**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.

3.31**momentary active power** **P_M**

actual AC active power output at a certain instant

3.32**nominal frequency** **f_n**

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: IEV 151-16-09, modified]

3.33**nominal voltage** **U_n**

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

3.34**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.

3.35**operation in parallel with the distribution network**

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

3.36**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 Technical Specification, the electric power system is the distribution network.

[SOURCE: IEV 617-04-01 MOD]

3.37**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: IEV 131-11-46]

3.38**power system stability**

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

[SOURCE: IEV 603-03-01]

3.39**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.

3.40**producer**

party who already has or is planning to connect an electricity generating plant to a distribution network

3.41**producer's network**

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

3.42**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]

3.43**protection system**

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

Note 1 to entry: A protection system includes one or more protection equipments, 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 448-11-03]

3.44**rated current**

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

[SOURCE: IEC 415-04-03, modified]

3.45**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 or the declared voltage of the distribution network.

[SOURCE: EN 50160, 3.18, modified]

3.46**single fault tolerance**

built-in capability of a system to provide continued correct execution of its function in the presence of a single fault

[SOURCE: IEC 394-33-13, modified]

3.47 step response behaviour

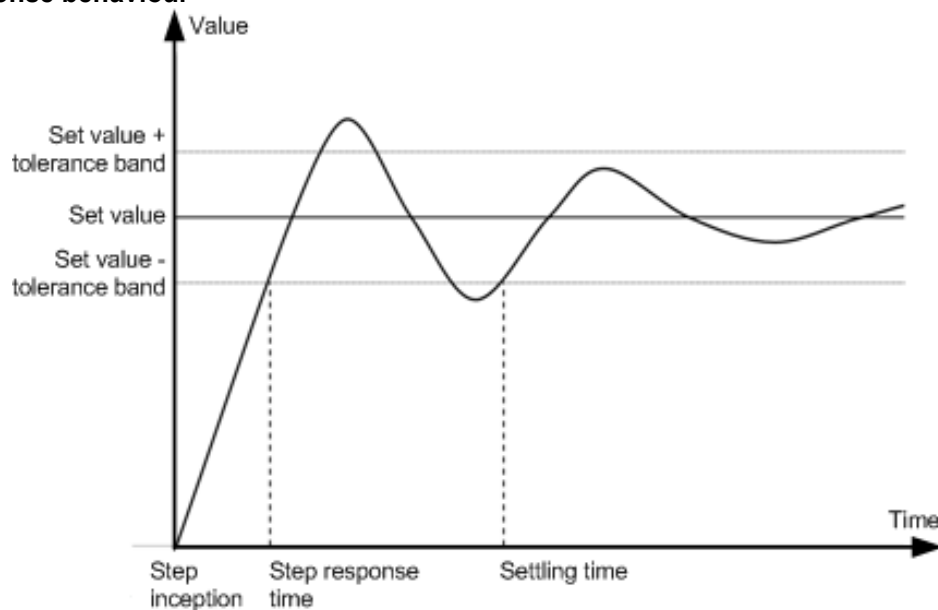


Figure 2 — Timing, step response time and settling time

3.47.1

step response time

time from a sudden change of a control quantity until the instant the corresponding change of an output quantity has reached the tolerance band of the set value for the first time

Note 1 to entry: See also Figure 2.

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3.47.2

settling time

time from a sudden change of a control quantity until the instant, from where on the corresponding change of an output quantity remains within the tolerance band of the set value

Note 1 to entry: See also Figure 2.

3.48 switch

device for changing the electric connections among its terminals

[SOURCE: IEC 151-12-22]