IEC TS 63384-1

Edition 1.0 2023-03

TECHNICAL SPECIFICATION

Power system stability control –
Part 1: Guideline for framework design of power system stability control

IEC TS 63384-1:2023-03(en)

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INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 33.200 ISBN 978-2-8322-6629-8

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FOREWORD

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IEC TS 63384-1 has been prepared by subcommittee 8C, Network management in interconnected electric power systems, of IEC technical committee 8: System aspects of electrical energy supply. It is a Technical Specification.

The text of this Technical Specification is based on the following documents:

Draft	Report on voting
8C/47/DTS	8C/61/RVDTS

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

The language used for the development of this Technical Specification is English.

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

A list of all parts in the IEC 63384 series, published under the general title *Power system stability control*, can be found on the IEC website.

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

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POWER SYSTEM STABILITY CONTROL –

Part 1: Guideline for framework design of power system stability control

1 Scope

This part of IEC 63384 provides guidance for power system stability control framework design. It covers the uniform use of terms and definitions, general objectives and principles for power system stability control, the classification of power system stability control, and the framework combining several types of stability controls in a coordinated and cost-effective (risk-based) manner.

In accordance with this guideline, the framework is designed to cope with disturbances of different probabilities of occurrence and impact on power system security and stability. Effective control approaches are designed to prevent or minimize the scope of future blackouts.

2 Normative references

There are no normative references in this document

3 Terms and definitions

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

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

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

3.1
power system stability control
< electric power system> control in a power system which prevents system insecurity, instability and collapse caused by disturbances and minimizes further loss of power supply

Note 1 to entry: Remedial Action Scheme, System Integrity Protection Schemes (SIPS), Special Protection System and System Protection Scheme are typical examples of stability control implementation.

3.2
power system stability control framework
<electric power system> framework designed to describe the fundamental principles of power system stability control, composed of a contingency list, the objective of control, the types of stability control, methods of control decision planning and control activation

Note 1 to entry: Usually, several types of stability control are combined to prevent system insecurity, instability, collapse, and blackouts upon occurrence of contingencies, so that the adaptability of each type of stability control can be enhanced and the coordination of different types of stability controls can be facilitated.

3.3
normal state
<electric power system> state wherein all system variables are within the normal range and no equipment is overloaded, and power system operates in a secure manner and is able to withstand predefined contingencies without violating any of the constraints

3.4
alert state
<electric power system> state wherein all system variables are within the normal range and no equipment is overloaded, and power system is unable to enter into its normal state if predefined contingencies occur without control actions

3.5
emergency state
<electric power system> stable state in which some system components are stressed beyond their ratings, or some bus voltages or system frequency are outside tolerances

[SOURCE: IEC 60050-692:2017, 692-02-06]

3.6
blackout state
<electric power system> state where the transmission system contains areas of almost no voltage as the consequence of the tripping of generation units, transmission equipment, or both

3.7
restorative state
<electric power system> state in which actions are performed to re-establish a normal state after the blackout state or the emergency state

3.8
contingency
<electric power system> event that usually involves the loss of one or more components, which affects the electric power system at least momentarily

3.9
contingency list
<electric power system> list of contingencies to be considered in order to test the compliance with the operational security limits

3.10
predefined contingency
<electric power system> contingency to be predefined in order to test the compliance with the operational security limits

3.11
normal type of contingency
<electric power system> contingency that incurs low risk to the secure and stable operation of the power system

3.12
exceptional type of contingency
<electric power system> contingency that incurs medium risk to the secure and stable operation of the power system

3.13
extreme type of contingency
<electric power system> contingency that incurs high risk to the secure and stable operation of the power system

3.14
risk
<electric power system> combination of the probability of occurrence of harm and the severity of that harm

Note 1 to entry: Risk can consider the probability of contingency occurrence and its impact on power system security and stability. Risk may be assessed by considering the probability of implementing stability control and its cost due to the contingency (if the impact of the contingency cannot be quantified).

[SOURCE: ISO/IEC Guide 51:2014, 3.9, modified – The Note to entry is different]

3.15
compliance
<electric power system stability control> conformity level of stability control schemes in respect of the requirements of national energy/electricity law and regulations

3.16
dependability
<electric power system stability control> ability to perform timely stability control actions and to prevent unintended stability control action

3.17
accuracy
<electric power system stability control> ability to implement the stability control action precisely at the right time with the right control amount and the correct control command

3.18
adaptability
<electric power system stability control> ability to carry out appropriate control actions considering the operating condition, the contingencies, the available control resources and the control objectives

Note 1 to entry: The control decision set should be adjusted to the current operating condition and the contingencies occurred. The available control resources should also be correctly identified.

3.19
coordination
<electric power system stability control> ability to fully explore characteristics of each type of stability control scheme for control decision planning

Note 1 to entry: Multiple automatic control schemes implemented in a region should be coordinated to avoid undesirable control actions.

3.20
rapidness
<electric power system stability control> ability to implement control actions as fast as needed, so the power system can satisfactorily recover from the ongoing disturbance

3.21
economy
<electric power system stability control> cost-effectiveness of stability control, meaning a balance between technical performance and economic cost

3.22
preventive control
<electric power system stability control> type of stability control, which is implemented before the occurrence of disturbances in order to prevent a power system from exhibiting a dynamically insecure behaviour if one of the predefined contingency scenarios would actually occur

Note 1 to entry: Preventive control is normally invoked by system operators, while automatic activation is permitted as well.

Note 2 to entry: Typical preventive control actions include generation re-dispatching, system reconfiguration, tap changer setpoint adjustment, high voltage direct current (HVDC) power change, shunt reactor/capacitor tripping or closing, etc.

3.23
event-based control
<electric power system stability control> type of stability control, which is immediately and automatically triggered by one of the predefined contingencies in order to prevent system instability or limit violation of key operating parameters

Note 1 to entry: Typical event-based control actions include generation tripping, load shedding, HVDC fast power running-up or running-back, shunt reactor/capacitor tripping or closing, etc.

3.24
response-based control
<electric power system stability control> type of stability control which is automatically triggered after violation of key operating parameter limits

Note 1 to entry: Triggering is achieved by comparing real-time measurements with predetermined conditions of power system responses (the disturbance-related changes in critical electrical and/or physical variables) to prevent system instability and system collapse.

Note 2 to entry: Typical response-based controls include out-of-step system separation, over-frequency generator tripping, over-voltage generator tripping, under-frequency load shedding, under-voltage load shedding, etc.

3.25
restorative control
<electric power system stability control> control actions performed to re-establish a normal state after the blackout state or the emergency state

Note 1 to entry: Restorative control takes actions to reconnect the facilities and restore system load as fast as possible in a safe manner after widespread loss of load and possibly in a scenario having islanded systems. Its objective is to minimize further loss of power supply.

Note 2 to entry: Typical restorative control actions include black start, grid reconnection of tripped equipment, start-up of reserved equipment, generation and/or transmission adequacy restoration, etc.

3.26
control decision planning
<electric power system stability control> process of identifying stability control decisions in advance, based on the analysis of steady state conditions and time-domain simulations for a set of predefined contingency scenarios

Note 1 to entry: Generally, for disturbances, control decisions shall be specified before implementing any specific control action.

Note 2 to entry: Control decisions are the control quantity, action sequences and threshold and/or setting values, etc. indexed by system operating conditions, predefined contingency scenarios or conditions (critical electrical variables, predetermined conditions of power system responses) for triggering a control action.

4 Classification of system states

4.1 General

The system operating conditions can be classified into system states, i.e., normal state, alert state, emergency state, blackout state, and restorative state.

4.2 The characteristics of normal state

The power system is in normal state when all the following aspects meet the operational security requirements:

a) voltage and power flows;

b) the steady state system frequency deviation;

c) active and reactive power reserves;

d) steady-state stability reserve;

e) the operation of the control area is and will remain within the operational security limits after the activation of automatic stability control actions following the occurrence of a contingency from the predefined contingency list.

4.3 The characteristics of alert state

The power system is in alert state if one of the following aspects does not meet the operational security requirements:

a) voltage and power flows;

b) the steady state system frequency deviation;

c) at least one contingency from the predefined contingency list leads to a violation of the requirements of operational security, even after the activation of automatic stability control actions.

4.4 The characteristics of emergency state

The power system is in emergency state if at least one of the following conditions occurs:

a) there is at least one violation of the operational security requirements for the voltage and the power flows of the network;

b) one of the individual variables that demonstrates the overall system state violates admissible operational limits;

c) system instability.

4.5 The characteristics of blackout state

The power system is in blackout state if any area of the transmission system is characterized by almost total absence of voltage as the consequence of the tripping of generation units, transmission equipment, or both.

4.6 Restorative state

To recover from emergency or blackout state, the power system enters into restorative state by activating measures of restoration plan.