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INTERNATIONAL STANDARD

colour inside

Microgrids –
Part 3-1: Technical requirements - Protection and dynamic control

IEC TS 62898-3-1:2020-09/AMD1:2023-11 CSV(en)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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FOREWORD

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This consolidated version of the official IEC Standard and its amendment has been prepared for user convenience.

IEC TS 62898-3-1 edition 1.1 contains the first edition (2020-09) [documents 8B/53/DTS and 8B/59/RVDTS] and its amendment 1 (2023-11) [documents 8B/174/DTS and 8B/199/RVDTS].

In this Redline version, a vertical line in the margin shows where the technical content is modified by amendment 1. Additions are in green text, deletions are in strikethrough red text. A separate Final version with all changes accepted is available in this publication.

The main task of IEC technical committees is to prepare International Standards. In exceptional circumstances, a technical committee may propose the publication of a Technical Specification when

- the required support cannot be obtained for the publication of an International Standard, despite repeated efforts, or
- the subject is still under technical development or where, for any other reason, there is the future but no immediate possibility of an agreement on an International Standard.

Technical Specifications are subject to review within three years of publication to decide whether they can be transformed into International Standards.

IEC TS 62898-3-1, which is a Technical Specification, has been prepared by IEC subcommittee 8B: Decentralized Electrical Energy Systems of IEC technical committee 8: System aspects of electrical energy supply.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts in the IEC 62898 series, published under the general title *Microgrids*, can be found on the IEC website.

The committee has decided that the contents of this document and its amendment 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

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

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INTRODUCTION

Microgrids can serve different purposes depending on the primary objectives of their applications. They are usually seen as a means to manage reliability of supply in a grid contingency and to facilitate local optimization of energy supply by controlling distributed energy resources (DER). Microgrids also present a way to provide electricity supply in remote areas, to use renewable energy as a systematic approach for rural electrification and to increase resiliency and security of supply to end users.

Deployment of DER can cause a microgrid or distribution system of a grid to face several challenges, including fault protection and dynamic control issues. There are, however, some issues commonly faced in the protection and control of microgrids which are less prevalent in large grids. These issues include: bidirectional flow of power resulting in voltage excursions outside acceptable limits, fault current being supplied from multiple sources, loss of synchronism between multiple sources when a fault occurs, potentially limited fault current magnitude, lower inertia or lower primary time constant, regular changes in operational configuration due to economic optimization, and intermittency of source-dependent renewable distributed generators. These issues worsen when the microgrid contains several converter-based generators (CBGs) and operates in island mode. As such, conventional protection and control strategies may not be suitable or sufficient for microgrids. Protection systems different from the conventional ones may be required. In some instances, protection systems may need to be adjusted dynamically based on the operating state of the microgrid.

Conventional power systems have predominantly consisted of power sources, such as fossil fuel-fired thermal power plants, hydro power plants and nuclear power plants, which are relatively stable and easy to control. On the other hand, microgrids often contain many different types of sources, many of which are intermittent. Hence, protection and dynamic control in microgrids need to be more sophisticated than in conventional power systems. However, the main grid contributes to the fault currents in the grid-connected mode of operation and hence the fault currents are large enough to actuate conventional protection devices. Though it is possible to employ conventional protection principles and existing standards for the protection of microgrids operating in grid-connected mode, the existing protection settings should be systematically assessed as the existence of DER may compromise the coordination of the protection system.

Due to the specific characteristics of microgrids and their frequent use of converter-based generators, disturbances in microgrids require special consideration. The disturbance problems in microgrids can be addressed by dynamic control. Dynamic control can be classified as transient disturbance control and dynamic disturbance control. Transient disturbance control damps disturbances in microgrids caused by forced or unintended sudden and severe voltage and current changes due to switching of large sources or loads, mode transfer or fault clearance, and characterized by large magnitude and phase change and with a time duration of milliseconds. Dynamic disturbance control regulates disturbances in microgrids caused by forced or unintended voltage and current changes due to generator and load variation, and characterized by magnitude and phase changes beyond the normal operating limits, and continuing for milliseconds to seconds.

The initial characteristics of faults are very similar to initial characteristics of transient and dynamic disturbances. Distinguishing the two types of incidents from each other is critical for the proper operation of microgrids. Thus, protection and dynamic control of microgrids are closely related and need to be coordinated with each other.

This part of IEC 62898 specifies requirements to address the above-mentioned protection and dynamic control issues in microgrids.

IEC TS 62898 (all parts) intends to provide general guidelines and technical requirements for microgrids.

a) IEC TS 62898-1 mainly covers the following issues:
   - determination of microgrid purposes and application;
   - preliminary study necessary for microgrid planning, including resource analysis, load forecast, DER planning and power system planning;
   - principles of microgrid technical requirements that should be specified during planning stage;
   - microgrid evaluation to select an optimal microgrid planning scheme.
b) IEC TS 62898-2 mainly covers the following issues:
   - operation requirements and control targets of microgrids under different operation modes;
   - basic control strategies and methods under different operation modes;
   - requirements of energy storage, monitoring and communication under different operation modes;
   - power quality.
c) IEC TS 62898-3-1 mainly covers the following issues:
   - requirements for microgrid protection;
   - protection systems for microgrids;
   - dynamic control for transient and dynamic disturbances in microgrids;

Microgrids can be stand-alone or a sub-system of an interconnected grid. The technical requirements in this Technical Specification are intended to be consistent with:

1) IEC 60364-7 (all parts and amendments related to low-voltage electrical installations);
2) IEC TS 62786, requirements for connection of generators intended to be operated in parallel with the grid;
3) IEC TS 62257 (all parts) with respect to rural electrification;
4) IEC TS 62749 with respect to power quality;
5) IEC TS 62898-1;
6) IEC TS 62898-2;
7) IEC TS 63268;

MICROGRIDS –

Part 3-1: Technical requirements – Protection and dynamic control

1 Scope

The purpose of this part of IEC 62898 is to provide guidelines for the specification of fault protection and dynamic control in microgrids. Protection and dynamic control in a microgrid are intended to ensure safe and stable operation of the microgrid under fault and disturbance conditions.

This document applies to AC microgrids comprising single or three-phase networks or both. It includes both isolated microgrids and non-isolated microgrids with a single point of connection (POC) to the upstream distribution network. It does not apply to microgrids with two or more points of connection to the upstream distribution network, although such systems can follow the guidelines given in this document. This document applies to microgrids operating at LV or MV or both. DC and hybrid AC/DC microgrids are excluded from the scope, due to the particular characteristics of DC systems (extremely large fault currents and the absence of naturally occurring current zero crossings).

This document defines the principles of protection and dynamic control for microgrids, general technical requirements, and specific technical requirements of fault protection and dynamic control. It addresses new challenges in microgrid protection requirements, transient disturbance control and dynamic disturbance control requirements for microgrids. It focuses on the differences between conventional power system protection and new possible solutions for microgrid protection functions.

Depending on specific situations, additional or stricter requirements can be defined by the microgrid operator in coordination with the distribution system operator (DSO).

This document does not cover protection and dynamic control of active distribution systems. This document does not cover product requirements for measuring relays and protection equipment.

This document does not cover safety aspects in low voltage electrical installations, which are covered by IEC 60364 (all parts and amendments related to low-voltage electrical installations). Requirements relating to low voltage microgrids can be found in IEC 60364-8-2.

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.

IEC 60364 (all parts), *Low voltage electrical installations*

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

3.1
code
<electric power system> collection of rules concerning rights and duties of the parties involved in a certain part of the electric power system

EXAMPLE Grid code, distribution code.

[SOURCE: IEC 60050-617:2009, 617-03-03]

3.2
(electronic) (power) converter
(electronic) (power) convertor
operative unit for electronic power conversion, comprising one or more electronic valve devices, transformers and filters if necessary and auxiliaries if any

Note 1 to entry: In English, the two spellings "convertor" and "converter" are in use, and both are correct. In this document, the spelling "converter" is used in order to avoid duplications.

[SOURCE: IEC 60050-551:1998, 551-12-01, modified – The figure has been deleted.]

3.3
converter-based generator
CBG
generator of AC power that is naturally a DC source, or an AC source whose frequency is different from the power frequency, and is connected to the electric power system through a power converter

3.3.1
grid-forming CBG
generator which is connected to the network through a converter that can be controlled as a voltage source capable of controlling voltage and frequency of the network

Note 1 to entry: There are also stiff grid-forming CBGs which are a special type of grid-forming CBGs delivering power at constant frequency and voltage.

3.3.2
grid-supporting CBG
generator which is connected to the network through a converter with a power source capable of actively assisting the regulation of voltage and frequency of the network

3.3.3
grid-following CBG
generator which is connected to the network through a converter with a power source that does not have the capability to actively assist the regulation of voltage and frequency of the network

3.4
distributed energy resources
DER
generators (with their auxiliaries, protection and connection equipment), including loads having a generating mode (such as electrical energy storage systems), connected to a low-voltage or a medium-voltage network

[SOURCE: IEC 60050-617:2017, 617-04-20]

3.4.1
renewable energy sources
RES
distributed energy resources whose primary energy source is constantly replenished and will not become depleted

Note 1 to entry: Examples of renewable energy are: wind, solar, geothermal, hydropower.

Note 2 to entry: Fossil fuels are non-renewable.

3.5
distributed generation
embedded generation
dispersed generation
DG
generation of electric energy by multiple sources which are connected to the power distribution system

[SOURCE: IEC 60050-617:2009, 617-04-09, modified – "distributed generation" has been listed as a first preferred term and the abbreviated term "DG" has been added.]

3.6
distribution system operator
distribution network operator
distributor
DSO
party operating a distribution system

[SOURCE: IEC 60050-617:2009, 617-02-10, modified – The abbreviated term "DSO" has been added.]

3.7
dynamic disturbance
<microgrid> series of voltage and current changes in a microgrid caused by output of renewable energy sources reaching a sufficiently high proportion, non-linear loads, intentional islanding, intermittency and output power fluctuation of renewable energy resources and grid side faults, which continue for a period of 50 ms to 2 s

3.8
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 electrical energy storage.

Note 1 to entry: The term “electrical energy storage” may also be used to indicate the activity that an apparatus, described in the definition, carries out when performing its own functionality.

Note 2 to entry: The term “electrical energy storage” should not be used to designate a grid-connected installation, "electrical energy storage system" is the appropriate term.

[SOURCE: IEC 62933-1:2018, 3.1]

3.8.1
energy intensive application
EES system application generally not very demanding in terms of step response performances but with frequent and long charge and discharge phases at variable discharge powers

Note 1 to entry: Reactive power exchange with the electric power system is frequently present together with active power exchange.