IEC TS 62898-3-1

Edition 1.0 2020-09

TECHNICAL SPECIFICATION

This document is a preview generated by EVS

colour inside

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



IEC TS 62898-3-1:2020-09(en)

THIS PUBLICATION IS COPYRIGHT PROTECTED
Copyright © 2020 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester. If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

IEC Central Office
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

About the IEC
The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications
The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigendum or an amendment might have been published.

IEC publications search - webstore.iec.ch/advsearchform
The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee,…). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished
Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and once a month by email.

IEC Customer Service Centre - webstore.iec.ch/csc
If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: sales@iec.ch.

Electropedia - www.electropedia.org
The world's leading online dictionary on electrotechnology, containing more than 22 000 terminological entries in English and French, with equivalent terms in 16 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

IEC Glossary - std.iec.ch/glossary
67 000 electrotechnical terminology entries in English and French extracted from the Terms and Definitions clause of IEC publications issued since 2002. Some entries have been collected from earlier publications of IEC TC 37, 77, 86 and CISPR.

This document is a preview generated by EVS

IEC TS 62898-3-1

Edition 1.0 2020-09

TECHNICAL SPECIFICATION

This document is a preview generated by EVS

colour inside

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

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 29.240.01

ISBN 978-2-8322-8764-4

Warning! Make sure that you obtained this publication from an authorized distributor.

® Registered trademark of the International Electrotechnical Commission

CONTENTS

FOREWORD 4
INTRODUCTION 6
1 Scope 8
2 Normative references 8
3 Terms and definitions 8
4 Microgrid protection requirements 15
4.1 General 15
4.2 Main requirements specific to microgrids 16
4.2.1 General 16
4.2.2 Phase fault protection 16
4.2.3 Earth fault protection 17
4.3 General protection requirements 17
4.3.1 General 17
4.3.2 Dependability of protection 17
4.3.3 Security of protection 18
4.3.4 Availability and selectivity of protection 18
4.3.5 Operating time (speed) of protection 19
4.4 Particular requirements for non-isolated microgrids 19
4.5 Particular requirements for isolated microgrids 20
5 Protection systems for microgrids 20
5.1 General 20
5.2 Short-circuit protection 21
5.2.1 Overcurrent protection 21
5.2.2 Directional overcurrent protection 23
5.2.3 Distance protection 24
5.2.4 Directional power protection 24
5.2.5 Differential protection 24
5.3 System protection 25
5.3.1 Under/over voltage protection 25
5.3.2 Frequency protection 26
5.4 Centralized protection systems 26
6 Dynamic stability and control 27
6.1 General 27
6.2 Dynamic stability in microgrids 27
6.2.1 General 27
6.2.2 Disturbances in microgrids 28
6.2.3 Voltage and frequency stability 28
6.3 Dynamic control in microgrids 29
6.3.1 General requirements 29
6.3.2 Dynamic control functions 29
6.3.3 Control elements in microgrids 30
6.3.4 Control systems of microgrids 31
6.3.5 Control of microgrids during grid-connected mode 35
6.3.6 Control of microgrids during island mode 35
Annex A (informative) Use cases for dynamic control of microgrids 36

This document is a preview generated by EVS

Bibliography 40

Figure 1 – Ratio between maximum load current/minimum short-circuit current in the microgrid 22
Figure 2 – Control elements in microgrids 30
Figure 3 – Hierarchical control levels of a microgrid 32
Figure 4 – Centralized multilevel control of microgrids 32
Figure A.1 – Simple microgrid platform for testing transient disturbance during motor start-up 36
Figure A.2 – Transient control strategy based on reactive current compensation control 36
Figure A.3 – Voltage profile during field testing of transient disturbance with and without transient control device 37
Figure A.4 – Current profile during field testing of transient disturbance with and without transient control device 37
Figure A.5 – Microgrid platform with high proportion of RES for testing dynamic disturbance control 38
Figure A.6 – Dynamic control strategy 38
Figure A.7 – Voltage profile of field testing with and without dynamic control device 39

This document is a preview generated by EVS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

_____

MICROGRIDS –

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

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
6) All users should ensure that they have the latest edition of this publication.
7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

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.

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

This document is a preview generated by EVS

Draft TS	Report on voting
8B/53/DTS	8B/59/RVDTS

Full information on the voting for the approval of this Technical Specification can be found in the report on voting indicated in the above table.

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 will remain unchanged until the stability date indicated on the IEC website under "http://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.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

This document is a preview generated by EVS

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.

Withdrawn
This document is a preview generated by EVS

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;

This document is a preview generated by EVS

MICROGRIDS –

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

This document is a preview generated by EVS

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.