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Microgrids

Part 3-4: Technical requirements — Microgrid monitoring and control systems

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MICROGRIDS

Part 3-4: Technical requirements – Microgrid monitoring and control systems

FOREWORD

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IEC TS 62898-3-4 has been prepared by subcommittee 8B: Decentralized electrical energy systems, of IEC technical committee TC 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
8B/154/DTS	8B/178/RVDTS

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

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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 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 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- withdrawn,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 means to manage reliability of supply and local optimization of energy supply by controlling distributed energy resources (DER). Microgrids also present a way to provide electricity supply in remote areas and to use clean and renewable energy as a systemic approach for rural electrification.

At present, there are many types of microgrid, often composed of distributed generation, battery energy storage, load, and other equipment. To achieve the effective integration and cooperative operation of the above equipment, a set of computer systems is often required, which is normally named as microgrid monitoring and control system. With the popularization of microgrids, the industry urgently needs a standard to specify the system architecture, component composition and functional requirements of microgrid monitoring and control system.

There are also various types of microgrid monitoring and control systems. For large scale (installed power > 100 kW) microgrid, its monitoring system and control system is more complex, usually using independent servers, workstations, remote terminal units, and others. Its communication protocol and data model can be based on the IEC 61850 series, and the system consists of a master station level and a local equipment level. For small-scale microgrids below 100 kW level, such as household microgrids with photovoltaic power generation and battery storage, it is relatively expensive to configure a complex microgrid monitoring and control system. At this time, the microgrid will generally adopt lightweight and cheap technical solutions, and the microgrid monitoring, control and energy management function will often be combined into a single device. Sometimes, for the small microgrid in remote mountainous areas, microgrid monitoring and control system based on the Internet of Things and cloud computing architecture is often used to realize the local autonomy and remote monitoring of the micro grid.

IEC TS 62898 series is intended to provide general guidelines and technical requirements for microgrid projects.

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.

IEC TS 62898-2 mainly covers the following issues:

- operation requirements and control targets of microgrids under various operation modes,
- the basic control strategies and methods under various operation modes,
- the requirements of electrical energy storage (EES), relay protection, monitoring and communication under various operation modes,
- power quality.

IEC TS 62898-3-XX subseries technical specifications deal with the technical requirements of microgrids.

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.

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IEC TS 62898-3-2[1] covers the energy management system of microgrids.

IEC TS 62898-3-3 covers the self-regulation of dispatchable loads of microgrids.

This document covers microgrid monitoring and control systems (MMCS). It aims to provide requirements to address state monitoring and operation control problems in microgrids.

[1] Under preparation.

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MICROGRIDS

Part 3-4: Technical requirements – Microgrid monitoring and control systems

1 Scope

The purpose of this part of IEC 62898 is to provide technical requirements for the monitoring and control of microgrids. This document applies to non-isolated or isolated microgrids integrated with distributed energy resources. This document describes the specific recommendations for low-voltage (LV) and medium-voltage (MV) microgrids.

This document focuses on standardization of the architecture, functions, and operation of microgrid monitoring and control systems (MMCS). It teases out the general functions of MMCS and provides technical requirements for MMCS. This document includes the following aspects of MMCS:

- system architecture,
- information exchange with other devices/functions in microgrid,
- performance requirement,
- main function descriptions.

The system architecture for MMCS:

- For a large scale (installed power > 100 kW) microgrid, microgrid energy management system (MEMS) and MMCS are normally separated. MMCS normally contains data servers, application servers, workstations, routers, information safety devices, SCADA, communication system, distributed generation controller, microgrid central controller, load controller, grid connection interface device and other ancillary equipment.
- For a small user-side microgrid (normally less than 100 kW), MEMS and MMCS are normally merged into one embedded device with system on chip, which is named as microgrid controller.

Main functions of MMCS:

- Data acquisition and processing, including collecting real-time data from the distributed generation, load, switches, transformers and reactive power compensation devices, and calculation and analysis of the acquired data.
- Database management, including maintaining, synchronizing, backing up, restoring the acquired data, and providing the data interface with other internal and external applications.
- Human-machine interface, including the real-time monitor screen and interface which is capable of remote control, mode switching, manual data entry, etc.
- Anti-maloperation locking and alarm, to lock the maloperation based on the predefined rule and logic.
- Time synchronization, including receiving the time synchronization signal from Global Navigation Satellite System (GNSS) or network time protocol (NTP) and synchronizing the time of each device within the microgrid.
- Local power quality evaluation and control the ability to collect information of out-of-limit voltage, power factor, harmonic, etc. and carry out control to improve power quality accordingly.
- Frequency/voltage regulation during steady state operation of an isolated microgrid to provide voltage and frequency inside an accepted operation range.

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- Sequence of operations, or steady transition from power-off to start-up and from start-up to power-off.
- Switch control of devices within microgrids, including turning on and off loads, generation units, transformers, reactive power compensation devices, etc.
- Islanding detection, including real-time detection on power outage of the upstream distribution system.
- Operation mode transition, including transition from grid-connected mode to island mode and transition from island mode to grid-connected mode.
- Active and reactive power control, including load shedding (if required), load sharing and controlling the active and reactive power in real time according to the MEMS or manual command.
- Black start, the ability to initiate power sources and loads to ensure the microgrid can initiate operation from a non-energized state.
- Interface with the protection system or earthing system when adaptations are required according to the microgrid operating modes.

2 Normative references

The following documents are referred to in the text in such a way that some or all 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 60870-5-101, *Telecontrol equipment and systems – Part 5-101: Transmission protocols – Companion standard for basic telecontrol tasks*

IEC 60870-5-104, *Telecontrol equipment and systems – Part 5-104: Transmission protocols – Network access for IEC 60870-5-101 using standard transport profiles*

IEC 61850 (all parts), *Communication networks and systems for power utility automation*

IEC 62443 (all parts), *Security for industrial automation and control systems*

IEC 62586-1, *Power quality measurement in power supply systems – Part 1: Power quality instruments (PQI)*

IEC TS 62898-1, *Microgrids – Part 1: Guidelines for microgrid projects planning and specification*

IEC TS 62898-2, *Microgrids – Part 2: Guidelines for operation*

IEC TS 62898-3-1, *Microgrids – Part 3-1: Technical requirements – Protection and dynamic control*

IEC TS 62898-3-2:—[2], *Microgrids – Part 3-2: Technical requirements – Energy management systems*

IEC TS 62898-3-3, *Microgrids − Part 3-3: Technical requirements − Self-regulation of dispatchable loads*

[2] Under preparation. Stage at the time of preparation: IEC DTS 62898-3-2:2023.

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IEEE Std 1815-2012, *IEEE Standard for Electric Power Systems Communications-Distributed Network Protocol (DNP3)*

IRIG-B Standards Documentation (IRIG.ORG) [viewed 2023-08-07]

Modbus Standards Documentation (Modbus.org) [viewed 2023-08-07]

NTP Standards Documentation (ntp.org) [viewed 2023-08-07]

OASIS Standards Documentation, MQTT Version 5.0 (oasis-open.org) [viewed 2023-07-24]

3 Terms, definitions and abbreviated terms

3.1 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

3.1.1
microgrid
<electric power system> group of interconnected loads and distributed energy resources with defined electrical boundaries forming a local electric power system at distribution voltage levels, that acts as a single controllable entity and is able to operate in island mode, no matter if it is standalone or grid-connected

Note 1 to entry: This definition covers both (utility) distribution microgrids and (customer owned) facility microgrids.

[SOURCE: IEC 60050-617:2017, 617-04-22, modified – "in either grid-connected or island mode" has been changed to " in island mode, no matter if it is standalone or grid-connected".]

3.1.2
microgrid monitoring and control systems
MMCS
computer or PLC based system performing real time monitoring and control of microgrid

Note 1 to entry: In large grid or large microgrid, such a system is also designated by PMS (Power Monitoring System).

3.1.3
microgrid energy management system
MEMS
system operating and controlling energy resources and loads of the microgrid

[SOURCE: IEC 60050-617:2018, 617-04-25]

3.1.4
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

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

3.1.5
renewable energy resource
RES
non-fossil energy resource such as wind, solar, hydropower, biomass, geothermal, etc

3.1.6
low voltage
LV
set of voltage levels used for the distribution of electricity and whose upper limit is generally accepted to be 1 000 V for alternating current

[SOURCE: IEC 60050-601:1985, 601-01-26]

3.1.7
medium voltage
MV
any set of voltage levels lying between low and high voltage

Note 1 to entry: The boundaries between medium- and high-voltage levels overlap and depend on local circumstances and history or common usage. Nevertheless, the band 30 kV to 100 kV frequently contains the accepted boundary.

[SOURCE: IEC 60050-601:1985, 601-01-28]

3.1.8
generic object-oriented substation event
GOOSE
mechanism used in the IEC 61850 series to meet the requirements of substation automation system fast communication

3.1.9
inter-range instrumentation group-B
IRIG-B code
time information transmission system that loads the time synchronization signal and the time code information such as second, minute, hour and day into the signal carrier with a frequency of 1 kHz

3.1.10
network time protocol
NTP
time synchronization protocol that serves computer clocks via the network

3.1.11
power system stability
capability of a power system to regain a steady state, characterized by the synchronous operation of the generators after a disturbance due, for example, to variation of power or impedance

[SOURCE: IEC 60050-603:1986, 603-03-01]

3.1.12
point of connection
POC
reference point on the electric power system where the user's electrical facility is connected

[SOURCE: IEC 60050-617:2009, 617-04-01]

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3.1.13
power conversion system
PCS
device that can control the charging and discharging process of a battery storage system, and carry out AC-DC conversion

3.1.14
state of charge
SOC
available capacity in a battery pack or system expressed as a percentage of rated capacity

[SOURCE: ISO 12405-4:2018, 3.20]

3.2 Abbreviated terms

DER	Distributed Energy Resource
DSO	Distribution System Operator
EPS	Electrical Power System
ESS	Energy Storage System
GOOSE	Generic Object-Oriented Substation Event
GIS	Geographic Information System
GUI	Graphic User Interface
GNSS	Global Navigation Satellite System
IRIG-B	Inter-Range Instrumentation Group-B
LV	Low Voltage
MV	Medium Voltage
MMCS	Microgrid Monitoring and Control System
MEMS	Microgrid Energy Management System
MQTT	Message Queuing Telemetry Transport
NTP	Network Time Protocol
POC	Point of Connection
PLC	Programmable Logic Controller
PCS	Power Conversion System
PQI	Power Quality Instrument
RES	Renewable Energy Source
SOC	State of Charge
UPS	Uninterruptible Power Supply

4 Overview

4.1 General

The operation control system of a microgrid can be divided into three layers according to the time scale, namely the energy management layer, the monitoring and control layer and the protection and dynamic control layer.

MMCS mainly concerns the monitoring and control layer in the microgrid system.

Functions listed in Figure 1 are project dependent. Some functions can be omitted depending on the scale or application of the microgrid. However, MMCS shall at least perform data

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