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TECHNICAL SPECIFICATION

colour inside

Recommendations for renewable energy and hybrid systems for rural electrification – Part 9-1: Integrated systems – Micropower systems

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

RECOMMENDATIONS FOR RENEWABLE ENERGY AND HYBRID SYSTEMS FOR RURAL ELECTRIFICATION –

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FOREWORD

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- 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 62257-9-1, which is a technical specification, has been prepared by IEC technical committee 82: Solar photovoltaic energy systems.

This second edition cancels and replaces the first edition, issued in 2008. It constitutes a technical revision.

The main technical changes with regard to the previous edition are as follows:

- Changing the voltage range covered by the technical specification to a.c. nominal voltage below 1 000 V and d.c. nominal voltage below 1 500 V (introduction)
- Defining the rating of the microgrids to be the output of the microgrid (introduction)
- Including 240 V 1-Ø/415 V 3-Ø, in the voltage levels (introduction)
- Specifying Non-separated MPPTs connecting LV d.c. arrays to ELV d.c. battery banks are not allowed (5.3.1.1)
- Noting that systems can now include a.c. bus arrangements and use MPPT's as the solar controllers thus increasing the internal voltages that occur in systems (5.3.1.2)
- Increased equipotential bonding for lightning protection from minimum 10 mm^2 to minimum 16 mm^2 (6.1.2.2)
- Included a new subclause (7.1.6) on battery enclosures including possible arrangements shown as Clause D.6
- Rewritten LV Multiple sources (7.2.2.3.1)
- Included start-up procedure in documentation (10.2)

The text of this technical specification is based on the following documents:

Enquiry draft	Report on voting
82/1028/DTS	82/1087/RVC

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.

This technical specification is to be used in conjunction with the IEC 62257 series and with future parts of this series as and when they are published.

A list of all parts in the IEC 62257 series, published under the general title *Recommendations for renewable energy and hybrid systems for rural electrification*, can be found on the IEC website.

Future standards in this series will carry the new general title as cited above. Titles of existing standards in this series will be updated at the time of the next edition.

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

- transformed into an International standard,
- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

A bilingual version of this publication may be issued at a later date.

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INTRODUCTION

The IEC 62257 series of documents intends to provide to the different players involved in rural electrification projects (such as project implementers, project contractors, project supervisors, installers, etc.) documents for the setting-up of renewable energy and hybrid systems with a.c. nominal voltage below 1 000 V, and d.c. nominal voltage below 1 500 V.

These documents are recommendations:

- to choose the right system for the right place;
- to design the system;
- to operate and maintain the system.

These documents are focused only on rural electrification concentrating on, but not specific to, developing countries. They must not be considered as all-inclusive to rural electrification. The documents try to promote the use of renewable energies in rural electrification; they do not deal with clean mechanisms developments at this time (CO_2 emission, carbon credit, etc.). Further developments in this field could be introduced in future steps.

This consistent set of documents is best considered as a whole with different parts corresponding to items for safety, sustainability of systems and at the lowest life-cycle cost as possible. One of the main objectives is to provide the minimum sufficient requirements, relevant to the field of application, that is, small renewable energy and hybrid off-grid systems.

RECOMMENDATIONS FOR RENEWABLE ENERGY AND HYBRID SYSTEMS FOR RURAL ELECTRIFICATION –

Part 9-1: Integrated systems – Micropower systems

1 Scope

Decentralized Rural Electrification Systems (DRES) are designed to supply electric power for sites which are not connected to a large interconnected system, or a national grid, in order to meet basic needs.

The majority of these sites are:

- isolated dwellings;
- village houses;
- community services (public lighting, pumping, health centres, places of worship or cultural activities, administrative buildings, etc.);
- economic activities (workshops, micro-industry, etc.).

The DRESs fall into the following three categories:

- process electrification systems (for example, for pumping);
- individual electrification systems (IES) for single users;
- collective electrification systems (CES) for multiple users.

Process or individual electrification systems exclusively consist of two subsystems:

- an electric energy generation subsystem;
- the user's electrical installation.

Collective electrification systems, however, consist of three subsystems:

- an electric energy generation subsystem;
- a distribution subsystem, also called microgrid;
- user’s electrical installations including interface equipment between the installations and the microgrid.

This technical specification applies to a micropower plant which is the electric energy generation subsystem associated with a decentralized rural electrification system.

It provides general requirements for the design, erection and operation of micropower plants and general requirements to ensure the safety of persons and property.

The micropower plants covered by this specification are low-voltage a.c., three-phase or single-phase, with rated capacity less than, or equal to, 100 kVA. The rated capacity is at the electrical output of the micropower plant, that is, the upstream terminals of the main switch between the micropower plant and the microgrid. They do not include voltage transformation.

The voltage levels covered under this specification are:

- the 240 V 1-Ø/415 V 3-Ø, the 230 V 1-Ø/400 V 3-Ø, the 220 V 1-Ø/380 V 3-Ø, and the 120 V 1-Ø/208 V 3-Ø systems at 60 Hz or 50 Hz; or obeyed by local code.

- the ELV (less than 120 V) d.c. systems.

The requirements cover “centralized” micropower plants for application in:

- process electrification;
- individual electrification systems and collective electrification systems.

It does not apply to distributed generation on microgrids.

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*

IEC 60364-5-53:2001, *Electrical installations of buildings – Part 5-53: Selection and erection of electrical equipment – Isolation, switching and control*

IEC TS 62257-2:2015, *Recommendations for renewable energy and hybrid systems for rural electrification – Part 2: From requirements to a range of electrification systems*

IEC TS 62257-4:2015, *Recommendations for renewable energy and hybrid systems for rural electrification – Part 4: System selection and design*

IEC TS 62257-5:2015, *Recommendations for renewable energy and hybrid systems for rural electrification – Part 5: Protection against electrical hazards*

IEC TS 62257-6:2015, *Recommendations for renewable energy and hybrid systems for rural electrification – Part 6: Acceptance, operation, maintenance and replacement*

IEC TS 62257-7-1:2010, *Recommendations for small renewable energy and hybrid systems for rural electrification – Part 7-1: Generators – Photovoltaic generators*

IEC TS 62257-7-3:2008, *Recommendations for small renewable energy and hybrid systems for rural electrification – Part 7-3: Generator set – Selection of generator sets for rural electrification systems*

IEC TS 62257-9-2:2016, *Recommendations for renewable energy and hybrid systems for rural electrification – Part 9-2: Integrated systems – Microgrids*

IEC TS 62257-9-4:2016, *Recommendations for renewable energy and hybrid systems for rural electrification – Part 9-4: Integrated systems – User installation*

IEC 62548:2016, *Photovoltaic (PV) arrays – Design requirements*

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
generator set
equipment producing electricity from a fossil fuel; it consists basically of an internal combustion engine producing mechanical energy and a generator which converts the mechanical energy into electrical energy and mechanical transmission, support and assembly components

3.2
reference earth
reference ground (US)
conductive part of the earth, considered as conductive, the electric potential of which is conventionally taken as zero, being outside the zone of influence of any earthing arrangement

[SOURCE: IEC 60050-826:2004, 826-13-01]

3.3
skilled person
person with relevant education or experience to enable him/her

- to perceive risks and to avoid hazards which electrical, chemical or mechanical equipment may create;
- to perform or supervise correctly the required task

3.4
instructed person
person adequately advised or supervised by skilled persons to enable him/her

- to perceive risks and to avoid hazards which electrical, chemical or mechanical equipment may create;
- to perform correctly the required task

3.5
ordinary person
person who is neither a skilled person nor an instructed person

3.6
licenced person
person who is authorized to perform electrical work under the appropriate state or territory statutes and regulations

Note 1 to entry: Only skilled or instructed persons can be licenced.

3.7
microgrid
subsystem of a DRES intended for power distribution, the prefix “micro” being intended to express the low level of transmitting capacity

3.8
micropower plant
subsystem of a DRES for power generation, the prefix “micro” being intended to express the low power level generated

3.9
protective conductor
identification: PE
conductor provided for purposes of safety, for example protection against electric shock

[SOURCE: IEC 60050-826:2004, 826-13-22]

3.10
PEN conductor
conductor combining the functions of both a protective earthing conductor and a neutral conductor

[SOURCE: IEC 60050-826:2004, 826-13-25]

3.11
power line
overhead or underground line installed to convey electrical energy for any purpose other than communication

3.12
renewable energy
RE
energy generated from natural resources such as sunlight, wind, rain, waves, tides, geothermal heat (list not exhaustive), which are renewable (naturally replenished)

Note 1 to entry: Renewable energy technologies include solar power, wind power, hydroelectricity, micro hydro, biomass, biofuels (list not exhaustive).

3.13
selectivity of protection

ability of a protection to identify the faulty section and/or phase(s) of a power system

[SOURCE: IEC 60050-448: 1995, 448-11-06]

3.14
lightning arrester
surge diverter
surge arrester
device intended to protect the electrical apparatus from high transient overvoltages and to limit the duration and frequently the amplitude of the follow-on current

[SOURCE: IEC 60050-811: 1991, 811-31-09]

3.15
technical room
cabinet
room or cabinet in which are located devices and apparatus dedicated to inter-connection of the different generators, protection of the different circuits, monitoring and control of the micropower plant and interfacing with the application

4 General

4.1 Boundary of a micropower plant

The micropower plant is defined as illustrated in Figure 1.

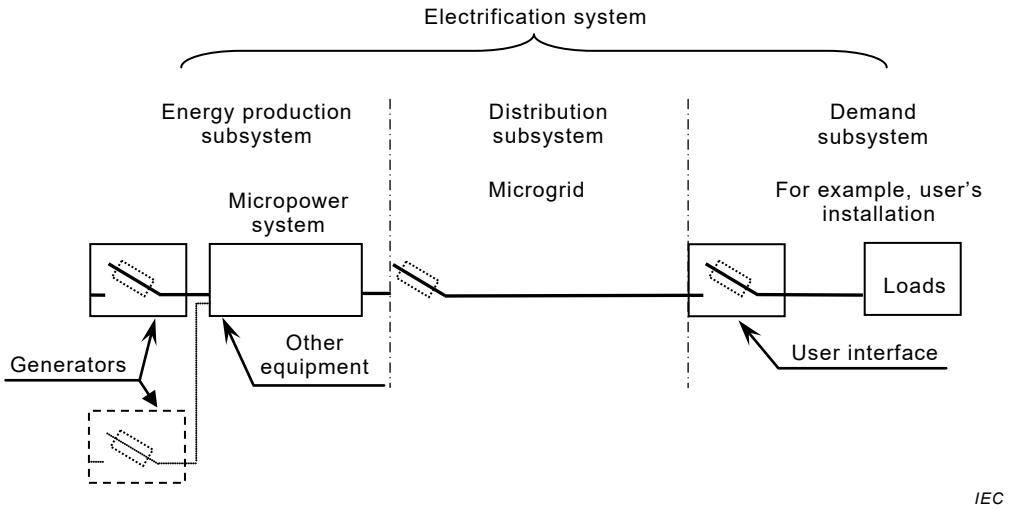

Figure 1 – Micropower system limits

The physical limits of the micropower plant are the upstream terminals of the main switch between the micropower plant and the microgrid.

4.2 Composition of a micropower plant

A micropower plant includes:

- one or several generators;
- storage devices (if needed) and associated charge controller;
- other equipment, such as
  - energy management device;
  - energy converter;
  - telecommunication equipment (if any);
  - main board;
  - interfaces:
    - between generators;
    - between the micropower plant and the microgrid or the application;
    - between the micropower plant and the operator;
  - switches;
  - protection devices;
- equipotential bonding;
- earthing system;
- civil works.

4.3 General functional layout of a micropower plant

Figure 2 illustrates an example of the general functional layout of a micropower plant combining the different equipment listed in 4.2.

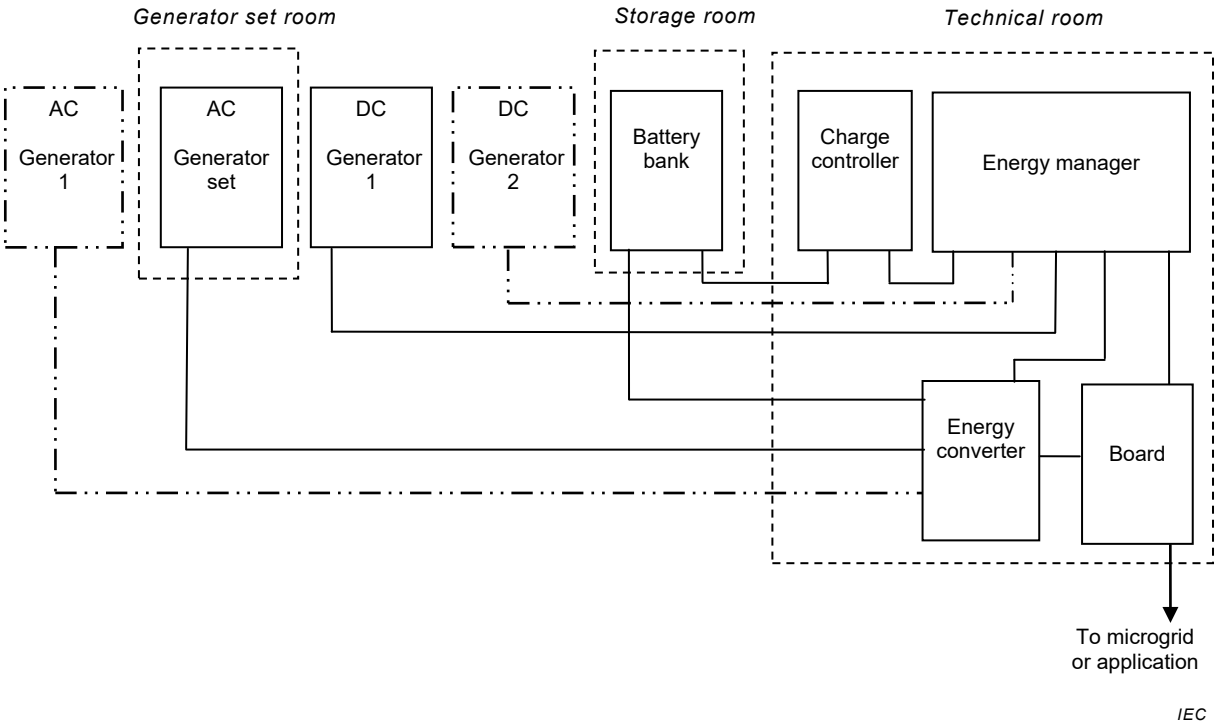

Figure 2 – Example of functional layout for a micropower plant supplying a.c. energy

5 Design

5.1 Design criteria

The design of any system should be guided by a number of criteria, determined by the project implementer (for example, user's affordable needs, lowest economic life-cycle cost, lowest environmental impact, site constraints). Some of the major areas to be considered are:

- average daily design d.c. load energy and average daily design a.c. load energy;
- maximum and surge power demand;
- system bus bar voltage and service (output) voltage;
- energy resources (sun, wind, hydro, fuel, biomass, etc.);
- budget constraints;
- power quality (for example, waveform quality or continuity of supply);
- environmental impact (for example, trimming or removal of trees for a PV system, civil works and diversion of water in a hydro system);
- use of existing equipment;
- acceptable extent of generator set running versus renewable energy contribution;
- acceptable noise levels;
- availability of spare parts and maintenance service;
- site accessibility;
- acceptable level of reliability and maintenance;
- level of automation versus direct user control;
- aesthetics.

The level of reliability should be determined in order to match the quality of service which is intended to be provided to the user in the general specification.