

Recommendations for small renewable energy and hybrid systems for rural electrification —

Part 5: Protection against electrical hazards

ICS 27.160; 27.180

National foreword

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Cross-references

The British Standards which implement international publications referred to in this document may be found in the *BSI Catalogue* under the section entitled “International Standards Correspondence Index”, or by using the “Search” facility of the *BSI Electronic Catalogue* or of British Standards Online.

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Summary of pages

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Part 5: Protection against electrical hazards



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INTRODUCTION

The IEC 62257 series of documents intends to provide to 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 500 V, d.c. nominal voltage below 750 V and nominal power below 100 kVA.

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 should 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 (CO₂ 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.

The purpose of this part of IEC 62257 is to specify the general requirements for the protection of persons and equipment against electrical hazards to be applied in decentralized rural electrification systems.

RECOMMENDATIONS FOR SMALL RENEWABLE ENERGY AND HYBRID SYSTEMS FOR RURAL ELECTRIFICATION –

Part 5: Protection against electrical hazards

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 centers, places of worship or cultural activities, administrative buildings, etc.),
- economic activities (workshops, micro-industry, etc.).

The DRE systems fall into 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 3 subsystems:

- an electric energy generation subsystem,
- a distribution subsystem, also called micro-grid,
- user's electrical installations including interface equipment between the installations and the micro-grid.

The purpose of this document is to specify the general requirements for the protection of persons and equipment against electrical hazards to be applied in decentralised rural electrification systems. Requirements dealing with protection against electric shock are based on basic rules from IEC 61140 and IEC 60364.

These general requirements are to be applied to all the identified categories of DRES. Application to each subsystem of a DRES is dealt within a specific section of IEC 62257-9.

2 Normative references

The following referenced documents are indispensable for the application 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 60050-826, *International Electrotechnical Vocabulary (IEV) – Part 826: Electrical installations*

IEC 60364 (all parts), *Electrical installations of buildings*

IEC 61024-1:1990, *Protection of structures against lightning – Part 1: General principles*

IEC 61140:1997, *Protection against electric shock – Common aspects for installation and equipment*

IEC 62257-1, *Recommendations for small renewable energy and hybrid systems for rural electrification – Part 1: General introduction to rural electrification*

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

IEC 62257-3, *Recommendations for small renewable energy and hybrid systems for rural electrification – Part 3: Project development and management*

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

IEC 62257-5, *Recommendations for small renewable energy and hybrid systems for rural electrification – Part 5: Safety rules*

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

IEC 62257-7, *Recommendations for small renewable energy and hybrid systems for rural electrification – Part 7: Technical specifications: generators*¹

IEC 62257-8, *Recommendations for small renewable energy and hybrid systems for rural electrification – Part 8: Technical specifications: batteries and converters*³

IEC 62257-9, *Recommendations for small renewable energy and hybrid systems for rural electrification – Part 9: Technical specifications: integrated systems*³

IEC 62257-10, *Recommendations for small renewable energy and hybrid systems for rural electrification – Part 10: Technical specifications: energy manager*³

IEC 62257-11, *Recommendations for small renewable energy and hybrid systems for rural electrification – Part 11: Technical specifications: considerations for grid connection*³

IEC 62257-12, *Recommendations for small renewable energy and hybrid systems for rural electrification – Part 12: Appliances*³

IEC 62257-13, *Recommendations for small renewable energy and hybrid systems for rural electrification – Part 13: Other topics*³

IEC 62305-2:2005, *Protection against lightning – Part 2: Risk management*

¹ Under consideration.

3 Terms and definitions

For the purpose of this part of IEC 62257, the following terms and definitions apply.

3.1

DRES

decentralized rural electrification system

3.2

REN

renewable energy

3.2

micro-grid

subsystem of a DRES intended for power distribution

NOTE The prefix «micro» being intended to express the low level of transmitting capacity, usually less than 50 kVA.

3.3

micro-powerplant

subsystem of a DRES intended for power generation. The prefix «micro» being intended to express the low power level generated (from a few kVA to a few tens of kVA)

3.4

SPD

Surge Protection Device

4 Classification of decentralised rural electrification systems

DRES are classified into six different types. See Table 1.

Table 1 – Typology of decentralized electrification systems

Type of generator		Classification of associated systems	
		Individual	Collective
REN only, hybrid or not	no storage	T ₁ .I	T ₁ .C
REN only, hybrid or not	storage	T ₂ .I	T ₂ .C
REN, hybrid or not plus Genset	no storage	T ₃ .I	T ₃ .C
REN, hybrid or not plus Genset	storage	T ₄ .I	T ₄ .C
Genset only	no storage	T ₅ .I	T ₅ .C
Genset only	storage	T ₆ .I	T ₆ .C
Notation principle: Ti.I = individual system, type i; Tj.C = collective system, type j. "Storage" = storage of energy produced by one of the generator of the system and which can be reconverted.			

Architecture and characteristics of the different electrification system types are developed in Clause 6 of IEC 62257-2.

5 Protection against electric shock

5.1 General

Basic rules for protection against electric shock are given in IEC 61140 and IEC 60364-4-41. Information is also available in Annex A.

5.2 Requirements on the d.c. side of a DRES

The principles for the design and erection of a d.c. electrical circuit are similar to those for an a.c. circuit. The main differences concern short-circuit current calculation and the selection of the protective devices.

Protection by extra-low voltage (SELV and PELV systems) or protection by double or reinforced insulation should preferably be adopted on the d.c. side of DRES.

NOTE Protection by automatic disconnection of supply on the d.c. side requires special measures which are under consideration.

Simple separation, at least, should be provided between the a.c. side and the d.c. side unless the inverter is not able, by construction, to feed d.c. fault current into the a.c. installation.

Earthing of one of the live conductors of the d.c. side is permitted, if there is at least simple separation between the d.c. side and the a.c. side.

5.3 Requirements on the a.c. side of a DRES

5.3.1 General

Protection by use of automatic disconnection of supply should preferably be adopted on the a.c. side of a DRES. For each circuit, maximum disconnecting times given in IEC 60364-4-41 should apply.

TN-S system should preferably be used for user's installations, TN-S or TN-C system being preferably used for the micro-grid.

TT system is acceptable. IT system is normally not used for DRES and has hence not been dealt with in this specification.

A residual current protective device, with a rated operating residual current not exceeding 30 mA, should be provided as additional protection for each installation or for a group of installations.

5.3.2 TT system

Basic protection is provided by basic insulation of live parts or by barriers or enclosures. Fault protection is provided by residual current devices regarding the resistance value of the earth electrode to which the PE conductor is connected. The fault current should be high enough to activate the differential current device. The rated operating residual current $I_{\Delta n}$ of the device should fulfil the formula:

$$I_{\Delta n} \leq \frac{U_L}{R_A} \quad \text{with} \quad U_L = 50 \text{ V}$$

where U_L is the conventional maximum voltage and R_A is the earthing resistance.

This formula results in the values shown in Table 2.

Table 2 – Rated operating residual current of the protective device depending on the value of the earthing resistance

R_A Ω	$I_{\Delta n}$ A
$R_A \leq 50$	1
$50 < R_A \leq 100$	0,5
$100 < R_A \leq 167$	0,3
$167 < R_A \leq 300$	0,1
$300 < R_A \leq 500$	0,03

5.3.3 TN system

Basic protection is provided by basic insulation of live parts or by barriers or enclosures. Fault protection is provided by devices protecting against over-currents.

Additional information is given in Annexes A and B.

6 Protection against overcurrent

6.1 General

Protective devices should be provided to break any over-current flowing in the circuit conductors before such a current could cause a danger due to thermal and mechanical effects or a temperature rise detrimental to insulation, joints, termination (see IEC 60364-4-43).

6.2 Protection against overload currents

The operating characteristics of a device protecting a cable against overload current should satisfy the two following conditions:

$$I_b \leq I_n \leq I_z$$

$$I_2 \leq 1,45 \times I_z$$

where

- I_b is the current for which the circuit is designed;
- I_z is the continuous current-carrying capacity of the cable;
- I_n is the nominal current of the protective device;
- I_2 is the current ensuring effective operation in the conventional time of the protective device.

6.3 Protection against short-circuits

For cables and isolated conductors, each short-circuit protective device should meet both of the following conditions:

- The breaking capacity should not be less than the prospective short-circuit current at the place of its installation, except where another protective device having the necessary breaking capacity and coordinated characteristics is installed upstream.