

TECHNICAL SPECIFICATION



**Renewable energy off-grid systems –
Part 9-8: Integrated systems – Requirements for stand-alone renewable energy
products with power ratings less than or equal to 350 W**

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INTERNATIONAL
ELECTROTECHNICAL
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INTERNATIONAL ELECTROTECHNICAL COMMISSION

RENEWABLE ENERGY OFF-GRID SYSTEMS –

Part 9-8: Integrated systems – Requirements for stand-alone renewable energy products with power ratings less than or equal to 350 W

FOREWORD

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IEC TS 62257-9-8 has been prepared by IEC technical committee 82: Solar photovoltaic energy systems. It is a Technical Specification.

This second edition cancels and replaces the first edition issued in 2020. It constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- a) Removed the PV module wiring inspection, partial shading test, and visual screening and durability tests for photovoltaic modules. Applicable tests are now referenced from IEC TS 62257-9-5.
- b) Increased the interval for recurring testing from two years to three years.

- c) Tightened the truth-in-advertising tolerance for numerical aspects other than luminous flux from 15 % to 10 %.
- d) Revised consumer information requirements to allow more flexibility and remove requirements for information that is not known to be valuable to consumers.
- e) Simplified and reorganized the requirements for 12 V and 5 V ports, and allow non-standard output voltages if clearly marked.
- f) Added requirements for ports with USB fast charging support.
- g) Revised the requirements for non-plug-and-play products to allow connectors that require special tools or training in products installed by trained technicians.
- h) Clarified cell- and pack-level safety requirements for single-cell lithium batteries.

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

Draft	Report on voting
82/2292/DTS	82/2321/RVDTS

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

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 62257 series, published under the general title *Renewable energy off-grid systems*, 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 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, or
- revised.

INTRODUCTION

The IEC 62257 series provides support and strategies for institutions involved in rural electrification projects. It documents technical approaches for designing, building, testing, and maintaining off-grid renewable energy and hybrid systems with AC nominal voltage below 500 V, DC nominal voltage below 750 V and nominal power below 100 kVA.

This series provides recommendations to support buyers who want to connect with good quality options in the market:

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

This series is focused only on technical aspects of rural off-grid electrification concentrating on, but not specific to, developing countries. They are not considered as all inclusive to rural electrification. The documents do not describe a range of factors that can determine project or product success: environmental, social, economic, service capabilities, and others. Further developments in this field could be introduced in future steps.

This series is best considered as a whole with different parts corresponding to items for safety, sustainability of systems, and costs. The main objectives are to support the capabilities of households and communities that use small renewable energy and hybrid off-grid systems and inform organizations and institutions in the off-grid power market.

The purpose of this document is to provide baseline standards for quality, durability and truth-in-advertising to protect consumers of stand-alone renewable energy products. This document is specifically related to renewable energy products that are packaged and made available to end-use consumers at the point of purchase as single, stand-alone products that do not require additional system components to function. This document applies to products with peak power ratings of 350 W or less. While most provisions apply to all products in this range, a few are applicable only to products with peak power ratings greater than 10,5 W and less than or equal to 350 W.

The term "stand-alone renewable energy product" is used in this document to describe this class of products. Other equivalent terms, including "off-grid solar" or "rechargeable," are often used by companies, distributors, and other stakeholders to describe these products. Many of these systems meet the definition of type T₂I (individual electrification systems with energy storage) in IEC TS 62257-2.

The intended users of this document are:

- Market support programmes that support the off-grid lighting market with financing, consumer education, awareness, and other services;
- Companies and distributors that need to verify the quality and performance of products;
- Bulk procurement programmes that facilitate or place large orders of products; and,
- trade regulators such as government policymakers and officials who craft and implement trade and tax policy.

This document establishes minimum requirements for quality standards and warranty requirements. Products are compared to specifications based on test results from IEC TS 62257-9-5 and other information about the product. The requirements are designed to be widely applicable across different markets, countries, and regions.

RENEWABLE ENERGY OFF-GRID SYSTEMS –

Part 9-8: Integrated systems – Requirements for stand-alone renewable energy products with power ratings less than or equal to 350 W

1 Scope

This part of the IEC 62257 series provides baseline requirements for quality, durability and truth in advertising to protect consumers of off-grid renewable energy products. Evaluation of these requirements is based on tests described in IEC TS 62257-9-5. This document can be used alone or in conjunction with other international standards that address the safety and durability of components of off-grid renewable energy products.

This document applies to stand-alone renewable energy products having the following characteristics:

- The products are powered by photovoltaic (PV) modules or electromechanical power generating devices (such as dynamos), or are designed to use grid electricity to charge a battery or other energy-storage device for off-grid use. The requirements may also be appropriate as guidance for evaluating the quality of products with other power sources, such as thermoelectric generators.
- The peak power rating of the PV module or other power generating device is less than or equal to 350 W.
- All components required to provide basic energy services are sold and installed as a kit, included as a part of a family of products as defined in 4.2.5, or integrated into a single component, including at a minimum:
 - a battery, batteries or other energy storage device(s);
 - power generating device, such as a solar panel, capable of charging the battery, batteries or other energy storage device(s);
 - cables, switches, wiring, connectors and protective devices sufficient to connect the power generating device, power control unit(s) and energy storage device(s).
- The system evaluated includes all the loads (lighting, television, radio, fan, etc.) and load adapter cables that are sold or included as part of the kit or integrated into kit components.
- The PV module maximum power point voltage and the working voltage of any other components in the kit do not exceed 35 V. Exceptions are made for AC-to-DC converters that meet appropriate safety standards, and systems that include PV modules (or combinations of PV modules) with open-circuit voltage greater than 35 V that meet additional safety requirements beyond those assessed in IEC TS 62257-9-5.

NOTE This voltage limit corresponds to the definition of decisive voltage classification A (DVC-A) for wet locations in IEC 62109-1. The limits of 240 W, 35 V and 8 A are consistent with the definition of Class III in IEC 61730-1.

- These requirements cover only DC outputs and loads. Products that include inverters, AC outputs or outlets, or AC appliances are not within the scope of this document. Products can have AC inputs.
- No design expertise is required to choose appropriate system components.
- All electrical connections, except for permanent connections made at the time of installation, can be made using plug-and-socket connectors without the use of any tools.

This document includes provisions related to safety; however, it is not intended to be a comprehensive safety standard. In particular, this document is not intended to be used as an alternative to safety standards such as IEC 62368-1 or the IEC 60335 series for appliances such as radios and televisions that are included with stand-alone renewable energy products. Nor is it intended to replace the safety requirements of IEC 62281 or UN 38.3 for battery safety during transport, or safety requirements of IEC 61730-1 and IEC 61730-2 for PV modules intended for use outside the context of stand-alone renewable energy products.

This document does not address electromagnetic compatibility (EMC). Field experience has not shown EMC to be a major concern in typical applications of stand-alone renewable energy products within the scope of this document. In applications where EMC is a concern (e.g. systems that include medical devices), the standards relevant to the specific application should be referenced.

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 60335-1, *Household and similar electrical appliances – Safety – Part 1: General requirements*

IEC 60335-2-29, *Household and similar electrical appliances – Safety – Part 2-29: Particular requirements for battery chargers*

IEC 60364-7-712:2017, *Low voltage electrical installations – Part 7-712: Requirements for special installations or locations – Solar photovoltaic (PV) power supply systems*

IEC 60529, *Degrees of protection provided by enclosures (IP Code)*

IEC 60598-1, *Luminaires – Part 1: General requirements and tests*

IEC 61215-1, *Terrestrial photovoltaic (PV) modules – Design qualification and type approval – Part 1: Test requirements*

IEC 61215-2, *Terrestrial photovoltaic (PV) modules – Design qualification and type approval – Part 2: Test procedures*

IEC 61730-1, *Photovoltaic (PV) module safety qualification – Part 1: Requirements for construction*

IEC 61730-2, *Photovoltaic (PV) module safety qualification – Part 2: Requirements for testing*

IEC TS 61836, *Solar photovoltaic energy systems – Terms, definitions and symbols*

IEC 62109-1, *Safety of power converters for use in photovoltaic power systems – Part 1: General requirements*

IEC 62133-2, *Secondary cells and batteries containing alkaline or other non-acid electrolytes – Safety requirements for portable sealed secondary cells, and for batteries made from them, for use in portable applications – Part 2: Lithium systems*

IEC TS 62257-9-5:2024, *Recommendations for renewable energy and hybrid systems for rural electrification: Integrated systems – Laboratory evaluation of stand-alone renewable energy products for rural electrification*

IEC TS 62257-12-1, *Recommendations for renewable energy and hybrid systems for rural electrification – Part 12-1: Laboratory evaluation of lamps and lighting appliances for off-grid electricity systems*

IEC 62281, *Safety of primary and secondary lithium cells and batteries during transport*

IEC 62368-1, *Audio/video, information and communication technology equipment – Part 1: Safety requirements*

IEC 62619, *Secondary cells and batteries containing alkaline or other non-acid electrolytes – Safety requirements for secondary lithium cells and batteries, for use in industrial applications*

IEC 62790, *Junction boxes for photovoltaic modules – Safety requirements and tests*

IEC TS 63163, *Terrestrial photovoltaic (PV) modules for consumer products – Design qualification and type approval*

ISO 4892 (all parts), *Plastics – Methods of exposure to laboratory light sources*

ANSI/CAN/UL 9540, *Energy Storage Systems and Equipment*

UL 1741, *Standard for inverters, converters, controllers and interconnection system equipment for use with distributed energy resources*

UL 1973, *Standard for batteries for use in stationary, vehicle auxiliary power and light electric rail (LER) applications*

UL 2054, *Standard for Household and Commercial Batteries*

UL 61730-1, *Photovoltaic (PV) module safety qualification – Part 1: Requirements for construction*

UL 61730-2, *Photovoltaic (PV) module safety qualification – Part 2: Requirements for testing*

UL 62133-2, *Secondary cells and batteries containing alkaline or other non-acid electrolytes – Safety requirements for portable sealed secondary cells, and for batteries made from them, for use in portable applications*

United Nations. *Recommendations on the transport of dangerous goods: manual of tests and criteria, Section 38.3: Lithium batteries (UN 38.3)*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC TS 61836 and the following 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 Terms related to photometric tests

3.1.1

illuminance

 E_v

density of incident luminous flux with respect to area at a point on a real or imaginary surface

$$E_v = \frac{d\Phi_v}{dA}$$

where Φ_v is luminous flux and A is the area on which the luminous flux is incident

Note 1 to entry: The illuminance is expressed in lux ($\text{lx} = \text{lm} \cdot \text{m}^{-2}$).

[SOURCE: IEC 60050-845:2020, 845-21-060, modified – Notes 1, 2, and 4 have been omitted.]

3.1.2

full width half maximum

FWHM

range of a variable over which a given characteristic is greater than 50 % of its maximum value

Note 1 to entry: FWHM can be applied to characteristics such as radiation patterns, spectral linewidths, etc., and the variable can be wavelength, spatial or angular properties, etc., as appropriate.

[SOURCE: IEC 60050-731:1991, 731-01-57, modified – in note 1, "may" has been replaced with "can".]

3.2

LED

light emitting diode

solid state device embodying a p-n junction, emitting incoherent optical radiation when excited by an electric current

[SOURCE: IEC 60050-845:2020, 845-27-050, modified – The notes have been omitted.]

3.3

power supply

electric energy converter which draws electric energy from a source and supplies it in a specified form to a load

[SOURCE: IEC 60050-151:2001, 151-13-76]

3.4

overvoltage protection

protection intended to operate when the power system voltage is in excess of a predetermined value

[SOURCE: IEC 60050-448:1995, 448-14-32]

3.5

cell block

group of cells in a battery connected together in parallel configuration with or without protective devices (e.g. fuse or positive temperature coefficient device (PTC)) and monitoring circuitry

Note 1 to entry: The cell block is not ready for use in an application because it is not yet fitted with its final housing, terminal arrangement and electronic control device.

[SOURCE: IEC 62619:2022, 3.8]

3.6

IP Code

coding system to indicate the degrees of protection provided by an enclosure against access to hazardous parts, ingress of solid foreign objects, ingress of water and to give additional information in connection with such protection

Note 1 to entry: In this document, certain IP Codes can be estimated using procedures in IEC TS 62257-9-5, which provides a simplified and lower-cost alternative to IEC 60529. The procedure in IEC TS 62257-9-5 evaluates protection against ingress of solid foreign objects and water, but not protection against access to hazardous parts.

[SOURCE: IEC 60529:1989, 3.4, modified – note 1 has been added.]

3.7 Component categories

3.7.1

portable

connected in a way that makes a product or subsystem easy for an individual to carry

Note 1 to entry: Products or subsystems are portable when two or more of the main components (energy source, energy storage, and light source) are connected in this way.

[SOURCE: IEC TS 62257-9-5:2024, 3.18]

3.7.2

fixed

designed for permanent or semi-permanent mounting and use in place

Note 1 to entry: Products or subsystems are fixed when the main components (energy source, energy storage, and light source) are designed in this way.

[SOURCE: IEC TS 62257-9-5:2024, 3.19]

3.7.3

separate

without PV module or with a PV module connected to other components via a cable with a length of at least 3 m

Note 1 to entry: The length criterion allows the PV module to collect energy outdoors while the other product components remain indoors.

[SOURCE: IEC TS 62257-9-5:2024, 3.20, modified – the 3 m length specification has been incorporated into the definition.]

3.7.4

integrated

with a PV module incorporated into another component or connected to another component (other than a fixed outdoor component) via a cable with a length less than 3 m

Note 1 to entry: The length of the cable is insufficient for the PV module to collect energy outdoors while the other product components remain indoors.

[SOURCE: IEC TS 62257-9-5:2024, 3.21, modified – the 3 m length specification has been incorporated into the definition.]

3.7.5 component

<of a product> constituent part of a product which cannot be physically divided into smaller parts as part of normal installation and use

Note 1 to entry: Examples of components include main units, power control units, appliances, PV modules, external batteries, and cables.

[SOURCE: IEC 60050-151:2001, 151-11-21, modified – "device" has been replaced with "product" and "without losing its particular function" with "as part of normal installation and use," and the note has been added.]

3.8 Electrical quantities

3.8.1 capacity

<for batteries or battery cells> electric charge which a battery or battery cell can deliver under specified discharge conditions

Note 1 to entry: The SI unit for electric charge, or quantity of electricity, is the coulomb ($1\text{ C} = 1\text{ A}\cdot\text{s}$) but in practice, capacity is usually expressed in ampere hours (Ah).

[SOURCE: IEC 60050-482:2020, 482-03-14]

3.8.2 standby loss

current drawn from a product's battery with the product switched off

[SOURCE: IEC TS 62257-9-5:2024, 3.25]

3.8.3 standard operating voltage

standardized voltage corresponding to a typical battery operating point during discharge

[SOURCE: IEC TS 62257-9-5:2024, 3.31]

3.8.4 typical battery discharge voltage

battery voltage corresponding to the "typical operating point" (e.g. the operating point resulting in the average value of power) during discharge

Note 1 to entry: The typical battery discharge voltage is an outcome of the full-battery run time test, while the standard operating voltage depends only on the battery chemistry and number of cells.

[SOURCE: IEC TS 62257-9-5:2024, 3.32]

3.8.5 appliance operating voltage

voltage supplied to an appliance by a port when the appliance is operating at a particular setting and the power control unit battery is at the typical battery discharge voltage

[SOURCE: IEC TS 62257-9-5:2024, 3.33]