



BSI Standards Publication

Recommendations for renewable energy and hybrid systems for rural electrification

Part 12-1: Selection of lamps and lighting
appliances for off-grid electricity systems

National foreword

This Published Document is the UK implementation of IEC/TS 62257-12-1:2015. It supersedes DD IEC/TS 62257-12-1:2007 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee GEL/82, Photovoltaic Energy Systems.

A list of organizations represented on this committee can be obtained on request to its secretary.

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TECHNICAL SPECIFICATION



**Recommendations for renewable energy and hybrid systems for rural electrification –
Part 12-1: Selection of lamps and lighting appliances for off-grid electricity systems**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 27.160

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**RECOMMENDATIONS FOR RENEWABLE ENERGY
AND HYBRID SYSTEMS FOR RURAL ELECTRIFICATION –****Part 12-1: Selection of lamps and lighting appliances
for off-grid electricity systems**

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 62257-12-1, 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 published in 2007. This edition constitutes a technical revision.

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

- Overall, the narrow focus on the needs of bulk procurement programmes has been shifted to a wider framework for structuring quality assurance using appropriate methods for a range of stakeholders including governments, manufacturers, buyers, and others.
- The document structure has been revised, with modular methods given in annexes.
- Normative references and definitions have been added to support the new document structure.
- The scope has been expanded from self-ballasted compact fluorescent lamps to include DC products and lighting appliances with LED, compact fluorescent, or linear fluorescent light sources.
- Several key test procedures have been created or modified:
 - manufacturer self-reported information;
 - random product sampling;
 - visual screening;
 - light output, distribution, and maintenance;
 - cycling test for fluorescent lights;
 - input voltage range;
 - mechanical durability;
 - physical ingress and water protection;
 - power quality and power consumption.

This Technical Specification is to be used in conjunction with other parts of the IEC 62257 series.

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

Enquiry draft	Report on voting
82/941/DTS	82/995/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 publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts of the IEC 62257 series, 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.

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.

INTRODUCTION

The IEC 62257 series provides support and strategies for organizations and 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 1 000 V, and DC nominal voltage below 1 500 V.

These documents are 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,
- to operate and maintain the system.

These documents are focused only on technical aspects of rural off-grid electrification concentrating on but not specific to developing countries. They are not 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 consistent set of documents is best considered as a whole with different parts corresponding to items for safety, sustainability of systems, and affordable 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 part of IEC 62257 is to specify quality assurance strategies for lamps and lighting appliances for off-grid electricity systems, including product specifications and tests. In addition to supporting the selection of products by project developers and implementers, quality assurance can help market support organizations, manufacturers, and governments achieve the goals they have for lighting appliances in off-grid applications.

This part of IEC 62257 presents a quality assurance framework that includes product specifications (a framework for interpreting test results) and test methods. The intended users of this part of IEC 62257 are listed below. In some clauses and subclauses of this part of IEC 62257, a description of the application of the subclause contents is offered to help provide context for each type of user.

- **Market support programmes** are programmes that support the off-grid lighting market with financing, consumer education, awareness, and other services. Market support programmes often use quality assurance to qualify for access to services like
 - greenhouse gas reduction certifications or other incentives,
 - access to financing (trade or consumer finance),
 - use of a buyer seal and certification (government or non-governmental institutional backing, consumer or “business to business” seals),
 - participation in a public product information database (for example, standardized specifications sheets),
 - access to a business network or trade group,
 - business support and development services,
 - access to market intelligence, and
 - participation in consumer awareness campaigns.

- **Manufacturers and distributors** verify the quality and performance of products from different batches and potential business partners. Manufacturers and distributors often use quality assurance plans or requirements to
 - support quality control processes at a manufacturing plant or upon receipt of goods from a contract manufacturer, and
 - choose products to distribute.
- **Bulk procurement programmes** facilitate or place large orders for devices from a distributor or manufacturer. Bulk procurement programmes often use quality assurance to
 - provide devices to a particular, relatively small group of end-users whose needs are understood (for example, project developers and implementers for an electrification project may include quality assurance requirements in the general specification of an electrification project (see IEC TS 62257-3)), and
 - organize a subsidy, buy-down, or giveaway programme that will serve a broad set of users.
- **Trade regulators** are typically government policymakers and officials who craft and implement trade and tax policy. Regulators often use quality assurance requirements to
 - qualify for exemption from tax or duties, and
 - establish requirements for customs.

There is a range of tests outlined in this part of IEC 62257; some are simple enough to be completed in the field by project developers while others require laboratory equipment. The tests and inspections are designed to be widely applicable across different markets, countries, and regions.

RECOMMENDATIONS FOR RENEWABLE ENERGY AND HYBRID SYSTEMS FOR RURAL ELECTRIFICATION –

Part 12-1: Selection of lamps and lighting appliances for off-grid electricity systems

1 Scope

This part of IEC 62257 establishes the framework for creating a product specification – the basis for evaluating quality for a particular context. Product specifications include minimum requirements for quality standards, warranty requirements, and/or performance criteria. Products are compared to specifications based on test results and other information about the product. The product specification framework is flexible and can accommodate the goals of diverse organizations and institutions.

This part of IEC 62257 applies to lamps and lighting appliances for off-grid electricity systems that have the following characteristics:

- The power supply is AC or DC:
 - AC nominal voltages up to 250 V;
 - DC nominal voltages up to 48 V.
- The light source is CFL, linear fluorescent, or LED.
- Operation of the lamp or lighting appliance does not require any components to be supplied by the testing laboratory other than lampholders, wire, connectors, and a power supply.
- The lamp or lighting appliance does not include a battery or energy source (for example, a photovoltaic module or electromechanical generator).

Luminaires are included in the definition of “lighting appliances” if packaged together with a lamp intended to be used with the luminaire. Luminaires without lamps are not included in the scope of this part of IEC 62257.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60068-2-6, *Environmental testing – Part 2-6: Tests – Test Fc: Vibration (sinusoidal)*

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

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

IEC 60598-2-1, *Luminaires – Part 2: Particular requirements. Section One: Fixed general purpose luminaires*

IEC TS 62257-9-5, *Recommendations for small renewable energy and hybrid systems for rural electrification – Part 9-5: Integrated system – Selection of stand-alone lighting kits for rural electrification*

CIE 084, *The measurement of luminous flux*

CIE 127, *Measurement of LEDs*

IESNA LM-78-07, *Approved method for total luminous flux measurement of lamps using an integrating sphere photometer*

IESNA LM-79-08, *Electrical and photometric measurement of solid state lighting products*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1

environmental conditions

characteristics, such as elevation, temperature, and humidity, that can influence performance

3.2

lux

SI unit of illuminance: illuminance produced on a surface of area 1 square metre by a luminous flux of 1 lumen uniformly distributed over that surface

[SOURCE: IEC 60050-845:1987, 845-01-52]

3.3

illuminance

illuminance of an elementary surface

E

luminous flux received by an elementary surface divided by the area of this surface

Note 1 to entry: In the SI system of units illuminance is expressed in lux (lx) or lumens per square metre (lm/m²).

[SOURCE: IEC 60050-723:1997, 723-08-30]

3.4

luminous efficacy

luminous efficacy of a source

quotient of the luminous flux emitted by the power consumed by the source

Note 1 to entry: Unit: lm/W.

[SOURCE: IEC 60050-845:1987, 845-01-55]

3.5

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]

3.6

power factor

under periodic conditions, ratio of the absolute value of the active power P to the apparent power S

[SOURCE: IEC 60050-131:2002, 131-11-46, modified – The formula and note have been omitted.]

3.7

active power

P

real power

effective power

under periodic conditions, mean value, taken over one period T , of the instantaneous power p :

$$P = \frac{1}{T} \int_0^T p dt$$

Note 1 to entry: The coherent SI unit for active power is the watt (W).

[SOURCE: IEC 60050-131:2013, 131-11-42, modified – Note 1 to entry has been omitted.]

3.8

total harmonic distortion

THD

ratio of the total r.m.s. value of the harmonics (in this context harmonic currents I_n of the order n) of orders 2 to 40 to the r.m.s. value of the fundamental:

$$\text{THD} = \sqrt{\sum_{n=2}^{40} \left(\frac{I_n}{I_1} \right)^2}$$

Note 1 to entry: This definition has been chosen in accordance with the relevant standard IEC 61000-2-2.

3.9

IP class

IP rating

ingress protection—degree of protection provided by enclosures for electrical equipment against penetration by foreign bodies and dust/water

[SOURCE: IEC TS 62257-9-5:2013, 3.23]

3.10

metadata

information that relates a test result to a specific sample and provides context about the result (e.g. specific test method used)

[SOURCE: IEC TS 62257-9-5:2013, 3.28]

3.11

multimeter

multirange multifunction measuring instrument intended to measure voltage, current and sometimes other electrical quantities such as resistance

[SOURCE: IEC 60050-312:2001, 312-02-24]

3.12

ammeter

instrument intended to measure the value of a current

[SOURCE: IEC 60050-313:2001, 313-01-01]

3.13

voltmeter

instrument intended to measure the value of a voltage

[SOURCE: IEC 60050-313:2001-07, 313-01-03]

3.14

illuminance meter

instrument for measuring illuminance

[SOURCE: IEC 60050-845:1987, 845-05-16]

3.15

integrating sphere

hollow sphere whose internal surface is a diffuse reflector, as non-selective as possible

Note 1 to entry: An integrating sphere is used to determine the total luminous flux (lumen output) of a lighting device.

Note 2 to entry: An integrating sphere is used frequently with a radiometer or photometer.

[SOURCE: IEC 60050-845:1987, 845-05-24]

3.16

lamp

device including a light source intended to be installed in or permanently fixed to a lampholder or luminaire

3.17

integrated compact fluorescent lamp

compact fluorescent lamp that incorporates, permanently enclosed, all elements that are necessary for starting and for stable operation

3.18

non-integrated compact fluorescent lamp

compact fluorescent lamp that incorporates electrical contacts intended for connection to a ballast through a lampholder

Note 1 to entry: Non-integrated compact fluorescent lamps are not included in the scope of this part of IEC 62257, but can be components of a lighting appliance that is included in the scope.

3.19

compact fluorescent lamp

CFL

tubular fluorescent lamp unit, having a bent tube, which does not include any replaceable or interchangeable parts

3.20

linear fluorescent lamp

straight tubular fluorescent lamp unit that incorporates electrical contacts intended for connection to a ballast through a lampholder, and which does not include any replaceable or interchangeable parts

3.21**light emitting diode****LED**

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

[SOURCE: IEC 60050-845:1987, 845-04-40]

3.22**integrated LED lamp**

device including an LED light source, LED driver, and other optical, mechanical, and thermal components, and intended to connect directly to a power source

3.23**non-integrated LED lamp**

device including an LED light source and other optical, mechanical, and thermal components, and intended to connect to an LED driver configured to control the lamp's light output

3.24**LED driver**

electronic device configured to control the output of an LED light source, intended to connect directly to a power source, either packaged along with the LED light source in an integrated LED lamp or packaged separately from the LED light source

3.25**cap****base, en US**

part of a lamp which provides connection to the electrical supply by means of a lampholder or lamp connector and, in most cases, also serves to retain the lamp in the lampholder

Note 1 to entry: The term "base" is also used in both the United Kingdom and the United States of America to denote an integral part of a lamp envelope which has been so shaped that it fulfils the function of a cap. It may engage either a holder or a connector, depending on other design features of the lamp- and holder system.

Note 2 to entry: The cap of a lamp and its corresponding holder are generally identified by one or more letters followed by a number which indicates approximately the principal dimension (generally the diameter) of the cap in millimetres. The standard code is to be found in IEC 60061.

[SOURCE: IEC 60050-845:1987, 845-08-15]

3.26**lampholder**

device which holds the lamp in position, usually by having the cap inserted in it, in which case it also provides the means of connecting the lamp to the electric supply

Note 1 to entry: The term "socket" or, when the context is clear, the abbreviation "holder" are commonly used instead of "lampholder".

Note 2 to entry: See Note 2 to entry 3.25.

[SOURCE: IEC 60050-845:1987:1987, 845-08-24]

3.27**luminaire**

apparatus which distributes, filters or transforms the light transmitted from one or more lamps and which includes, except the lamps themselves, all the parts necessary for fixing and protecting the lamps and, where necessary, circuit auxiliaries together with the means for connecting them to the electric supply

Note 1 to entry: Luminaires that are not supplied with lamps are outside the scope of this part of IEC 62257.

[SOURCE: IEC 60050-845:1987, 845-10-01, modified – Note 1 to entry has been added.]

3.28

lighting appliance

apparatus which distributes, filters or transforms the light transmitted from one or more light sources or lamps and which includes all the parts necessary for fixing and protecting the lamps and, where necessary, circuit auxiliaries together with the means for connecting them to the electric supply

Note 1 to entry: A lighting appliance can be a luminaire with one or more lamps installed, including luminaires with integral lamps. A luminaire with no lamp installed or provided is not a complete lighting appliance (and is outside the scope of this part of IEC 62257).

3.29

device under test

DUT

particular sample that is being measured or observed

4 Characteristics of lamps and lighting appliances

4.1 Product categories

Lamps and lighting appliances can be placed into one of three categories based on their expected range of use. It is important to categorize them because they have different inherent utility to the user and will encounter different environmental conditions based on their design.

Different quality standards and performance criteria may apply to different categories.

A product will fall into one of the following categories:

- Indoor-only products are designed for indoor use only, meaning they are generally intended to be mounted permanently or semi-permanently indoors.
- Indoor/outdoor products are designed to be used indoors or outdoors or both, depending on the user's needs.
- Outdoor-only systems are designed specifically for outdoor use, meaning they are generally intended to be mounted permanently or semi-permanently outdoors.

4.2 System measurements and observations

4.2.1 General

Subclause 4.2 describes aspects of a lamp or lighting appliance for off-grid electricity systems that may be measured and/or observed to ascertain its quality and performance. The aspects are grouped into categories, and each aspect begins with a description of its relevance. The aspects may be measured and/or observed using test procedures, which are generally classified as class A or class B. Class A test procedures will generally result in measurements that are more accurate or less subjective than class B procedures, but class A procedures are also generally more costly to implement. The appropriateness of class A or class B procedures depends on the particular aspect and context of the testing. The description of each aspect concludes with a description of the result from the test procedure, the units, and an example result. In some cases, multiple pieces of information are grouped in a single aspect for clarity and concision.

4.2.2 Design, manufacture, and marketing

4.2.2.1 Arrangement of components

The arrangement of components, as in the example below, is a critical aspect to observe because it determines the product category.

- a) Class A test procedure(s): Annex F – visual screening
- b) Class B test procedure(s): n/a
- c) Result: qualitative description of the components comprising the lamp or lighting appliance
- d) Units: qualitative description
- e) Example: The product is an LED luminaire with all components integrated into a single enclosure.

4.2.2.2 Lighting system information

This aspect describes the types of light sources used in the product and their arrangement. This description is important for understanding the general product design.

- a) Class A test procedure(s): Annex F – visual screening
- b) Class B test procedure(s): Annex C – manufacturer self-reported information
- c) Result: qualitative description of the type, number, and arrangement of light sources
- d) Units: qualitative description
- e) Example: [Photographs attached to test reports], The luminaire consists of 3 LEDs mounted on a circuit board. The LEDs and board are encased in a clear plastic globe and attached to an Edison screw-type cap, making the entire product appear similar to a traditional incandescent light bulb.

4.2.2.3 Packaging and user's manual information

Information about the packaging, user's manual, and other consumer-facing information helps establish a baseline for comparing measured values in truth-in-advertising assessments. It may also be important to document if certain programmes require particular information to be included in the manual, such as instructions for end-of-life disposal.

- a) Class A test procedure(s): Annex F – visual screening
- b) Class B test procedure(s): n/a
- c) Result: there are two types of results
 - 1) photographic documentation of the packaging and manual (or digital copies of the original proofs)
 - 2) notes on the type of manual and which languages are included
- d) Units: qualitative type and photographs
- e) Example: [Photographs attached to test reports], The user's manual is a single-sheet included in the package and includes pictograms with explanations in Hindi, English, French, and Swahili.

4.2.2.4 Warranty information

The terms and duration of warranty coverage provided to end-users are important factors for engendering confidence in stand-alone off-grid lighting and trying to prevent early failure. In practice, servicing warranties is highly variable depending on the structure of supply and service chains.

- a) Class A test procedure(s): Annex F – visual screening
- b) Class B test procedure(s): Annex C – manufacturer self-reported information
- c) Result: detailed warranty terms and a concise version that highlights the key points of coverage and duration.
- d) Units: qualitative type
- e) Example: [Detailed warranty terms are documented in scanned attachments to test report], Coverage is against manufacturing defects or under normal use conditions. The product in general is covered for 12 months from the time of purchase.

4.2.2.5 Other visual screening results

This incorporates various other important results obtained from visual screening (Annex F), including, but not limited to, component dimensions, component masses, the number of light output settings, and provided specifications.

- a) Class A test procedure(s): Annex F – visual screening
- b) Class B test procedure(s): Annex C – manufacturer self-reported information
- c) Result: various results including qualitative descriptions and quantitative measurements
- d) Units: qualitative descriptions and quantitative measurements
- e) Example (for one result): The lighting appliance has a mass of 0,3 kg.

4.2.3 Durability and workmanship

4.2.3.1 Water protection – enclosure

This provides a description of the product enclosure's ability to keep out water in terms of IP class. For products intended to be used and/or charged outside, water protection is important for product function as well as user safety.

- a) Class A test procedure(s): IEC 60529, or the alternative methods in Annex O (physical ingress and water protection) if the alternative method results are unequivocal
- b) Class B test procedure(s): Annex O – physical ingress and water protection
- c) Result: pass or fail for IP class (second digit) and a description of degree of water protection provided by enclosure
- d) Units: pass or fail and qualitative description
- e) Example: The product is estimated to pass IPx3. The product's enclosure contains tight fitting components, all of which have gaskets to prevent water intrusion.

4.2.3.2 Water protection – circuit protection and drainage

This provides a description of any drainage means incorporated into a product and/or circuit board protection methods used in the product. The incorporation of drainage or circuit board protection is crucial for products intended to be outdoors that have enclosures providing little to no water intrusion protection.

- a) Class A test procedure(s): Annex F (visual screening) combined with Annex C (manufacturer self-reported information)
- b) Class B test procedure(s): Annex C – manufacturer self-reported information
- c) Result: qualitative description of drainage or circuit protection methods used
- d) Units: qualitative description
- e) Example: The product has a conformal coating on its circuit board as well as drainage holes in the base of the enclosure to allow drainage of collected water.

4.2.3.3 Physical ingress protection

This provides a description of the degree of protection from the intrusion of foreign objects a product's enclosure provides in terms of IP class. Physical ingress protection is important for user safety as well as product functionality.

- a) Class A test procedure(s): IEC 60529 or the alternative methods in Annex O (physical ingress and water protection) if the alternative method results are unequivocal.
- b) Class B test procedure(s): Annex O – physical ingress and water protection
- c) Result: pass or fail for IP class (first digit) and description of degree of physical ingress protection
- d) Units: pass or fail and qualitative description

- e) Example: The product passes IP4x; the product enclosure's components fit together snugly without gaps, so that only tiny particulate matter (e.g. dust) could intrude.

4.2.3.4 Shipping vibration durability

This provides an evaluation of a product's robustness and ability to withstand vibrations during shipping and distribution.

- a) Class A test procedure(s): Annex N – mechanical durability test
- b) Class B test procedure(s): n/a
- c) Result: pass or fail for functionality, damage, and the presence of user safety hazards
- d) Units: a pass or fail result based on whether the DUT functions, incurs damage, or presents a safety hazard to the user
- e) Example: When subjected to vibrations similar to those experienced during shipping, the product stopped working. Functional: fail. Damage: pass. Safety hazard: pass.

4.2.3.5 Gooseneck durability

This provides an evaluation of a product's gooseneck's robustness and ability to withstand being torqued through its expected range of motion. Gooseneck durability is important for product functionality and user safety and satisfaction.

- a) Class A test procedure(s): Annex N – mechanical durability test
- b) Class B test procedure(s): n/a
- c) Result: a pass or fail for functionality, damage, and the presence of user safety hazards
- d) Units: a pass or fail result based on whether the DUT functions, incurs damage, or presents a safety hazard to the user.
- e) Example: After the gooseneck test, the LEDs worked properly but there was visible damage (a cracked housing) that did not pose a hazard. Functional: pass. Damage: fail. Safety: pass.

4.2.3.6 Connector durability

This provides an evaluation of a product's connectors' robustness and ability to withstand plug cycling. Connector durability is important for product functionality and user safety and satisfaction.

- a) Class A test procedure(s): Annex N – mechanical durability test
- b) Class B test procedure(s): n/a
- c) Result: a pass or fail for functionality, damage, and the presence of user safety hazards
- d) Units: a pass or fail result based on whether the DUT functions, incurs damage, or presents a safety hazard to the user.
- e) Example: After 400 cycles in the connector test, the barrel plug socket detached from the LED driver enclosure, rendering the connector unusable. Functional: fail. Damage: fail. Safety: pass.

4.2.3.7 Switch durability

This provides an evaluation of a product's switches' robustness and ability to withstand switch cycling. Switch durability is important for product functionality and user safety and satisfaction.

- a) Class A test procedure(s): Annex N – mechanical durability test
- b) Class B test procedure(s): n/a
- c) Result: a pass or fail for functionality, damage, and the presence of user safety hazards
- d) Units: a pass or fail result based on whether the DUT functions, incurs damage, or presents a safety hazard to the user.

- e) Example: After 600 cycles in the switch test, the DUT's light switch stopped turning on the DUT. Functional: fail. Damage: fail. Safety: pass.

4.2.3.8 Strain relief durability

This provides an evaluation of a product's strain reliefs' robustness and ability to withstand being pulled. Strain relief durability is important for product functionality and user safety and satisfaction.

- a) Class A test procedure(s): Annex N – mechanical durability test
- b) Class B test procedure(s): n/a
- c) Result: a pass or fail for functionality, damage, and the presence of user safety hazards
- d) Units: a pass or fail result based on whether the DUT functions, incurs damage, or presents a safety hazard to the user.
- e) Example: The DUT's strain reliefs all withstood the strain relief test without incurring any damage. Functional: pass. Damage: pass. Safety: pass.

4.2.3.9 Wiring quality

This provides a qualitative evaluation of a product's wiring quality, including (but not limited to) neatness and connection quality.

- a) Class A test procedure(s): Annex F – visual screening
- a) Class B test procedure(s): n/a
- b) Result: a qualitative description of wiring quality
- c) Units: qualitative description and number of failures with respect to key indicators
- d) Example: The DUT's wires are neatly arranged (e.g. bundled into harnesses and secured with cable ties) and the solder joints are of good quality. There are no bad joints, pinched wires, or other poor wiring indicators.

4.2.4 Electrical characteristics

4.2.4.1 Operating input voltage range

This provides the voltage range over which the DUT can safely and properly operate.

- a) Class A test procedure(s): Annex K – input voltage range
- b) Class B test procedure(s): n/a
- c) Result: table showing relative light output over the operating voltage range; maximum allowable voltage; pass or fail for functionality, damage, and safety
- d) Units: volts, DC or AC (V DC or V AC), and percentage (%); volts; pass/fail; qualitative description
- e) Example: [Table with column headings: operating voltage (V), DUT voltage (V), and relative light output (%); a maximum allowable voltage of 15,8 V DC achieved.] The DUT remained functional after the test and no damage or safety hazard was present.

4.2.4.2 Power consumption

The power consumed by a lamp or lighting appliance is an important metric for use in off-grid applications in which the supply of energy is limited. The power consumption is also used in the calculation of luminous efficacy.

- a) Class A test procedure(s): Annex P – power consumption and power quality
- b) Class B test procedure(s): n/a
- c) Result: active power (AC) or DC power
- d) Units: watts (W)

e) Example: 1,50 W

4.2.4.3 Power factor

The power factor of an AC device is the ratio of the active power (real power, measured in watts) to the apparent power (measured in volt-amperes). The power factor is an important metric for off-grid applications since the power output capacity of generators and inverters is often given in terms of apparent power. Using devices with high power factor results in more efficient use of a given generator or inverter's capacity.

- a) Class A test procedure(s): Annex P – power consumption and power quality
- b) Class B test procedure(s): n/a
- c) Result: active power (AC) or DC power
- d) Units: unitless
- e) Example: 0,95

4.2.4.4 Current total harmonic distortion (THD)

The current total harmonic distortion is a measure of harmonic content in a device's current waveform – that is, how much the current waveform deviates from a true sine wave. High levels of harmonic current can cause heating in power generation and distribution equipment (such as generators and transformers) and can lead to distortions in the system's voltage waveform, negatively impacting the performance of other equipment connected to the electricity system.

- a) Class A test procedure(s): Annex P – power consumption and power quality
- b) Class B test procedure(s): n/a
- c) Result: active power (AC) or DC power
- d) Units: percentage (%)
- e) Example: 15 %

4.2.5 Photometric performance measures

4.2.5.1 Luminous flux output

Luminous flux output is the light output of a DUT when it is driven at a specific voltage. This is a key metric that compares the overall light output of DUTs.

- a) Class A test procedure(s): CIE 084, CIE 127, IESNA LM-78-07, or IESNA LM-79-08
- b) Class B test procedure(s): Annex I – light output
- c) Result: luminous flux
- d) Units: lumens (lm)
- e) Example: 95,6 lm

4.2.5.2 Luminous efficacy

Luminous efficacy is the light output of a DUT (in lumens) divided by the power the DUT is consuming (in watts). This is a key metric that compares the ability of DUTs to turn electrical power into usable light.

- a) Class A test procedure(s): CIE 084, CIE 127, IESNA LM-78-07, or IESNA LM-79-08
- b) Class B test procedure(s): Annex I – light output
- c) Result: luminous efficacy
- d) Units: lumens per watt (lm/W)
- e) Example: 96,3 lm/W

4.2.5.3 Full width half maximum (FWHM) angles

The full width half maximum angle is a metric used to understand the light distribution of a DUT and is the total angle over which the illumination is greater than or equal to half the illumination at the brightest point at a given distance from the light source in a given plane.

- a) Class A test procedure(s): CIE 084, CIE 127, IESNA LM-79-08
- b) Class B test procedure(s): Annex J – light distribution
- c) Result: vertical and horizontal FWHM angles
- d) Units: degrees (°)
- e) Example: The DUT's horizontal and vertical FWHM angles are both 65°.

4.2.5.4 Light distribution characteristics

A light distribution is the illuminance “map” of a DUT. This metric is useful for determining the utility with respect to task lighting. The test is done by driving the DUT at a specific voltage.

- a) Class A test procedure(s): CIE 084, CIE 127, IESNA LM-79-08
- b) Class B test procedure(s): Annex J – light distribution
- c) Result: useable area at a specified distance and illuminance on a work surface
- d) Units: square metres (m²)
- e) Example: The DUT's useable area at a distance of 0,5 m is 0,76 m²

4.2.5.5 Colour characteristics

The colour characteristics of light include the colour rendering index (CRI), a measure of how accurately the light renders colours, and the correlated colour temperature (CCT), a measure of the colour of the light expressed as a temperature in kelvin.

- a) Class A test procedure(s): Annex I – light output
- b) Class B test procedure(s): n/a
- c) Result: CRI and CCT values
- d) Units: CRI is unitless and the CCT is in kelvin (K)
- e) Example: The CRI is 80 and the CCT is 7 000 K.

4.2.6 Photometric durability measures

4.2.6.1 Lumen maintenance (LED)

This is a measure of the amount of degradation in light output after 1 000 h and 2 000 h of operation at a constant voltage, which can provide valuable insight into the quality of the LEDs and/or the DUT's circuitry.

- a) Class A test procedure(s): Annex L – lumen maintenance
- b) Class B test procedure(s): n/a
- c) Result: percentage of lumen output maintained after 1 000 h and 2 000 h of constant operation
- d) Units: percentage (%)
- e) Example: The DUT maintained 96 % and 93 % of its original lumen output after 1 000 h and 2 000 h of operation, respectively.

4.2.6.2 Cycle life (fluorescent)

This is a measure of the number of on/off cycles a fluorescent DUT can undergo before the DUT ceases to properly function.

- a) Class A test procedure(s): Annex M – cycling

- b) Class B test procedure(s): n/a
- c) Result: a pass or fail for functionality after 3 000, 6 000, and 12 000 on/off cycles
- d) Units: a pass or fail for functionality
- e) Example: The DUT continued to function after 12 000 on/off cycles.

4.2.7 Self-declaration aspects

4.2.7.1 Product and manufacturer information

Manufacturer-reported product and manufacturer information is important for tracking purposes as well as for ensuring the test laboratory has up-to-date product information.

- a) Class A test procedure(s): Annex C – manufacturer self-reported information
- b) Class B test procedure(s): n/a
- c) Result: various qualitative and quantitative information
- d) Units: qualitative and quantitative
- e) Example: The product's free-on-board price is 30 USD; it is sold in Kenya and India; etc.

4.2.7.2 Warranty coverage

Warranty coverage goes beyond the terms of a warranty and provides detail on coverage in a particular location. It is typically only provided in cases where it is necessary to verify coverage in a particular town or region.

- a) Class A test procedure(s): Annex C – manufacturer self-reported information
- b) Class B test procedure(s): n/a
- c) Result: qualitative description
- d) Units: qualitative description
- e) Example: The support in [region name] is provided by a small network of technicians who have been trained to repair products by [manufacturer or distributor name]. For repairs that are beyond the scope of their capabilities, replacement products are provided. The consumers in [region name] can access warranty service by dialling a phone number that is on a sticker placed on the original packaging.

4.2.7.3 Third-party marks and certifications

Third-party marks and certifications (e.g. UL) can be an important aspect in the eyes of consumers and investors, alike.

- a) Class A test procedure(s): Annex C – manufacturer self-reported information
- b) Class B test procedure(s): n/a
- c) Result: qualitative marks and certifications
- d) Units: qualitative type
- e) Example: ISO 9001 certified.

5 Product specification

5.1 General

Quality standards, warranty requirements, and performance criteria are used to interpret the measurements and observations made about a product. Together they form a product specification. See Figure 1.



Figure 1 – The three components of a product specification

- **Quality standards** set a minimum level of durability and protect buyers and users from false advertising claims.
- **Warranty requirements** set a minimum level of user protection from early failure.
- **Performance criteria** set a recommended level of service and features.

Each criterion in a specification refers to a particular aspect of the product, as listed in 4.2, and requires a minimum level of quality, service, or performance.

The standards, requirements, and performance criteria should be appropriate for the goals of the organization or individual who is using them as a framework for quality assurance and should consider the following factors:

- availability of products on the market with the necessary quality and performance;
- ability of buyers to pay for the products;
- diversity of end-user needs;
- tolerance for manufacturing variation.

Clause 5 describes the framework for standards, requirements, and performance criteria in general and offers insights on the best practices for creating a product specification. It includes a template product specification followed by guidance on completing each section. Annex A presents an example specification for off-grid lighting market support programme qualification. Annex B presents another example, for bulk procurement.

5.2 Applications

Product specifications that include some combination of quality standards, warranty requirements, and performance criteria can support a broad range of quality assurance needs. Table 1 below lists examples of how they are applied depending on the type of quality assurance (QA) framework.

Table 1 – Applications of product specifications

Type of QA framework	Example(s) of applying Clause 5
General market support	Use quality standards and general warranty requirements to qualify for institutional market support; provide additional services if performance criteria are also met. Use quality standards to qualify for “verified product” programmes. Use quality standards and other requirements to qualify for investment or financing.
Manufacturing/distribution	For manufacturers: incorporate quality standards and performance criteria from market support programmes or distributors in the design and production quality control processes. For distributors: set minimum quality standards, warranty requirements, and/or performance criteria for products to identify suppliers.
Bulk procurement	Set minimum quality standards, warranty requirements, and/or performance criteria for products to qualify in a request for offers. If the project is in a specific location, the warranty requirements may also include specific levels of service in that particular area.
Trade regulation	Set minimum quality standards for tax exemption or customs.

5.3 Quality assurance principles

5.3.1 General

The framework for considering quality standards, warranty requirements, and performance criteria presented in this part of IEC 62257 is designed to support broad types of programmes and institutions in the off-grid lighting market. The following key principles guide the framework:

- Balance quality and affordability for price-sensitive buyers – it does not matter how well products perform if the target users cannot afford them.
- Encourage innovation and technological diversity. Wherever possible, be open-ended in the technical approaches that are allowed.
- Empower buyers to choose the right product for their needs and budget by focusing product specifications and communication on outcomes for end-users.
- Use low-cost, rigorous, targeted tests to match the general affordability requirements for the market and accommodate both incremental and innovative changes to product design. The tests should be feasible for use by a broad set of potential users.
- Focus quality standards on elements of a product that are difficult for typical buyers to assess themselves, like truth-in-advertising and durability.
- Focus warranty requirements on providing a baseline of support.
- Focus performance criteria on bottom-line user experience metrics like run time and brightness.

5.3.2 Rationale for dividing quality, warranty, and performance

Quality standards, warranty requirements, and performance criteria are considered separately to allow programmes and institutions the flexibility to establish targets with their goals in mind:

- Quality standards deal with basic consumer protection (from early product failure, unsafe operation, or false advertising) and typically are a “baseline” or minimum level.
- Warranty requirements deal with aspects of the products and projects that are not controlled at the factory or installation site – the service available for products is typically very dependent on the supply chain and geography.
- Performance criteria are typically in addition to quality standards and define service levels that should be met. The diversity of needs, power availability, and ability of end-users to pay for appliances and electric service shall be known to precisely set performance criteria.
- Enables tiered service offerings for market support programmes. For instance, it is possible to have a tiered support system in which certain services only require meeting quality standards and warranty requirements while others also require meeting performance criteria.

5.4 Product specification framework description

5.4.1 General

Subclause 5.4 describes a framework of product specification documents for lamps and lighting appliances included in the scope of this part of IEC 62257. First, a blank specification is provided that lists all the pieces that may be specified. It is followed by a subclause describing guidelines for setting tolerances in a product specification. Finally, the main sections in a specification are described in more detail with notes and guidance.

There are example product specifications in Annex A and Annex B; one is for general market support programmes and the other is a “sample tender” for bulk purchasing.

A product specification has six parts, as follows:

- a) **Scope** defines the applicability and use of the quality standards and performance criteria.

- b) **Test requirements** defines requirements for test result validity.
- c) **Product category requirements** unambiguously defines the categories that may be referenced later.
- d) **Quality standards** lists quality-related aspects and minimum or required results for each aspect with a tolerance; may be subdivided by product category.
- e) **Warranty requirements** lists requirements for minimum levels of warranty support.
- f) **Performance criteria** lists performance-related aspects and minimum or required results for each aspect with a tolerance; may be subdivided by product category.

5.4.2 Product specification template

5.4.2.1 General

Subclause 5.4.2 is a blank, rough template for setting quality standards, warranty requirements, and performance criteria to support the goals of a programme or institution. Note that in many applications certain criteria or entire categories of criteria may not apply and should be removed.

NOTE *Text in italics* is intended for replacement and describes what should go in each space.

5.4.2.2 Scope

Describe the intended use of the product specification. Describe the contents in general and provide guidance on how to use the document.

5.4.2.3 Test requirements

Specify the level of testing that is required. For example, Quality Test Method (QTM) level testing (see Clause 6).

Describe any product sampling requirements for qualification testing.

5.4.2.4 Product category requirements

Describe which product technology categories (e.g. AC and/or DC, lamps and/or luminaires, LEDs and/or CFLs, etc.) are covered/allowed.

Describe any voltage limits or other required electrical system integration tolerances (e.g. nominal 12 V DC, AC voltage input range 100 V to 250 V, AC frequency 50 Hz, etc.).

Describe any other categorical requirements for products (e.g. shall have an E27 Edison screw cap, etc.).

5.4.2.5 Quality standards

The product shall meet each of the criteria listed in the truth-in-advertising (Table 2), safety and durability (Table 3), power quality for AC products (Table 4), and end-user support (Table 5) tables.

Table 2 – Truth-in-advertising tolerance

Truth-in-advertising criterion	Aspect(s) considered in assessment	Requirement
System performance tolerance – numeric ratings	4.2.5 Photometric performance measures Others, if applicable	<i>Define the tolerance for deviation from ratings.</i>
Other numeric ratings tolerance	Multiple	<i>Define the tolerance for deviation from ratings.</i>
Overall truth-in-advertising statement	Multiple	<i>Include an overall description of the requirements for truth-in-advertising that may not be covered by the requirements above.</i>

Table 3 – Safety and durability standards

Safety or durability criterion	Aspect(s) considered in assessment	Product category (form factor and/or technology)	Requirement
Level of water exposure protection (<i>overall, technical, or enclosure-only</i>)	4.2.3.1 Water protection – enclosure	Category 1	<i>Define level of protection in terms of water protection integrated assessment:</i> <i>No protection, occasional rain, frequent rain, or permanent outdoor exposure.</i>
	4.2.3.2 Water protection – circuit protection and drainage 4.2.7.1 Product and manufacturer information 4.2.2.3 Packaging and user's manual information	Category 2...	<i>Define level of protection in terms of water protection integrated assessment.</i>
Physical ingress protection	4.2.3.3 Physical ingress protection	Category 1	<i>Define level of protection in terms of IP class.</i>
		Category 2...	<i>Define level of protection in terms of IP class.</i>
Mechanical durability – shipping vibration	4.2.3.4 Shipping vibration durability	All products ^a	<i>Define maximum number of failures out of the number that are tested for damage, functionality, and safety.</i>
Mechanical durability – goosenecks	4.2.3.5 Gooseneck durability	Products with goosenecks	<i>Define maximum number of failures out of the number that are tested for damage, functionality, and safety.</i>
Mechanical durability – connectors	4.2.3.6 Connector durability	Products with connectors	<i>Define maximum number of failures out of the number that are tested for damage, functionality, and safety.</i>
Mechanical durability – switches	4.2.3.7 Switch durability	All products	<i>Define maximum number of failures out of the number that are tested for damage, functionality, and safety.</i>
Mechanical durability – strain relief	4.2.3.8 Strain relief durability	Products with connectors	<i>Define maximum number of failures out of the number that are tested for damage, functionality, and safety.</i>