IEC/TS 62257-7-1

Edition 2.0 2010-09

TECHNICAL SPECIFICATION

colour inside

Recommendations for small renewable energy and hybrid systems for rural electrification – Part 7-1: Generators – Photovoltaic generators

IEC/TS 62257-7-1:2010(E)

IEC Central Office
3, rue de Varembé
CH-1211 Geneva 20
Switzerland
Email: inmail@iec.ch
Web: www.iec.ch

About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigenda or an amendment might have been published.

- Catalogue of IEC publications: www.iec.ch/searchpub
The IEC on-line Catalogue enables you to search by a variety of criteria (reference number, text, technical committee,…). It also gives information on projects, withdrawn and replaced publications.

- IEC Just Published: www.iec.ch/online_news/justpub
Stay up to date on all new IEC publications. Just Published details twice a month all new publications released. Available on-line and also by email.

- Electropedia: www.electropedia.org
The world's leading online dictionary of electronic and electrical terms containing more than 20 000 terms and definitions in English and French, with equivalent terms in additional languages. Also known as the International Electrotechnical Vocabulary online.

- Customer Service Centre: www.iec.ch/webstore/custserv
If you wish to give us your feedback on this publication or need further assistance, please visit the Customer Service Centre FAQ or contact us:

Email: csc@iec.ch
Tel.: +41 22 919 02 11
Fax: +41 22 919 03 00

IEC/TS 62257-7-1

Edition 2.0 2010-09

TECHNICAL SPECIFICATION

colour inside

Recommendations for small renewable energy and hybrid systems for rural electrification – Part 7-1: Generators – Photovoltaic generators

INTERNATIONAL ELECTROTECHNICAL COMMISSION

PRICE CODE XC

ICS 27.160

ISBN 978-2-88912-177-9

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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

Part 7-1: Generators – Photovoltaic generators

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
6) All users should ensure that they have the latest edition of this publication.
7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

The main task of IEC technical committees is to prepare International Standards. In exceptional circumstances, a technical committee may propose the publication of a technical specification when

– 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 62257-7-1, 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 2006 and constitutes a technical revision.

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

– This new version is focused on small PV generators up to 100 kW_p.
– Case studies are provided.

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

Enquiry draft	Report on voting
82/583/DTS	82/604/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, published under the general title, *Recommendations for small renewable energy and hybrid systems for rural electrification* can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site 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 edition of this document 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 of publications 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. voltage below 500 V, d.c. voltage below 750 V and power below 100 kVA.

These publications provide recommendations for

- choosing the right system for the right place;
- designing the system;
- operating and maintaining the system.

These publications are focused only on rural electrification concentrated in, but not specific to, developing countries. They must not be considered as all-inclusive of rural electrification. The publications try to promote the use of renewable energies in rural electrification. They do not deal with clean mechanism 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 publications is best considered as a whole, with different parts corresponding to items for the safety and sustainability of systems at the lowest possible life-cycle cost. One of the main objectives of the series is to provide the minimum sufficient requirements relevant to the field of application, i.e. for small renewable energy and hybrid off-grid systems.

The purpose of IEC 62257-7-1 is to propose a technical specification for the design and building of small PV generators (e.g. up to 100 kW_p) used in rural electrification.

Numerous experts of TC 82 have expressed the opinion that the first edition of IEC/TS 62257-7-1 is far more general than just the PV array for rural electrification but can also be used for big PV arrays in big PV power stations.

Therefore it is now necessary to develop a second edition more dedicated and more specific to rural electrification. It is the purpose of this second edition to specify the general requirements for the design and the safety of PV generator used in decentralized rural electrification systems.

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

Part 7-1: Generators – Photovoltaic generators

1 Scope

This part of IEC 62257 specifies the general requirements for the design and safety of generators used in decentralized rural electrification systems.

The earthing systems of the exposed conductive parts and neutral earthing systems which are considered in this technical specification are those specified in IEC 62257 series for IES (see IEC 62257-9-3 and IEC 62257-9-4) and CES (IEC 62257-9-2).

This technical specification contains requirements for ELV and LV PV arrays (see Table 1). Particular attention must be paid to voltage level, as this is important for safety reasons and has an influence on protective measures and on the skill and ability level of people operating the systems.

Table 1 – Voltage domains for PV arrays

Voltage domain	Voltage V	
	Alternating current	Smoothed direct current
ELV	$U_n \leq 50$ V	$U_{oc} \leq 120$ V
LV	50 V < $U_n \leq$ 1 000 V	120 V < $U_{oc} \leq$ 1 500 V
NOTE ELV limits are provided by IEC 61201.		

For the sake of completeness, this technical specification gives requirements for d.c. voltages below and above 120 V.

The aim is to provide safety and fire protection requirements for:

– uninformed persons, including owner(s)/occupier(s) and users of the premises where photovoltaic arrays are installed;
– informed workers (e.g. electricians) working on these systems; and
– emergency workers (for example fire fighters).

For installation of PV arrays see IEC 60364-7-712.

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 60050-811:1991, *International Electrotechnical Vocabulary (IEV) – Chapter 811: Electric traction*

IEC 60287 (all parts), *Electric cables – Calculation of the current rating*

IEC 60364 (all parts), *Low-voltage electrical installations*

IEC 60364-4-41, *Low-voltage electrical installations – Part 4-41: Protection for safety – Protection against electric shock*

IEC 60364-5-54, *Electrical installations of buildings – Part 5-54: Selection and erection of electrical equipment – Earthing arrangements, protective conductors and protective bonding conductors*

IEC 60364-7-712:2002, *Electrical installations of buildings – 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 61140, *Protection against electric shock – Common aspects for installation and equipment*

IEC 61215, *Crystalline silicon terrestrial photovoltaic (PV) modules – Design qualification and type approval*

IEC 61643-12, *Low voltage surge protective devices – Part 12: Surge protective devices connected to low voltage power distribution systems – Selection and application principles*

IEC 61646, *Thin–film terrestrial photovoltaic (PV) modules – Design qualification and type approval*

IEC 61730 (all parts), *Photovoltaic (PV) module safety qualification*

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

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

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

IEC 62257-9-1, *Recommendations for small renewable energy and hybrid systems for rural electrification – Part 9-1: Micropower systems*

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

IEC 62257-9-3, *Recommendations for small renewable energy and hybrid systems for rural electrification – Part 9-3: Integrated system – User interface*

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

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

IEC 62305-3, *Protection against lightning – Part 3: Physical damage to structures and life hazard*

3 Terms and definitions

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

3.1
available, readily
capable of being reached for inspection, maintenance or repairs without necessitating the dismantling of structural parts, cupboards, benches or the like

3.2
blocking diode
diode connected in series to module(s), panel(s), sub-arrays and array(s) to block reverse current into such module(s), panel(s), sub-array(s) and array(s)

3.3
bypass diode
diode connected across one or more cells in the forward current direction to allow the module current to bypass shaded or broken cells to prevent hot spot or hot cell damage resulting from the reverse voltage biasing from the other cells in that module

3.4
cable
assembly of one or more conductors and/or optical fibres, with a protective covering and possibly filling, insulating and protective material

3.5
cable core
the conductor with its insulation but not including any mechanical protective covering

3.6
CES
Collective electrification system

3.7
shield (of a cable)
a surrounding earthed metallic layer to confine the electric field within the cable and/or to protect the cable from external electrical influence

NOTE Metallic sheaths, armour and earthed concentric conductors may also serve as shields.

[IEC 60050-461:1984, 461-03-04]

3.8
class I equipment
equipment in which protection against electric shock does not rely on basic insulation only, but which includes an additional safety precaution in that accessible conductive parts are connected to the protective earthing conductor in the fixed wiring of the electrical installation in such a way that accessible parts cannot become live in the event of a failure of the basic insulation

NOTE 1 Class I equipment may have parts with double insulation or parts operating at SELV.

NOTE 2 For equipment intended for use with a flexible cord or cable, this provision includes a protective earthing conductor as part of the flexible cord or cable.

3.9
class II equipment
equipment in which protection against electric shock does not rely on basic insulation only, but in which additional safety precautions such as double insulation or reinforced insulation

are provided, there being no provision for protective earthing or reliance upon installation conditions. Such equipment may be one of the following types:

– equipment having durable and substantially continuous enclosures of insulating material which envelops all metal parts, with the exception of small parts, such as nameplates, screws and rivets, which are isolated from live parts by insulation at least equivalent to reinforced insulation. Such equipment is called insulation-encased Class II equipment;

– equipment having a substantially continuous metal enclosure, in which double insulation is used throughout, except for those parts where reinforced insulation is used, because the application of double insulation is manifestly impracticable. Such equipment is called metal-encased Class II equipment;

– equipment that is a combination of the types described in items (a) and (b)

NOTE 1 The enclosure of insulation-encased Class II equipment may form part of the whole of the supplementary insulation or of the reinforced insulation.

NOTE 2 If the equipment with double insulation or reinforced insulation throughout has an earthing terminal or earthing contact, it is considered to be of Class I construction.

NOTE 3 Class II equipment may be provided with means for maintaining the continuity of protective circuits, insulated from accessible conductive parts by double insulation or reinforced insulation.

NOTE 4 Class II equipment may have parts operating at SELV.

3.10
class III equipment
equipment in which protection against electric shock relies on supply at SELV and in which voltages higher than those of SELV are not generated

NOTE Equipment intended to be operated at SELV and which have internal circuits that operate at a voltage other than SELV are not included in the classification and are subject to additional requirements.

3.11
double insulation
insulation comprising both basic insulation and supplementary insulation

[IEC 60050-195:1998, 195-06-08]

3.12
earthing
a protection against electric shocks

3.13
extra-low voltage
ELV
voltage not exceeding the relevant voltage limit of band I specified in IEC 60449

[IEC 60050-826:2004, 826-12-30]

NOTE 1 See also IEC 61201.

NOTE 2 Voltage not exceeding 50 V a.c. and 120 V d.c. ripple free are considered to be ELV.

3.14
HMPS
hybrid micropower system: micropower system including generators from different technologies

3.15
IES
Individual electrification system

3.16
***I*MOD_REVERSE**
the current a module can withstand in the reverse direction to normal without damage to the module. This rating is obtained from the manufacturer at expected operating conditions

NOTE 1 This current rating does not relate to bypass diode rating. The module reverse current is the current flowing through the PV cells in the reverse direction to normal current.

NOTE 2 A typical figure for crystalline silicon modules is between 2 and 2,6 times the normal short circuit current rating ISC MOD.

3.17
***I*SC MOD**
the short circuit current of a PV module or PV string at Standard Test Conditions (STC), as specified by the manufacturer in the product specification plate

NOTE As PV strings are a group of PV modules connected in series, the short circuit current of a string is equal to $I_{SC\ MOD}$.

3.18
***I*SC S-ARRAY**
the short circuit current of a PV sub-array at Standard Test Conditions (STC), and equal to:

$$I_{SC\ S\text{-}ARRAY} = I_{SC\ STC\ MOD} \times S_{SA}$$

where S_{SA} is the number of parallel-connected PV strings in the PV sub-array

3.19
***I*SC ARRAY**
the short circuit current of the PV array at Standard Test Conditions, and is equal to:

$$I_{SC\ ARRAY} = I_{SC\ STC\ MOD} \times S_A$$

where S_A is the total number of parallel-connected PV strings in the PV array

3.20
junction box
closed or protected connecting device allowing making of one or several junctions

[IEC 60050-442:1998, 442-08-03]

3.21
live part
conductor or conductive part intended to be energized in normal operation, including a neutral conductor, but by convention not a PEN conductor or PEM conductor or PEL conductor

NOTE This concept does not necessarily imply a risk of electric shock.

[IEC 60050-195:1998, 195-02-19]

3.22
PEL conductor
conductor combining the functions of both a protective earthing conductor and a line conductor

[IEC 60050-195:1998, 195-02-14]