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TECHNICAL SPECIFICATION

Renewable energy and hybrid systems for rural electrification – Part 9-7: Recommendations for selection of inverters

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FOREWORD

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Technical specifications are subject to review within three years of publication to decide whether they can be transformed into International Standards.

IEC TS 62257-9-7, which is a Technical Specification, has been prepared by IEC technical committee 82: Solar photovoltaic energy systems.

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

Enquiry draft	Report on voting
82/1473/DTS	82/1546A/RVDTS

Full information on the voting for the approval of this technical specification can be found in the report on voting indicated in the above table.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

This part of IEC 62257 is to be used in conjunction with IEC 62257 (all parts).

A list of all parts in the IEC 62257 series, published under the general title *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 document will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

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

RENEWABLE ENERGY AND HYBRID SYSTEMS FOR RURAL ELECTRIFICATION –

Part 9–7: Recommendations for selection of inverters

1 Scope

This part of IEC 62257, which is a technical specification, specifies the criteria for selecting and sizing inverters suitable for different off-grid applications integrating solar as an energy source.

As well as off-grid system, this document can also apply to inverters where a utility grid connection is available as a backup for charging batteries, but it is not intended to cover applications in which inverters synchronize and inject energy back into a utility grid, even though this capability may incidentally be a part of the functionality of the inverters.

Single and multi-phase applications are included.

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

IEC 61683, *Photovoltaic systems – Power conditioners – Procedure for measuring efficiency*

IEC 61800, *(all parts), Adjustable speed electrical power drive systems*

IEC 61800-3, *Adjustable speed electrical power drive systems – Part 3: EMC requirements and specific test methods*

IEC 61800-5-1, *Adjustable speed electrical power drive systems – Part 5-1: Safety requirements – Electrical, thermal and energy*

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

IEC 62109, (*all parts), Safety of power converters for use in photovoltaic power systems*

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

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

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

IEC TS 62257-7-4: *Recommendations for renewable energy and hybrid systems for rural electrification – Part 7-4: Generators – Integration of solar with other forms of power generation within hybrid power systems*

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

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
renewable energy
REN
energy from a source that is not depleted when used

3.2
hybrid power plants
multi-sources system with at least two kinds of energy generation technology

3.3
storage
storage of electrical energy produced by one of the generators of the system in a battery

3.4
DC bus
node of the electrical system to which the DC input of the battery inverter is connected to

3.5
AC bus
node of the electrical system to which the AC output of the battery inverter is connected to

3.6
black start
process of starting an electrical power supply without relying on any other external generating source

4 Overview

Inverters are used to convert DC power into AC power. For off-grid renewable applications, there are different types of inverters that may be used depending upon the architecture of the system.

Some systems work with batteries and use the firm energy they provide to form the conditions of the micro-grid (grid-forming inverters) and some inverters synchronize to an existing grid.

In addition, some inverters are bi-directional inverter/chargers, which not only convert DC battery current into AC, but also reverse the process and transform the AC current into a DC battery charging current to permit battery charging from the AC side of the inverter.

Off-grid inverters need to be correctly selected for the features which they possess, and sized accordingly depending upon the loads they shall feed or the energy sources they are fed by.

5 System architecture and inverter selection

Different sorts of system architectures of isolated electrification systems are given in IEC TS 62257-2. Not all of them require inverters, but several do. Depending on the situation encountered, the inverters will need to possess certain features.

Table 1 shows the system architectures from IEC TS 62257-2 that need inverters, and gives the general correspondence of which inverter is suitable for which application, with some exceptions noted.

Table 1 – Types of inverter and system architecture it is applicable to

Type of inverter	Principal system architecture	Description	Example applications	Variations on architecture
Variable Speed Drives	T1I-c	REN systems operating with no storage and no diesel generators or grid backup	Solar water pumping	Some drives may also use diesel or grid
Grid forming inverters that work with batteries	T2I	REN systems with storage and no diesel generators or grid backup REN and battery are coupled on the DC bus	Solar home systems	Some systems may allow generators or grid to connect via an additional battery charger
Grid-Tie Inverters that synchronize to another AC source	T3I	REN systems operating with diesel generators or grid backup but no storage	Reduction of diesel consumption in off-grid industrial applications	Some systems may use some battery storage to smooth transition between renewables and diesel
Bi-directional inverters that work with batteries	T4I	REN systems operating with diesel generators or grid backup and storage REN and battery are coupled at DC or AC bus	Mini-grid systems; telecommunications towers; larger solar home systems	Some mini-grid systems may not include diesel or grid back-up

NOTE There are also dual-mode inverters, which synchronize to a grid under normal circumstances, but under grid failure become grid-forming inverters. The typical application for this sort of inverter is for grid-connected systems, where the grid is weak and unreliable, and has been excluded from the scope of this document.

6 General considerations

6.1 Overview

The following are generally applicable to all types of inverters:

6.2 IP rating

All inverters should have an IP rating according to IEC 60529 suitable for the environmental conditions they will be installed in.

6.3 Ambient temperature

Inverters may not be installed in an ambient temperature outside of their specification.

Attention should be paid to how changing ambient temperature affects the power output of the inverters. Power/temperature curves of inverters are available from manufacturers which should be used for correct inverter sizing.

6.4 Altitude

Attention should be paid to the altitude in which the inverters will be installed.

Altitude has impact on insulation, clearances and creepage. When exceeding the altitude specification of the inverter a lower DC voltage may need to be applied.

Altitude also affects the ventilation of inverters. Outside of the altitude specification the manufacturer should be consulted regarding the power/temperature curves.

6.5 Direct sunlight

Special care should be taken when inverters will be exposed to direct sunlight. Direct sunlight can damage LCD screens on inverters, and under those conditions it may be necessary to select inverters without such screens, or to install them along with sun-shields.

6.6 Efficiency

The conversion efficiency of inverters should be considered at design stage to correctly quantify system performance.

6.7 No-load and stand-by power requirements

Consideration should be taken over whether the inverters have any stand-by or no-load power requirements, which may have an impact on overall system performance.

6.8 Ventilation requirements

Manufacturer's instructions regarding clearances around the inverters and sufficient ventilation in the spaces they are installed in shall be considered in order to avoid overheating of the units.

6.9 Earthing arrangements

Manufacturer's instructions should be consulted to ensure that the inverter is compatible with the system earthing arrangements. Applicable standards and regulations shall be followed regarding earthing of the system.

6.10 Waveform quality

Common types of inverter are pure sine wave inverters and modified sine wave inverters. Sine wave inverters will have a low harmonic distortion, while modified square wave inverters will have a higher harmonic distortion.

Although some loads will work with an inverter with higher wave-form distortion, others will not run at all or may get damaged, and other potential consequences are motor loads working less efficiently and timers not working properly. It is important to take into consideration the amount of harmonic distortion that can be tolerated by the loads in the system.

6.11 Compatibility with loads that produce significant harmonics

If any of the loads on the system cause significant harmonic currents, for example because of half-wave rectification in a welding machine, then the manufacturer should be consulted to ensure the inverter is capable of supplying energy to that load.