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Ground-mounted photovoltaic power plants – Design guidelines and recommendations

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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 TS 62738, 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
82/1291/DTS	82/1374/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.

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- withdrawn,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

This document sets out general guidelines and recommendations for the design and installation of utility scale ground-mounted photovoltaic (PV) power plants. The focus is largely on design aspects that differ from those of conventional residential and commercial PV systems. Power plants are a significant and growing component of the PV market, yet design methodologies range considerably, partly due to the fact that systems are not accessible to the public or non-qualified personnel. Overall guidelines are still needed to ensure safe, reliable, and productive systems.

GROUND-MOUNTED PHOTOVOLTAIC POWER PLANTS – DESIGN GUIDELINES AND RECOMMENDATIONS

1 Scope

This document sets out general guidelines and recommendations for the design and installation of ground-mounted photovoltaic (PV) power plants. A PV power plant is defined within this document as a grid-connected, ground-mounted system comprising multiple PV arrays and interconnected directly to a utility's medium voltage or high voltage grid. Additional criteria is that PV power plants are restricted from access by non-qualified persons and are continuously monitored for safety and protection, either by on-site personnel or by active remote monitoring. Technical areas addressed are those that largely distinguish PV power plants from smaller, more conventional installations, including ground mounted array configurations, cable routing methods, cable selection, overcurrent protection strategies, equipotential bonding over large geographical areas, and equipment considerations.

Safety and design requirements are referenced to the applicable requirements of IEC 62548 to address distinct differences relative to the design requirements for residential, commercial and other non-power plant applications. In general, existing standards are referenced wherever possible for uniformity. Emphasis is placed on systems employing d.c. string based systems using large scale central inverters or 3-phase string inverters, but relevant sections are also applicable to systems employing a.c. modules or d.c./d.c. converters. Medium voltage transformers, switchgear, collection systems, substations, utility interconnection, auxiliary loads, energy storage systems, and communication services are addressed, but discussion is mostly limited to recommended references to other standards and requirements.

Rooftop-mounted systems, building integrated PV (BIPV) and building applied PV (BAPV) are not included in the scope of this document. The principles of restricted-access power plants are not compatible with systems on buildings, which are used for purposes other than power generation.

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 60076-1, *Power transformers – Part 1: General*

IEC 60076-2, *Power transformers – Part 2: Temperature rise for liquid-immersed transformers*

IEC 60076-3, *Power transformers – Part 3: Insulation levels, dielectric tests and external clearances in air*

IEC 60076-4, *Power transformers – Part 4: Guide to the lightning impulse and switching impulse testing – Power transformers and reactors*

IEC 60076-5, *Power transformers – Part 5: Ability to withstand short-circuit*

IEC 60076-7, *Power transformers – Part 7: Loading guide for mineral-oil-immersed power transformers*

IEC 60085, *Electrical insulation – Thermal evaluation and designation*

IEC 60137, *Insulated bushings for alternating voltages above 1000 V*

IEC 60183, *Guidance for the selection of high-voltage A.C. cable systems*

IEC 60228, *Conductors of insulated cables*

IEC 60255-21-3, *Electrical relays – Part 21: Vibration, shock, bump and seismic tests on measuring relays and protection equipment – Section 3: Seismic tests*

IEC 60296, *Fluids for electrotechnical applications – Unused mineral insulating oils for transformers and switchgear*

IEC 60364-5-52, *Low-voltage electrical installations – Part 5-52: Selection and erection of electrical equipment – Wiring systems*

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

IEC 60502-1, *Power cables with extruded insulation and their accessories for rated voltages from 1 kV (Um = 1,2 kV) up to 30 kV (Um = 36 kV) – Part 1: Cables for rated voltages of 1 kV ((Um = 1,2 kV) and 3 kV (Um = 3,6 kV)*

IEC 60502-2, *Power cables with extruded insulation and their accessories for rated voltages from 1 kV (Um = 1,2 kV) up to 30 kV (Um = 36 kV) – Part 2: Cables for rated voltages from 6 kV (Um = 7,2 kV) up to 30 kV (Um = 36 kV)*

IEC 60853 (all parts), *Calculation of the cyclic and emergency current rating of cables*

IEC 60870-5-104, *Telecontrol equipment and systems – Part 5-104: Transmission protocols – Network access for IEC 60870-5-101 using standard transport profiles*

IEC TR 60890, *A method of temperature-rise verification of low-voltage switchgear and controlgear assemblies by calculation*

IEC 60947-3:2008, *Low-voltage switchgear and controlgear – Part 3: Switches, disconnectors, switch-disconnectors and fuse-combination units*

IEC 60947-3:2008/AMD1:2012
IEC 60947-3:2008/AMD2:2015

IEC 61000-4-2, *Electromagnetic compatibility (EMC) – Part 4-2: Testing and measurement techniques – Electrostatic discharge immunity test*

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

IEC 61238-1 (all parts), *Compression and mechanical connectors for power cables*

IEC 61427-2, *Secondary cells and batteries for renewable energy storage – General requirements and methods of test – Part 2: On-grid applications*

IEC 61439-1, *Low-voltage switchgear and controlgear assemblies – Part 1: General rules*

IEC 61439-2, *Low-voltage switchgear and controlgear assemblies – Part 2: Power switchgear and controlgear assemblies*

IEC 61643-32, *Low-voltage surge protective devices – Part 32: Surge protective devices connected to the d.c. side of photovoltaic installations – Selection and application principles*

IEC 61724-1, *Photovoltaic system performance – Part 1: Monitoring*

IEC TS 61724-2, *Photovoltaic system performance – Part 2: Capacity evaluation method*

IEC TS 61724-3, *Photovoltaic system performance – Part 3: Energy evaluation method*

IEC 61850 (all parts), *Communication networks and systems for power utility automation*

IEC 61936-1, *Power installations exceeding 1 kV a.c. – Part 1: Common rules*

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

IEC 62109-2, *Safety of power converters for use in photovoltaic power systems – Part 2: Particular requirements for inverters*

IEC 62271-1, *High-voltage switchgear and controlgear – Part 1: Common specifications for alternating current switchgear and controlgear*

IEC 62271-100, *High-voltage switchgear and controlgear – Part 100: Alternating current circuit-breakers*

IEC 62271-102, *High-voltage switchgear and controlgear – Part 102: Alternating current disconnectors and earthing switches*

IEC 62271-103, *High-voltage switchgear and controlgear – Part 103: Switches for rated voltages above 1 kV up to and including 52 kV*

IEC 62271-200, *High-voltage switchgear and controlgear – Part 200: AC metal-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV*

IEC TS 62271-210, *High-voltage switchgear and controlgear – Part 210: Seismic qualification for metal enclosed and solid-insulation enclosed switchgear and controlgear assemblies for rated voltages above 1 kV and up to and including 52 kV*

IEC TR 62271-300, *High-voltage switchgear and controlgear – Part 300: Seismic qualification of alternating current circuit-breakers*

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

IEC 62446-1, *Photovoltaic (PV) systems – Requirements for testing, documentation and maintenance – Part 1: Grid connected systems – Documentation, commissioning tests and inspection*

IEC 62446-2, *Photovoltaic (PV) systems – Requirements for testing, documentation and maintenance – Part 2: Grid connected systems – Maintenance of PV systems* (to be published)

IEC 62548:2016, *Photovoltaic (PV) arrays – Design requirements*

IEC 62817, *Photovoltaic systems – Design qualification of solar trackers*

IEC 62852, *Connectors for DC-application in photovoltaic systems – Safety requirements and tests*

EN 50539-11, *Low-voltage surge protective devices – Surge protective devices for specific application including d.c. – Part 11: Requirements and tests for SPDs in photovoltaic applications*