



UL 62093

STANDARD FOR SAFETY

Balance-of-System Components for Photovoltaic
Systems – Design Qualification Natural
Environments

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UL Standard for Safety for Balance-of-System Components for Photovoltaic Systems – Design Qualification Natural Environments, UL 62093

First Edition, Dated February 24, 2017

Summary of Topics

UL 62093 is an adoption of IEC 62093, Balance-of-System Components for Photovoltaic Systems – Design Qualification Natural Environments (First Edition, issued March 2005). Please note that the following clauses are National Differences: 5.1DV, 8DV, 11.1.2DV, and 11.5.3DV.

The new requirements are substantially in accordance with Proposal(s) on this subject dated September 30, 2016 and January 20, 2017.

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ANSI/UL 62093-2017

UL 62093

**Balance-of-System Components for Photovoltaic Systems – Design
Qualification Natural Environments**

First Edition

February 24, 2017

This ANSI/UL Standard for Safety consists of the First Edition dated February 24, 2017.

The most recent designation of ANSI/UL 62093 as an American National Standard (ANSI) occurred on February 24, 2017. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, Title Page, or Preface. The National Difference Page and IEC Foreword are also excluded from the ANSI approval of IEC-based standards.

Comments or proposals for revisions on any part of the Standard may be submitted to UL at any time. Proposals should be submitted via a Proposal Request in UL's On-Line Collaborative Standards Development System (CSDS) at <https://csds.ul.com>.

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PREFACE

This UL Standard is based on IEC Publication IEC 62093: First edition Balance-of-System Components for Photovoltaic Systems – Design Qualification Natural Environments. IEC publication IEC 62093 is copyrighted by the IEC.

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Note – Although the intended primary application of this Standard is stated in its Scope, it is important to note that it remains the responsibility of the users of the Standard to judge its suitability for their particular purpose.

NATIONAL DIFFERENCES

In the UL publication of this standard, National Differences from the text of International Electrotechnical Commission (IEC) Publication 62093, Standard for Balance-of-System Components for Photovoltaic Systems – Design Qualification Natural Environments copyright 2005 are indicated by notations (differences) and are presented in bold text. The national difference type is included in the body.

There are five types of National Differences as noted below. The difference type is noted on the first line of the National Difference in the standard. The standard may not include all types of these National Differences.

DR – These are National Differences based on the **national regulatory requirements**.

D1 – These are National Differences which are based on **basic safety principles and requirements**, elimination of which would compromise safety for consumers and users of products.

D2 – These are national differences from IEC requirements based on existing **safety practices**. These requirements reflect national safety practices, where empirical substantiation (for the IEC or national requirement) is not available or the text has not been included in the IEC standard.

DC – These are National Differences based on the **component standards** and will not be deleted until a particular component standard is harmonized with the IEC component standard.

DE – These are National Differences based on **editorial comments or corrections**.

Each national difference contains a description of what the national difference entails. Typically one of the following words is used to explain how the text of the national difference is to be applied to the base IEC text:

Addition / Add - An addition entails adding a complete new numbered clause, subclause, table, figure, or annex. Addition is not meant to include adding select words to the base IEC text.

Modification / Modify - A modification is an altering of the existing base IEC text such as the addition, replacement or deletion of certain words or the replacement of an entire clause, subclause, table, figure, or annex of the base IEC text.

Deletion / Delete - A deletion entails complete deletion of an entire numbered clause, subclause, table, figure, or annex without any replacement text.

INTERNATIONAL ELECTROTECHNICAL COMMISSION

BALANCE-OF-SYSTEM COMPONENTS FOR PHOTOVOLTAIC SYSTEMS – DESIGN QUALIFICATION NATURAL ENVIRONMENTS

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 nongovernmental 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.

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International Standard IEC 62093 has been prepared by IEC technical committee 82: Solar photovoltaic energy systems.

The text of this standard is based on the following documents:

FDIS	Report on voting
82/374/FDIS	82/380/RVD

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Full information on the voting for approval 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.

The committee has decided that the contents of this publication will remain unchanged until the maintenance result 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

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

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BALANCE-OF-SYSTEM COMPONENTS FOR PHOTOVOLTAIC SYSTEMS – DESIGN QUALIFICATION NATURAL ENVIRONMENTS

1 Scope and object

This International Standard establishes requirements for the design qualification of balance-of-system (BOS) components used in terrestrial photovoltaic (PV) systems. This standard is suitable for operation in indoor, conditioned or unconditioned; or outdoor in general open-air climates as defined in IEC 60721-2-1, protected or unprotected. It is written for dedicated solar components such as batteries, inverters, charge controllers, system diode packages, heat sinks, surge protectors, system junction boxes, maximum power point tracking devices and switch gear, but may be applicable to other BOS system components.

This standard is based on that which is specified in IEC 61215 and IEC 61646 for the design qualification of PV modules. However, changes have been made to account for the special features of the balance-of-system components, and to add different levels of severity for the different service environments. Dust, fungus, insects, shipping vibration and shock, and protection class have been added to the appropriate environmental categories. The high and low temperature and humidity limits have also been modified for the appropriate service environments.

This standard does not apply to photovoltaic modules. These are covered by IEC 61215 or IEC 61646. Also, this standard does not apply to concentrator modules or to complete PV systems. Specific electrical safety aspects are not part of this standard.

This standard is applicable to lead-acid and nickel-cadmium cells and batteries. Other electrochemical storage systems will be included when they become available.

The object of this test sequence is to determine the performance characteristics of each BOS components and to show, as far as possible within reasonable constraints of cost and time, that the component is capable of maintaining this performance after exposure to the simulated service natural environmental conditions for which it is intended to be applicable as specified by the manufacturer. The actual life expectancy of components so qualified will depend on their design, their environment and the system conditions under which they are operated.

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 60068-1, *Environmental testing – Part 1: General and guidance*

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

IEC 60068-2-21, *Environmental testing – Part 2-21: Tests – Test U: Robustness of terminations and integral mounting devices*

IEC 60068-2-27, *Environmental testing – Part 2: Tests. Test Ea and guidance: Shock*

IEC 60068-2-30, *Environmental testing – Part 2: Tests. Test Db and guidance: Damp heat, cyclic (12 + 12-hour cycle)*

IEC 60068-2-75, *Environmental testing – Part 2-75: Tests – Test Eh: Hammer tests*

IEC 60068-2-78, *Environmental testing – Part 2-78: Tests – Test Cab: Damp heat, steady state*

IEC 60068-3-6, *Environmental testing – Part 3-6: Supporting documentation and guidance – Confirmation of the performance of temperature/ humidity chambers*

IEC 60410, *Sampling plans and procedures for inspection by attributes*

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

IEC 60721-2-1, *Classification of environmental conditions – Part 2-1: Environmental conditions appearing in nature – Temperature and humidity*

IEC 60904-3:1989, *Photovoltaic devices – Part 3: Measurement principles for terrestrial photovoltaic (PV) solar devices with reference spectral irradiance data*

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

IEC 61345, *UV test for photovoltaic (PV) modules*

IEC 61427:2005, *Secondary cells and batteries for solar photovoltaic energy systems – General requirements and methods of test*

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

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

IEC 62262, *Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts (IK code)*

ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories*

3 Sampling

For qualification testing a quantity of at least three samples of a component (plus spares as desired) shall be taken at random from a production batch or batches, in accordance with the procedure given in IEC 60410. The components shall have been manufactured from specified materials and components in accordance with the relevant drawings and process sheets and shall have been subjected to the manufacturer's normal inspection, quality control and production acceptance procedures. The components shall be complete in every detail and shall be accompanied by the manufacturer's handling, mounting and connection instructions, including the maximum permissible system voltage.

In the case of items, for example wires and cables, that do not have previously defined measures, a sufficient amount for the testing purposes shall be taken at random from a production batch or batches, in accordance with the procedure given in IEC 60410.

4 Marking

Each component shall carry the following clear and indelible markings:

- name, monogram or symbol of manufacturer/supplier;
- type or model number;
- serial/batch number, if practical;
- the design service use of this component; outdoor unprotected, outdoor protected, indoor unconditioned and indoor conditioned;
- polarity of terminals or leads (only colour coding is not permissible);
- maximum system voltage for which the component is suitable;
- nominal and minimum values of the power consumption, as specified by the manufacturer for the product type.

The date (and preferably time) and place of manufacture shall be marked on the component or be traceable from the serial or batch number.

NOTE Small components such as wires, connectors, fuses, etc. need not have these elaborate markings. The minimum information is name/monogram/symbol of manufacturer or supplier and the type or model number.

5 Documentation

5.1 General

The documentation shall contain the following information (if relevant):

- compliance with relevant standards (this is especially important with respect to European Directives and the related CE marking);
- installation and disconnection instructions;
- operating instructions;
- service use of the component (see 6.1);
- technical data (circuit diagram and technical specifications);
- troubleshooting instructions;
- safety warnings and instructions;
- information on spare parts;
- warranty;
- instructions for decommissioning and disposal.

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In particular, the documentation shall indicate (if relevant):

a) Conditions of surroundings

- 1) Range of operating temperature
- 2) Range of storage temperature
- 3) Maximum relative humidity

b) Physical properties of the component

- 1) Dimensions of the enclosure
- 2) Weight
- 3) Properties of the enclosure (material)
- 4) Fasteners
- 5) Protection class (IP and IK Code)
- 6) Connecting terminals
- 7) Cables (inlet, pull relief, cross-sections)
- 8) Spare parts

c) Electrical properties of the component

1) For charge controllers

- Listing of incompatible and compatible battery types
- Nominal voltage of input and output (V)
- Maximum module current (A)
- Maximum load current (A)
- Type of controller (series controller, shunt controller, etc.)
- Working principle (PWM, two-point-regulation, state of charge algorithm, etc.)
- All used thresholds (V)
- Temperature compensation for the thresholds (mV/°C/cell)
- Quiescent current
- Curve indicating input and output power/current vs. ambient temperature

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- Power consumption to be measured during operation immediately after deep discharge disconnection
- Power consumption during operation at nominal voltage
- Overload protection
- Reverse-polarity protection
- Definition of the allowable voltage area at the input and at the output side
- Warning before load disconnect
- Definition of the output behaviour in the case of no battery connection
- Delayed load disconnection
- Displays (LEDs, display, accuracy)
- Additional functions (MPP tracking, etc.)
- Maximum AC ripple on the battery charging current

NOTE If the negative terminal of the battery, module and load cannot be linked together, this must be clearly stated and the behaviour in such a case must be defined.

2) For batteries

- Type of battery: NiCd, lead-acid, vented (flooded), valve-regulated, gas-tight sealed (NiCd only), tubular plate, flat plate, etc.
- Nominal voltage
- Specific gravity of the electrolyte
- Capacity expressed in C_{120} , C_{20} , C_{10} , C_5
- Charge retention expressed as a percentage: monthly self-discharge/nominal capacity
- Endurance in cycles, measured according to IEC 61427
- Charging efficiency (see IEC 61427)
- Instructions for starting up (the manufacturer must advise if there are special considerations for the initial charging with only the solar generator available as the power source), maintenance, and safety.
- Transportation restrictions

3) For inverters

- Maximum input current (A)

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