

Balance-of-system components for photovoltaic systems — Design qualification natural environments

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British Standard

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National foreword

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The UK participation in its preparation was entrusted to Technical Committee GEL/82, Solar photovoltaic energy systems, which has the responsibility to:

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Design qualification natural environments
(IEC 62093:2005)**

Composants BOS des systèmes
photovoltaïques –
Qualification et essais d'environnement
(CEI 62093:2005)

BOS-Bauteile für photovoltaische
Systeme –
Bauartegnung natürliche Umgebung
(IEC 62093:2005)

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Foreword

The text of document 82/374/FDIS, future edition 1 of IEC 62093, prepared by IEC TC 82, Solar photovoltaic energy systems, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 62093 on 2005-04-01.

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- | | | |
|--|-------|------------|
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Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 62093:2005 was approved by CENELEC as a European Standard without any modification.

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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.

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
 - 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)
- Maximum output current (A)
- Nominal input voltage and range (V)
- Nominal output voltage and range (V)
- Absolute maximum solar voltage (V_{oc})
- Number of phases
- Frequency (Hz)
- Output voltage: sine wave, square wave or modified square wave, etc.
- Galvanic separation
- Overload capability curve
- Curve indicating output power at nominal input voltage vs. ambient temperature
- Curve indicating maximum output power at nominal input voltage vs. ambient air-pressure (may be expressed in height of installation above sea-level)
- Maximum ambient temperature
- Type of load allowed, for example maximum $\cos(\phi)$, regenerative loads
- Earthing requirements
- For standalone inverters: power consumption to be measured during operation immediately after deep discharge disconnection and in standby-mode (there may be several standby modes, e.g. sleep-mode, no-load mode, etc.)
- Power consumption in standby-mode (there may be several standby modes, e.g. sleep-mode, low-solar-input-mode, etc.)
- Efficiency curve according to IEC 61683
- Fuse required on the AC-side of the inverter: size and class
- If applicable, recommended fuse on the DC-side of the inverter, size and class
- Definition of the behaviour of the inverter during an overload situation and overload protection
- Reverse-polarity protection on the DC-side
- Warning before load disconnect, if relevant
- Delayed load disconnection, if relevant
- Displays (LED's, display, accuracy)
- Additional functions (MPP tracking, etc.)
- Total harmonic output distortion on a linear load at nominal conditions
- Total harmonic output voltage distortion on non-linear loads at nominal conditions with a crest factor of 2,5 %
- List of generic appliances, known to be incompatible with the inverter

All data shall be verified in the course of the following test sequences. Data, which are missing or do not conform to the indications of the manufacturer, shall be conscientiously recorded.

6 Testing

6.1 Service use

The test severities are based on the service use (to be indicated by the manufacturer) of the component. These are defined as follows.

a) Outdoor, unprotected

The component is fully exposed to direct rain, sun, wind, dust, fungus, ice, radiation to the cold night sky, etc.

b) Outdoor, protected

The component is partially covered to protect it from direct rain, sun, wind-blown dust, ice, fungus, and radiation to the cold night sky, etc.

c) Indoor, unconditioned

The component is fully covered by a building or enclosure to protect it from direct rain, sun, wind-blown dust, fungus, and radiation to the cold night sky, etc, but the building or enclosure is not conditioned in terms of temperature, humidity or air filtration.

d) Indoor, conditioned

The component is fully covered by a building or enclosure to fully protect it from rain, sun, wind-blown dust, fungus, and radiation to the cold night sky, etc, and the building or enclosure is generally conditioned in terms of temperature, humidity and air filtration.

The test conditions for these different services are summarized in Table 1.

6.2 Test sequence

The components shall be divided into three groups and subjected to the qualification test sequences in Table 1, carried out in the order laid down. Each box refers to the corresponding subclause in this standard. Test procedures and severities, including initial and final measurements where necessary, are detailed in Clause 11 and summarised in Table 1. Three groups of components shall first be subjected to basic environmental testing, after which a damp heat, cyclic test (see 11.15) shall be done. After each basic environmental test, a visual inspection (VI), a functioning test (FT) and an insulation test (IT) shall be done. All groups/pieces shall be subjected to their individual functioning test before and after each qualification test.

Table 1 contains a summary of test levels. For electronic equipment all tests apply. For batteries certain tests do not apply, a summary can also be found in Table 1.

NOTE 1 Where the final measurements for one test serve as the initial measurements for the next test in the sequence, they need not be repeated. In these cases, the initial measurements are omitted from the test.

NOTE 2 In the case where the component under test has already been subjected to a certain test in another qualification sequence by an accredited test lab, this test may be omitted if it does not have an influence on the whole testing sequence.

In carrying out the tests, the tester shall strictly observe the manufacturer's handling, mounting and connection instructions. The test report shall state the basis for any test omission.

Table 1 – Summary of test levels

Test	Title	Test conditions	Secondary batteries	Other electronic equipment
11.1	Visual inspection	See detailed inspection list in 11.1.2	Yes	Yes
11.2	Functioning test	Ambient temperature: 25 °C; 40 ± 20 % RH Specific component parameter	Yes	Yes
11.4	Insulation test	500/1 000 V DC + twice the open-circuit voltage of the system or 1 min. Insulation resistance of not less than 50 MΩ at 500 V DC.	No	Yes
11.5	Outdoor exposure test - outdoor, unprotected - outdoor, protected - indoor, unconditioned - indoor, conditioned	60 kWh·m ⁻² total solar irradiation Not required Not required Not required	No	Yes
11.6	Protection against mechanical impact (IK) - outdoor, unprotected - outdoor, protected - indoor, unconditioned - indoor, conditioned	IK05 IK05 IK05 IK05	Yes	Yes
11.7	Protection against dust, water and foreign bodies (IP-code) - outdoor, unprotected - outdoor, protected - indoor, unconditioned - indoor, conditioned	IP44 IP44 IP20 IP20	Not relevant	Yes
11.8	Shipping vibration test	10 Hz to 11,8 Hz; 11,9 Hz to 150 Hz Amplitude: 3,5 mm, acceleration: 2 g 1 octave/min, Duration on each axis: 2 h; overall: 6 h	Yes	Yes
11.9	Shock test	15 g, half-sine, Duration: 11 ms; Sequence: 1 s Number of shocks: 18 (6 × 3)	Yes	Yes