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TECHNICAL SPECIFICATION

colour inside

Photovoltaic modules – Bypass diode electrostatic discharge susceptibility testing

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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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 62916, which is a technical specification, has been prepared by IEC technical committee 82: Solar photovoltaic systems.

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

Enquiry draft	Report on voting
82/1059/DTS	82/1259/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- withdrawn,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.

PHOTOVOLTAIC MODULES – BYPASS DIODE ELECTROSTATIC DISCHARGE SUSCEPTIBILITY TESTING

1 Scope

This document describes a discrete component bypass diode electrostatic discharge (ESD) immunity test and data analysis method. The test method described subjects a bypass diode to a progressive ESD stress test and the analysis method provides a means for analyzing and extrapolating the resulting failures using the two-parameter Weibull distribution function.

It is the object of this document to establish a common and reproducible test method for determining diode surge voltage tolerance consistent with an ESD event during the manufacturing, packaging, transportation or installation processes of PV modules.

This document does not purport to address causes of electrostatic discharge or to establish pass or fail levels for bypass diode devices. It is the responsibility of the user to assess the ESD exposure level for their particular circumstances. The data generated by this procedure may support qualification of new design types, quality control for incoming material, and/or identify the need for additional ESD controls in the manufacturing process.

Finally, this document does not apply to large energy surge events such as direct or indirect lightning exposure, utility capacitor bank switching events, or the like.

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 61000-4-2:2008, *Electromagnetic compatibility (EMC) – Part 4-2: Testing and measurement techniques – Electrostatic discharge immunity* test

3 Terms, definitions and abbreviated terms

For the purposes of this document, the terms and definitions of 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
DUT
device under test

3.2
contact discharge method
method of testing in which the electrode of the test generator is kept in contact with the DUT and the discharge is actuated by the discharge within the generator

Note 1 to entry: In this document, the contact is to the electrical lead of the DUT with no intervening electrical insulation material.

3.3
diode check function
usage of a multimeter with diode function check to verify the diode is functional, short or open

3.4
direct application
application of the test surge directly to the DUT

Note 1 to entry: In this technical specification, the surges are directed to bypass diodes for photovoltaic applications outside of the actual photovoltaic application (e.g., DUT are tested outside of the junction box and are not associated with the photovoltaic module itself when characterized).

3.5
surge relaxation time
amount of time necessary for the DUT to thermally stabilize in the event that surge application creates localized regions of heat generation

4 General

Production line quality excursions due to bypass diode failure have been observed in the PV module manufacturing process due to changes in the electrostatic discharge (ESD) susceptibility of bypass diodes. This document provides a method to evaluate the susceptibility of bypass diodes to fail due to ESD events that may occur in the production, transport or installation of photovoltaic (PV) modules. ESD events occur whenever there is contact, or sufficiently close proximity between objects of different electrostatic charge. The magnitude of the ESD event is a function of the charge difference between the objects and the impedance associated with the charge transfer. Of specific interest in this document are relatively low energy, short-duration surges that may be associated with the manufacturing process, testing, or installation events where the bypass diodes are directly exposed to an ESD event.

Several standard ESD models exist for the evaluation of surge immunity. This document adopts the model provided by IEC 61000-4-2:2008 that provides a method for assessing damage to electrical and electronic equipment subjected to static electricity discharges from operators directly, and from personnel to adjacent objects.

5 Sampling

Ten unconditioned diodes are required for this test. Several factors should be considered when making sample selection:

- Diode types shall be identical. Different diode types will not provide useful surge immunity information.
  - Each diode type that was tested during the development of this procedure yielded a different failure distribution indicating that mixed type testing would not be meaningful.
- Diode date codes and factory location should be identical.
  - The best characterization of a diode's surge immunity will be obtained when the diodes are from one manufacturing location and from a specific manufacturing batch.
  - Comparison of the failure distributions that result from applying this procedure to several different date codes may provide the user with a qualitative understanding of the diode manufacturer's quality control from a surge immunity perspective. Similarity of results from different date codes would indicate a tighter quality control method.
- Diodes are tested independently and outside of a module or junction box. The leads shall be in the form required before assembly into a junction box.

– Lead trimming or lead forming operations should be done before testing as these operations can create stress on the diode die that may have an impact on the diode's surge immunity.

6 Test equipment

Test equipment shall conform to the requirements stated in IEC 61000-4-2:2008, Clause 6 using the discharge electrode for contact discharges. The discharge return connection from the surge generator shall be connected to a grounding block designed to accommodate the DUT samples, taking into account spacing requirements that may be required for formed leads as shown in Figure 1. Multiple DUT samples may be connected to a single grounding block.

The equipment shall be capable of positive polarity surges (with respect to earth ground), conducted in a single-surge mode, and with a voltage that can be incremented in 5 kV steps from 5 kV to a recommended 30 kV or higher capability. Equipment having a surge voltage limitation that is less than 30 kV may be used, but this may limit DUT failure information and subsequent data analysis for a very surge-resistant DUT.

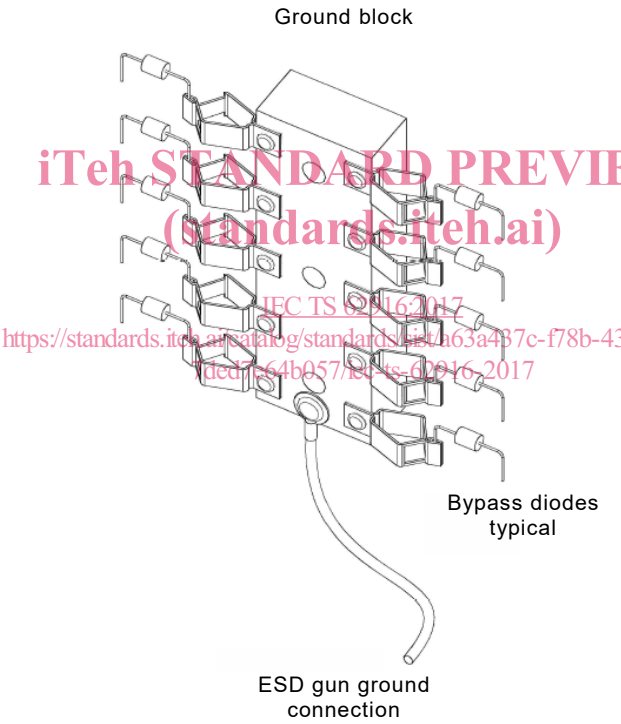

Figure 1 – Example of a test setup for bypass diodes

7 Test method

7.1 Preparation

a) Place 10 unconditioned DUTs into an electrically grounded fixture such that the DUT anode is grounded and the cathode is exposed and accessible (Figure 1).

b) Use a multimeter with diode-check functionality to verify that all DUTs are functional in the forward bias direction and that none are shorted in the reverse bias direction. In the event that a DUT is found to be in a non-operational state before test, replace as necessary so that ten functional units are subjected to the surge testing.