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BSI Standards Publication

Photovoltaic (PV) modules — Test methods for the detection of potential-induced degradation

Part 1: Crystalline silicon

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National foreword

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The UK participation in its preparation was entrusted to Technical Committee GEL/82, Photovoltaic Energy Systems.

A list of organizations represented on this committee can be obtained on request to its secretary.

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Part 1: Crystalline silicon

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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 62804-1, which is a technical specification, has been prepared by IEC technical committee 82: Solar photovoltaic energy systems.

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

DTS	Report on voting
82/885/DTS	82/921A/RVC

Full information on the voting for the approval of this standard 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.

A list of all parts in the IEC 62804 series, published under the general title *Photovoltaic (PV) modules – Test methods for the detection of potential-induced degradation,* can be found on the IEC website.

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

- 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- withdrawn,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 part of IEC 62804 is for testing and evaluating the durability of crystalline silicon photovoltaic modules to stresses that induce potential-induced degradation (PID). The applied stresses, mainly system voltage, manifest themselves in different degradation mechanisms depending on the module technology. A series of Technical Specifications is therefore proposed to define PID tests for different photovoltaic module technologies.

IEC TS 62804-1 defines test methods for evaluating PID in crystalline silicon PV modules.

IEC TS 62804-2 defines test methods for evaluating PID in thin-film PV modules.

Additional Technical Specifications in the series may be introduced in the future for emerging module technologies.

Voltage potential that exists between the active circuit and the grounded module surfaces can lead to module degradation by multiple mechanisms including ionic transport in the encapsulant, superstrate or substrate; hot carriers in the cell; redistribution of charges that degrade the active layer of the cell or its surfaces; failure of adhesion at interfaces, and corrosion of module components. These degradation mechanisms in crystalline silicon photovoltaic modules caused by voltage stress and promoted by high temperature and humidity have been labeled potential-induced degradation, polarization, electrolytic corrosion, and electrochemical corrosion. They are most active in wet or damp environments, and in environments prone to soiling of modules with conductive, acidic, caustic, or ionic species that lead to increased conduction on the module surfaces. In the field, modules have been observed to degrade in positive as well as negative polarity strings depending on the cell construction, module materials, and design. The testing in this Technical Specification therefore specifies the evaluation of the effects of voltage stress in both polarities for modules that may be operated in either polarity, or in the polarity defined by the manufacturer's documented specifications. Some crystalline silicon module designs undergoing system voltage bias stress have shown degradation manifested by junction failure, leading to changes in the reverse-bias breakdown characteristics and a resulting degradation in safety because of the increased potential for development of hot spots in the module. This Technical Specification describes two methods to measure the ability of a module to withstand degradation from system voltage effects that manifest in the relatively short term.

The stress-test levels in this Technical Specification have not been related to those of the natural environment. Modules types undergoing damp heat chamber testing with a 60 °C and 85 % relative humidity stress level with the temperature, humidity, and bias voltage ramped simultaneously at the start of a 96 h stress test were found resistant to PID in outdoor tests in Florida, USA. However, to improve reproducibility, test details including environmental chamber temperature and humidity ramps and tolerances have been tightened, which very significantly reduce the total stress applied and invalidate the correspondences previously found. The relevance to real outdoor stress conditions of the test contained herein using foil as the ground conductor is also not proven. Alternative levels beyond the basic stress levels in this Technical Specification are thus included.

It is known that variability in manufacturing processes can affect the susceptibility of modules to system voltage stress. Retesting of module samples by the test protocols contained herein and according to sampling plans of IEC 60410, internal quality assurance programs, or external audits will aid in verifying not only the durability of the design of the module to system voltage stress, but also the effects of variability of the materials and manufacturing processes.

PHOTOVOLTAIC (PV) MODULES – TEST METHODS FOR THE DETECTION OF POTENTIAL-INDUCED DEGRADATION –

Part 1: Crystalline silicon

1 Scope

This part of IEC 62804 defines procedures to test and evaluate the durability of crystalline silicon photovoltaic (PV) modules to the effects of short-term high-voltage stress including potential-induced degradation (PID). Two test methods are defined that do not inherently produce equivalent results. They are given as screening tests—neither test includes all the factors existing in the natural environment that can affect the PID rate. The methods describe how to achieve a constant stress level.

The testing in this Technical Specification is designed for crystalline silicon PV modules with one or two glass surfaces, silicon cells having passivating dielectric layers, for degradation mechanisms involving mobile ions influencing the electric field over the silicon semiconductor, or electronically interacting with the silicon semiconductor itself. This Technical Specification is not intended for evaluating modules with thin-film technologies, tandem, or heterostructure devices.

This Technical Specification describes methods to measure the module design's ability to withstand degradation from system voltage effects that manifest in the relatively short term. The testing in this Technical Specification does not purport to examine certain combined effects that may occur over longer periods of time in modules such as encapsulation failure, which could lead in turn to rapid moisture ingress and electrochemical corrosion. This Technical Specification does not incorporate illumination of the module that can affect the rate of degradation.

The test methods are designed to measure PID sensitivity and will give results according to the stress levels and the module grounding configuration inherent to the respective tests. Because stress method (a), testing in an environmental chamber, employs a non-condensing humidity level to serve as a conductive pathway to electrical ground, it frequently applies less stress toward the centre of the module face and the PID effect is concentrated toward the module edges as a result. Stress method (b), contacting the surfaces with a grounded conductive electrode, evaluates cell sensitivity and some effects of the component packaging materials such as glass and encapsulant resistivity, but does not differentiate the effects of some construction methods of mitigating PID, for example, the use of rear rail mounts, edge clips, and insulating frames.

The actual durability of modules to system voltage stress will depend on the environmental conditions under which they are operated. These tests are intended to assess PV module sensitivity to PID irrespective of actual stresses under operation in different climates and systems.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.