

ICS 27.160

Testing crystalline silicon solar cells for susceptibility to potential induced degradation (PID)

Prüfung von kristallinen Silicium-Solarzellen auf die Anfälligkeit für Potential-induzierte Degradation

Méthode d'essai pour déterminer la susceptibilité au potential induced degradation (PID) des cellules solaires à base de silicium cristallin

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Gesamtumfang 16 Seiten

Dieses Dokument wurde durch die im Vorwort genannten Verfasser erarbeitet und verabschiedet.

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Foreword

This DIN SPEC has been developed according to the PAS procedure. The development of a DIN SPEC according to the PAS procedure is carried out in workshops and does not require the participation of all stakeholders.

This DIN SPEC (PAS) is the result of the INS (Innovation with Norms and Standards) project “Spezifikation der Prüfung von Solarzellen auf die Anfälligkeit für Potential-induzierte Degradation” funded by the German Federal Ministry for Economic Affairs and Energy (BMWi).

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At present, there are no standards covering this topic.

DIN SPECs are not part of the body of German Standards.

A draft of this DIN SPEC has not been published

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Introduction

Power loss of photovoltaic (PV) modules with crystalline silicon solar cells under the influence of high voltage was reported first in 2005. Since 2010, a similar effect is known for standard (p-type) crystalline silicon PV modules, causing power loss by shorts in the solar cells. The effect has been termed potential induced degradation (PID). High negative electrical potentials between the solar cells and the grounded PV module surfaces were identified as triggering factors. These electric potentials are due to the specific installation conditions. Affected solar cells exhibit a dramatic decrease of the electrical characteristic value “parallel resistance”, which is also referred to as “shunting”. PID of shunting type is called PID-s in order to distinguish this type from other PID effects. In the following years PID-s was identified as one of the most critical defects for PV plant operators and manufacturers of PV modules. PID-s can lead to significant yield losses in PV power plants when modules are not resistant against PID-s.

A number of measures against PID were developed in the PV industry since it became apparent. Crystalline silicon PV modules (hereafter: “modules”) are tested for their susceptibility to PID within qualification tests for a design according to IEC/TS 62804-1 *“Photovoltaic (PV) modules — Test methods for the detection of potential-induced degradation — Part 1: Crystalline silicon”* [1], [2].

For this, modules are exposed to a high voltage at a constant temperature and humidity in climatic chambers by either (a) applying an electrical voltage between the module frame and embedded solar cells or (b) applying an electrical voltage between an electrically conductive plate on the module front glass surface and the solar cells. The IEC Technical Specification specifies preconditioning measures and test parameters to be maintained in order to ensure comparability between test results. The power loss is measured after a certain time at these defined test conditions. Correspondingly, PID testing of PV modules in the laboratory scale causes high costs for investments on climatic chambers and module manufacturing equipment as well as high operating costs.

Since 2011, there are publications on PID test procedures that work without time-consuming production of complete PV modules [3], [4], [5], [6], [7]. The advantages of PID tests on solar cell level lead to a large demand for standardization of test conditions for PID cell tests, which are currently gaining importance in the PV industry. Best correlation to module-based PID tests is achieved when the sun-facing encapsulation layer stack of PV modules is imitated in the PID cell test setup, which is addressed in the present DIN SPEC. Thus, the principle or stress scenario of this PID cell test corresponds to the variant (b) of abovementioned IEC Technical Specification [1], although the PID cell test manages without finished PV modules. Due to the need previously described herein, a test method on cell level to determine the susceptibility of solar cells to potential induced degradation of the shunting type including specific test conditions is specified.

1 Scope

This DIN SPEC specifies requirements for the test of non-encapsulated crystalline silicon solar cells for potential induced degradation (PID) that is associated with shunting of the cells.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1

PV module module

smallest complete environmentally protected assembly of interconnected cells

[SOURCE: DIN EN 61850-7-420:2009-10, 3.1.27]

3.2

potential induced degradation PID

change of physical properties of photovoltaic modules and/or solar cells therein under the influence of an electric potential between cells and earthed components of the PV system, potentially or actually leading to loss of power

3.3

PID test

procedure with the aim to measure the susceptibility of solar cells or modules to potential induced degradation

3.4

PID-s

PID caused by shunting of the solar cell

3.5

leakage current

electric current through insulating components between solar cells and counter electrode during a PID test
symbols and abbreviations