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Photovoltaic power systems – DC arc detection and interruption

Systèmes photovoltaïques – Détection et interruption d'arc en courant continu



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INTERNATIONAL
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COMMISSION

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

PHOTOVOLTAIC POWER SYSTEMS – DC ARC DETECTION AND INTERRUPTION

FOREWORD

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Draft	Report on voting
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Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

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INTRODUCTION

This document provides requirements and testing procedures for arc-fault protection devices used in PV systems to reduce the risk of igniting an electrical fire.

A PV system contains a number of distributed DC sources (PV modules) and circuits. In AC systems series arc durations are limited by the alternating current crossing through zero ampere twice per cycle. In DC systems the arcing current may be constant and longer arc durations are expected. In contrast to a centralized power supply, where in case of a fault the circuit is disconnected at the connection to the supply, a PV system is made up of distributed power supplies which cannot disconnect circuits in a single location. For extinguishing series arcs, however, the location of the arc within the circuit is irrelevant as long as the current is interrupted. This arc fault protection may be located inside the inverter, on array circuit, subarray circuits, string circuits, or at the module level. Therefore, this document provides a range of test setups to cover the expected system topologies.

In PV systems earth fault protection is required according to the IEC installation standards. Moreover, single core cables with double or reinforced insulation are required (except ELV systems). Consequently, the risk of parallel arcs is quite low because in most cases an earth fault occurs first. As such, this document does not address requirements or testing for parallel arc detection. The larger risk for PV systems comes from series arcs, therefore the focus of this document is to provide requirements and tests for arc fault protection equipment to ensure that most series arcs in a PV system will be detected.

Many arc fault detectors detect arcs by analyzing and comparing the arc's HF signal emission. These devices may trip due to external disturbances from other equipment connected to the PV array, e.g. the inverter. Therefore, interoperability tests to be evaluated. Other external influences such as radio signals, sparks from transformers, and load switching, among others, may also cause nuisance tripping. These causes are a performance issue and therefore not addressed by this document.

Arc fault detectors for PV systems have been introduced as a requirement in the USA since the 2011 U.S. National Electrical Code was published. This led to the development of a PV arc-fault protection product standard, UL 1699F. Experience derived from these documents and their application in the USA has been used as a basis for this document. This document was written in parallel to the maintenance of UL 1699B. Both writing teams considered the work of each other and aligned requirements as much as possible, including the dimensions of the electrodes.

Arc fault detectors have been mandatory for many years in the USA for certain AC installations. Within the IEC, arc fault detectors required according to IEC 62606 have been introduced for certain locations for AC circuits. For PV circuits there was no IEC product standard available. This document therefore now provides test procedures for PV system arc fault detectors, where required by installation standards.

This document was written for the special needs and characteristics of PV systems. The unique aspects of PV DC sources (group of distributed sources, current behavior, dependency to irradiance, system impedance, etc.) differ considerably from other DC sources and applications. Therefore, this PV specific standard was necessary, and equipment compliant to this document is not suitable for other DC sources and applications.

PHOTOVOLTAIC POWER SYSTEMS – DC ARC DETECTION AND INTERRUPTION

1 Scope

This document applies to equipment used for the detection and optionally the interruption of electric DC arcs in photovoltaic (PV) system circuits. The document covers test procedures for the detection of series arcs within PV circuits, and the response times of equipment employed to interrupt the arcs.

The document defines reference scenarios according to which the testing is conducted. This document covers equipment connected to systems not exceeding a maximum PV source circuit voltage of 1 500 V DC.

The detection of parallel circuit arcs is not covered in this document. This document is not applicable to DC sources or applications other than PV DC sources.

NOTE Parallel arc detection may be considered for a future edition.

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 60730-1:2013, *Automatic electrical controls – Part 1: General requirements*
IEC 60730-1:2013/AMD1:2015
IEC 60730-1:2013/AMD2:2020

IEC 60947-1:2020, *Low-voltage switchgear and controlgear – Part 1: General rules*

IEC 60947-3:2020, *Low-voltage switchgear and controlgear – Part 3: Switches, disconnectors, switch-disconnectors and fuse-combination units*

IEC 61508 (all parts), *Functional safety of electrical/electronic/programmable electronic safety-related systems*

IEC TS 61836:2016, *Solar photovoltaic energy systems – Terms, definitions and symbols*

IEC 62109-1:2010, *Safety of power converters for use in photovoltaic power systems – Part 1: General requirements*