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**Low-voltage switchgear and controlgear –
Part 9-2: Active arc-fault mitigation systems – Optical-based internal
arc-detection and mitigation devices**

**Appareillage à basse tension –
Partie 9-2: Systèmes actifs de limitation des défauts d'arc – Dispositifs optiques
de détection et de limitation d'arcs internes**



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IEC Central Office
3, rue de Varembe
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

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INTERNATIONALE

ICS 29.120.40; 29.130.20

ISBN 978-2-8322-9606-6

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

LOW-VOLTAGE SWITCHGEAR AND CONTROLGEAR –

**Part 9-2: Active arc-fault mitigation systems –
Optical-based internal arc-detection and mitigation devices**

FOREWORD

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IEC 60947-9-2 has been prepared by subcommittee 121A: Low-voltage switchgear and controlgear, of IEC technical committee 121: Switchgear and controlgear and their assemblies for low voltage. It is an International Standard.

The text of this International Standard is based on the following documents:

Draft	Report on voting
121A/406/FDIS	121A/417/RVD

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/standardsdev/publications.

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INTRODUCTION

Low-voltage switchgear and controlgear, as well as complementary protective and measuring devices, are installed in assemblies according to IEC 61439 series standards and/or others, which provide rules and requirements for interface characteristics, service conditions, construction, performance and verification.

The main objective of these standards is to achieve the safe operation of low-voltage switchgear and controlgear assemblies under normal operating conditions as well as under abnormal operating conditions, e.g. occurrence of overvoltage, overload or short-circuit currents.

The case of an arc-fault inside a LV assembly is considered by the following publications:

- IEC TR 61641, which specify tests requirements for assemblies under internal arc-fault;
- IEC TR 61439-0:2013, which identifies arc-fault containment in its Annex C;
- IEC TS 63107, which specifies tests to verify correct integration of internal arc-fault mitigation systems in power switchgear and controlgear assemblies (PSC assemblies) according to IEC 61439-2.

Even in a Class I assembly according to IEC TR 61641, the occurrence of an internal arc cannot be completely excluded. Typically, internal arc-faults result from:

- conducting materials inadvertently left inside equipment during manufacture, installation or maintenance;
- failures in materials or workmanship;
- inadvertent contact with a live conductor;
- entry of small animals such as mice, snakes, ants, etc.;
- use of an incorrect assembly for the application resulting in overheating and subsequently an internal arcing fault;
- inappropriate operating conditions (for example water, fungus, or dust);
- incorrect operation; or,
- lack of maintenance or inappropriate maintenance (loose parts, paint, etc.).

The occurrence of arcs inside enclosed assemblies is associated with various physical phenomena. For example, the arc energy resulting from an arc developed in air at atmospheric pressure within the enclosure will cause an internal overpressure and local overheating which will result in mechanical and thermal stressing of the assembly. Moreover, the materials involved may produce hot decomposition products, either gases, metals or vapours, which may be discharged outside of the enclosure.

Due to the risk of personal injury, damage and loss of energy supply as consequences of internal arc-faults there is a growing demand for internal arc-fault sensing and mitigation. This is the reason why some standards have been drafted to give specifications including test protocol and acceptance criteria for corresponding devices. Arc-fault effects can be dramatically reduced by active arc-fault mitigation systems, combining fast detection of the internal arc-fault, and related actions on short-circuit protection devices and/or additional quenching devices. Therefore, the application of such devices can result in:

- reduction of incident/released energy;
- shortening of power outage/downtime (by minimizing damage to the enclosed equipment, switchgear and controlgear as well as other measuring and protective devices);
- limitation of side-effects to other systems, due to high and continuously increasing density of installed apparatus.

This document is intended to cover devices and functions dedicated to:

- detect an arc-fault internal to an assembly by processing optical effects of an internal arc-fault, and to signal and trigger devices intended to mitigate the internal arc-fault, and
- detect by processing optical effects of an internal arc-fault and mitigate the impact of the internal arc-fault by its extinction.

NOTE Even when both terms are related to assemblies in which an arc occurs between conductors, arc-flash is terminology mainly used in NFPA 70E, CSA Z462 and IEEE 1584, which usually describes effects of direct exposure of workers to thermal energy emitted, whereas the term "internal arc-fault" as used in this document describes the hot-gas flow phenomena which can injure people in the vicinity of the arcing current.

LOW-VOLTAGE SWITCHGEAR AND CONTROLGEAR –

Part 9-2: Active arc-fault mitigation systems – Optical-based internal arc-detection and mitigation devices

1 Scope

This document covers internal arc-fault control devices, hereinafter referred to as IACD, which are intended to:

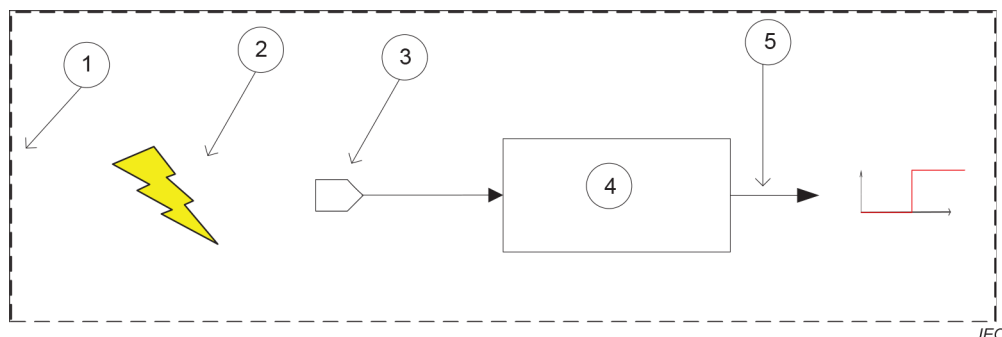
- detect internal arc-faults in low-voltage switchgear and controlgear assemblies, by processing (at a minimum) the optical effect of an internal arc-fault, and
- operate mitigation device (either external or combined)

in order to minimize the effects of the internal arc-fault (see Figure 1).

For the purpose of this document the terms "light" or "optical" covers more than visible spectra. They may cover also, for example, infrared or ultraviolet electromagnetic radiations (see Annex D).

For combined-type IACD, this document is considered in addition to the relevant product standard for internal arc-fault mitigation devices (IARD per IEC TS 63107:2020). Compliance to the relevant product standard is mandatory and cannot be claimed by testing to this document alone.

NOTE 1 Low-voltage switchgear and controlgear assemblies are usually described by IEC 61439 series.



NOTE This figure displays a simplified IACD schematic with only one optical sensor and no other sensing means that can be used for secondary confirmation of an arcing fault, such as current sensing.

Key

- 1 assembly enclosure
- 2 internal arc-fault
- 3 optical sensor
- 4 processing unit
- 5 trigger output used to operate e.g. mitigation device

Figure 1 – Optical-based IACD schematic (stand-alone type and no secondary sensor)

Therefore, this document covers the following:

- internal arc-fault control device (stand-alone, multifunction or combined);
- one or more associated sensor(s) used to detect optical effect of the internal arc-fault;
- sensor(s), sensing another physical effect, to confirm the fault;
- associated or combined mitigation device.