IEC TS 63107

Edition 1.0 2020-04

TECHNICAL SPECIFICATION

SPECIFICATION TECHNIQUE

colour inside

Integration of internal arc-fault mitigation systems in power switchgear and controlgear assemblies (PSC assemblies) according to IEC 61439-2

Intégration de systèmes de limitation de défaut d'arc interne dans des ensembles d'appareillage de puissance (EAP) conformément à l'IEC 61439-2

IEC TS 63107:2020-04(en-fr)

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

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

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

COMMISSION ELECTROTECHNIQUE INTERNATIONALE

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INTEGRATION OF INTERNAL ARC-FAULT MITIGATION SYSTEMS IN POWER SWITCHGEAR AND CONTROLGEAR ASSEMBLIES (PSC-ASSEMBLIES) ACCORDING TO IEC 61439-2

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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 63107, which is a technical specification, has been prepared by subcommittee 121B: Low-voltage switchgear and controlgear assemblies, of IEC technical committee 121: Switchgear and controlgear and their assemblies for low-voltage.

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

DTS	Report on voting
121B/89/DTS	121B/97/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 technical specification is to be read in conjunction with IEC 61439-1 and IEC 61439-2. The provisions of IEC 61439-1 and IEC 61439-2 are applicable to this document where they are specifically cited. When this document states "addition", "modification" or "replacement", the relevant text in IEC 61439-1 and IEC 61439-2 is to be adapted accordingly.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific document. At this date, the document will be

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INTRODUCTION

Internal arc-fault mitigation systems (IAMS) denote systems that consist of an internal arc-fault control device (IACD) and an internal arc-fault reduction device (IARD).

An IACD and an IARD can be combined and designed in one device.

An IACD uses the effects of an arc, e.g. light, gas pressure, change of current and/or voltage to detect an arc inside the power switchgear and controlgear assembly (PSC-assembly) to generate a trigger signal for an associated IARD.

An IARD reduces the arc energy below the level which would be released if an IARD was not present and the fault would be interrupted by the conventional short-circuit protective device (SCPD).

The operation of IARDs can be achieved by various methods, individually or in combination including, but not limited to, the following examples:

a) by interruption using an upstream SCPD triggered by an IACD;

b) by parallel connection of a low-impedance current path by using an arc quenching device (AQD) for commutation of current to this parallel path. The operation of an upstream SCPD is also required to interrupt the short-circuit current caused by the AQD before it exceeds its current carrying capabilities;

c) by introducing a defined impedance in series with the arc-fault circuit by using an internal arc-fault limiting device (IALD). An upstream SCPD may be required to extinguish the arc.

The most commonly used techniques are described under a) and b) above.

The purpose of this document is:

– to define the specific requirements for the correct integration of the IAMS into PSC-assemblies which shall be fulfilled by the original manufacturer of the assembly.

– to provide the necessary requirements in order to verify the correct operation of the IAMS.

– to provide the user with details of the different options that can be considered when requiring IAMS within a PSC-assembly.

– to provide guidance to the original manufacturer of PSC-assemblies on the constructional requirements needing particular attention when incorporating the IAMS.

For the safe and reliable operation of the IAMS, the proper operation of the IARD in conjunction with the accompanying IACD is crucial. It is assumed, that passing all tests detailed in this document will verify the correct functioning of the entire system (combination and integration of the respective devices).

This document defines tests to verify there will be no unintentional operation of the IAMS which could be caused by e.g. switching operation of built-in components.

It is important to consider the behaviour of the complete system when an internal arc occurs immediately after the assembly is energised.

Additionally, external influences in surrounding environment, e.g. sources of light, have to be considered.

The aim of the integration of the IAMS into PSC-assemblies is to reduce the released energy in case of an internal arc-fault by using the activation of an IARD in order to:

– reduce the damage to PSC-assemblies;

– improve the suitability of PSC-assemblies for further service after an internal arc-fault;

– improve the ability of PSC-assemblies to reduce the risk of injury to personnel;

The protection offered by an IAMS has some limitations. These are described in this document in the term "IAMS protected area" (verified within specific ranges of values for the rated operational voltage and the prospective short-circuit current) for the correct functioning of the IAMS.

IEC TR 61641 provides guidance for testing of PSC-assemblies with an integrated IAMS under conditions of arcing in air due to an internal fault and addresses personnel safety and damage to the PSC-assembly. Subclause 10.101.4 of this document (Verification of an IAMS in PSC-assemblies by test) is intended to be used in conjunction with IEC TR 61641.

INTEGRATION OF INTERNAL ARC-FAULT MITIGATION SYSTEMS IN POWER SWITCHGEAR AND CONTROLGEAR ASSEMBLIES (PSC-ASSEMBLIES) ACCORDING TO IEC 61439-2

1 Scope

This document states requirements for integration and testing of IAMS in low-voltage switchgear and controlgear assemblies – power switchgear and controlgear assemblies according to IEC 61439-1 and IEC 61439-2 (PSC-assemblies) to demonstrate their correct operation.

This document does not address personnel safety or damage to the PSC-assembly. These requirements are dealt with in IEC TR 61641 (see also 10.10.1).

NOTE This document can be used as a reference for other types of assemblies in the IEC 61439 series, but adaptation of the test procedures and acceptance criteria can apply taking into account the specifics of such other assemblies or products.

IAMS consist of IACDs and IARDs complying with their relevant product standard (e.g. optical based IACDs in accordance with IEC 60947-9-2, AQDs in accordance with IEC 60947-9-1 and SCPD's in accordance with IEC 60947-2). For the reliable function in a PSC-assembly, the verification of correct operation of the complete system under built-in conditions is addressed.

This document applies only to enclosed PSC-assemblies and deals with all required verifications needed for the integration in conjunction with IEC 61439-1 and IEC 61439-2.

The test procedure given in this document takes into consideration:

– the correct function of the IAMS within the PSC-assembly;

– the prevention of unintended operation of the IAMS within the PSC-assembly;

– the functioning behaviour of the system immediately after the assembly is energised.

Different tests under more severe conditions (e.g. doors in open position) can be performed with an agreement between the user and the original manufacturer of the PSC-assembly.

This document does not supersede any individual product standard. Individual devices are required to comply with their relevant standard.

This document does not apply to integration of arc fault detection devices (AFDD) according to IEC 62606.

The informative Annex II gives guidance on particular constructional requirements for incorporation of IAMS within a PSC-assembly.

The informative Annex HH gives guidance for the user of PSC-assemblies about the criteria to be considered when specifying a PSC-assembly with an integrated IAMS.

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 60947-9-1:2019, *Low-voltage switchgear and controlgear - Part 9-1: Active arc-fault mitigation systems - Arc quenching devices*

IEC 60947-9-2:—, *Low-voltage switchgear and controlgear - Active arc-fault mitigation systems - Part 9-2: Optical-based internal arc-detection and mitigation devices*[1]

IEC 61439-1:2020, *Low-voltage switchgear and controlgear assemblies - Part 1: General rules*

IEC 61439-2:—, *Low-voltage switchgear and controlgear assemblies - Part 2: Power switchgear and controlgear assemblies*[2]

IEC TR 61641:2014, *Enclosed low-voltage switchgear and controlgear assemblies - Guide for testing under conditions of arcing due to internal fault*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 61439-2, 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
internal arc-fault mitigation system
IAMS

system consisting of an internal arc-fault control device (IACD) and an internal arc-fault reduction device (IARD) that operates in case of an internal arc-fault

Note 1 to entry: An IAMS can include a "combined type" single device which combines the functions of an IACD and an IARD as defined in IEC 60947-9-2.

Note 2 to entry: This note applies to the French language only.

3.2
internal arc-fault control device
IACD

device intended to detect an internal arc-fault, which provides a signal for operation of a separate mitigation device, or automatically mitigates the internal arc-fault

Note 1 to entry: IACD with mitigation capability combines in the same device internal arc-fault detection and breaking or making capabilities.

Note 2 to entry: This note applies to the French language only.

[SOURCE: IEC 60947-9-2:—, 3.3]

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1 Under preparation. Stage at the time of publication: IEC/CCDV 60947-9-2:2020.

2 Under preparation. Stage at the time of publication: IEC/RFDIS 61439-2:2020.

3.3
internal arc-fault reduction device
IARD
device intended to reduce the energy released by an internal arc-fault

Note 1 to entry: An IARD can be achieved by a SCPD, AQD or IALD.

Note 2 to entry: This note applies to the French language only.

3.3.1
arc quenching device
AQD
IARD intended to eliminate internal arc-faults by creating a lower impedance current path in order to cause the arcing current to transfer to the new current path

Note 1 to entry: This note applies to the French language only.

[SOURCE: IEC 60947-9-1:2019, 3.1, modified – In the definition "device" has been replaced with "IARD" and the Note 1 to entry has been deleted.]

3.3.2
internal arc-fault limiting device
IALD
IARD intended to reduce the arc-fault current below a particular level other than a SCPD with current limiting functionality e.g. fuse or circuit-breaker

Note 1 to entry: This note applies to the French language only.

3.4
IAMS protected area
area monitored by an IAMS where an internal arc-fault is detected, mitigated and finally extinguished, and where unintended operation as a result of a switching arc will not occur

3.5
automatic transfer switching equipment
ATSE
self-acting transfer switching equipment

Note 1 to entry: ATSE normally includes all necessary devices for monitoring and transferring operations.

Note 2 to entry: ATSE can have an optional feature for manual operation.

Note 3 to entry: This note applies to the French language only.

[SOURCE: IEC 60947-6-1:2005/AMD1:2013, 3.1.4]

3.6
arc-fault mitigation time in an assembly
t_{mtA}
interval of time between the ignition t_0 of the internal arc-fault and the significant commutation of currents into the AQD

Note 1 to entry: Arc-fault mitigation time in an assembly is as described in Figure JJ.2 between points c) and g).

Note 2 to entry: For applications without AQD(s) the arc-fault extinction time of IEC 60947-9-2 can be used as an alternative to t_{mtA}.

3.7
arc-energy
E_{arc}
energy released by the arc during the arcing-fault

4 Symbols and abbreviated terms

For the purposes of this document, symbols and abbreviated terms given in IEC 61439-2, as well as those given in Table 1, apply.

Table 1 – Symbols and abbreviated terms

Symbol/Abbreviated term	Term	Subclause
ACB	air circuit-breaker	JJ.1
AQD	arc quenching device	3.3.1
ATSE	automatic transfer switching equipment	3.5
E_{arc}	arc-energy	3.7
IACD	internal arc-fault control device	3.2
IALD	internal arc-fault limiting device	3.3.2
IAMS	internal arc-fault mitigation system	3.1
IARD	internal arc-fault reduction device	3.3
t_{mtA}	arc-fault mitigation time in an assembly	3.6

5 Interface characteristics

Clause 5 of IEC 61439-2 is applicable except as follows.

Addition:

5.101 Characteristics for each individual IAMS protected area

Declaration of IAMS protected areas shall include following parameters:

– range of prospective short-circuit current (I_{cp}) at the incoming terminals of the PSC-assembly declared for each IAMS protected area for which the IAMS is effective;

– range of rated operational voltages (U_e) at the incoming terminals of the PSC-assembly declared for each IAMS protected area for which the IAMS is effective;

– maximum arc energy during the tests (E_{arc}) which is the highest value declared for the whole assembly defined by test(s) in 10.101.4.

The functioning behaviour of the IAMS immediately after the assembly is energised shall be considered.

NOTE The prospective short short-circuit current and rated operational voltages are in correlation.

6 Information

Clause 6 of IEC 61439-2:— is applicable except as follows.

6.1 PSC-assembly designation marking

Addition:

d) the type of IARD according to 6.2.1.101.

e) designation markings as required by the device manufacturer's instructions shall be complied with.

Replacement of item g):

g) IEC 61439-2, IEC TS 63107

Addition:

6.2.1.101 Type of IAMS components used in the PSC-assembly

– Type of SCPD, if used as IARD;
– Type of AQD (e.g. single shot AQD, resettable AQD, fixed or withdrawable);
– Type of IALD;
– Type of IACD (e.g. stand-alone, multifunction or combined/with or without secondary-sensor(s)).

6.2.2 Instructions for handling, installation, operation and maintenance

Addition after first paragraph:

If an optical based IACD is used, the assembly manufacturer (using the original manufacturer's instructions where applicable) shall provide information in respect to unintended operations caused by any exposure to light source e.g. sun-light, flash-light, artificial lighting.

In the case of a reusable IARD, a functional test shall be considered during maintenance.

The assembly manufacturer's instructions (based on the original manufacturer's instructions) shall include all necessary information to enable the assembly to be restored to operational conditions following an activation of the IAMS. This should include guidance, for example, on fault investigation, maintenance, resetting or replacing one or several components of the IAMS.

7 Service conditions

Clause 7 of IEC 61439-2:— is applicable.

8 Constructional requirements

Clause 8 of IEC 61439-2:— is applicable except as follows.

8.5.3 Selection of switching devices and components

Addition:

Optical based IACD shall be selected taking into account its immunity to ambient light, according to the requirements of IEC 60947-9-2 (see 8.2.3, Light-immunity tests).

Additional subclauses:

8.5.102 Installation of IAMS

For assemblies including IAMS the original manufacturer shall provide specific technical documentation for installation, e.g. the installation requirements of the IAMS in consideration of the number, position and the required verifications to check the correct function of the sensors after installation within the PSC-assembly.

8.5.103 Quantity and location of sensors of an IAMS

The quantity, location and arrangement of the sensors to detect an internal arc-fault shall be made according to the recommendations of the IACD manufacturer (see Annex II.2) and where applicable, the knowledge gained from previous testing.

Relevant characteristics for integration of an optical-based IACD delivered by the device manufacturer are:

– selection of the type of sensors;
– distance for guaranteed detection at a specified distance (e.g. 10 kA and higher, X cm), with various angles;
– orientation of sensor(s) detection.

The number, locations and arrangements of the sensors shall be verified by the tests as detailed in this document and documented by the original manufacturer in the drawings, engineering and manufacturing documents.

Where secondary sensor(s) are used as part of the IAMS, care should be exercised to locate these so that the agreed area is monitored.

8.5.104 Connection of an AQD

The main connection of an AQD shall be as close as possible on the load side of the incoming / feeding device of the specific section in question. The conductors shall be as short as possible to reduce the voltage drop. These conductors shall take into account the mechanical constrains due to the magnetic forces and also the thermal stress according to the performance of the AQD.

8.102 Performance of an IAMS in PSC-assemblies

Areas within the PSC-Assembly which are to be protected shall be agreed between the assembly manufacturer and the user.

See 9.101 for requirements on assembly manufacturer's instructions related on IAMS protected areas.

The particular construction requirements linked to the application, e.g. interaction with ATSE shall be considered. The informative Annex II gives guidance on incorporation of an IAMS in a PSC-assembly.

9 Performance requirements

Clause 9 of IEC 61439-2:— is applicable, with the following addition.

Additional subclauses:

9.101 Identification of an IAMS protected area(s)

An IAMS protected area (see 5.101) shall fulfil the following requirements:

– internal arc-fault detection is achieved (see 10.101.1 10.101.2);
– unintended operation is avoided (see 10.101.3);
– the detected internal arc-fault can be mitigated and finally extinguished (see 10.101.4).

An assessment shall be made by the original manufacturer of the PSC-assembly to determine the likely source of unintended operation due to switching arcs and the tests be carried out. Such assessment can result in identification of area(s) which are not protected.

NOTE 1 There might be areas in the PSC-assembly where the protection is related to certain conditions, e.g. switching position of the incoming SCPD with downstream IARD.

NOTE 2 internal arc-faults ignited outside of a protected area also might cause an unintended operation. If this is intended or unintended operation depends to the needed solution/project.

10 Design verification

Clause 10 of IEC 61439-2:— is applicable except as follows.

10.10.1 General

Addition after the last paragraph:

If the manufacturer of the IARD has stated temperature-rise limits for the IARD (e.g. for ambient air temperature or for temperature-rise at the terminals) which are lower than the temperature-rise limits otherwise applied in the section of the assembly where the IARD will be mounted (e.g. incomer section), then the IARD has to be included in the temperature-rise tests of the corresponding section. The thermal effects on the actuating part of a combined-type IACD shall also be considered.

10.11.1 General

Addition:

Assemblies containing an AQD shall be tested to prove the short-circuit withstand strength of the AQD main circuit including the conductors from the incoming supply terminals of the PSC-assembly to the point of its AQD connection. The duration and prospective short-circuit current shall be as declared by the original manufacturer of the PSC-assembly.

10.11.5.5 Results to be obtained

Addition after the second paragraph:

In applications with an IAMS using an AQD, no crack(s) within the busbar system are allowed. Assessment shall be by visual inspection with normal or corrected vision after the test.

Additional subclauses:

10.101 Performance of an IAMS in PSC-assemblies

10.101.1 General

The correct functioning of an IAMS is the reliable detection and reduction of consequences of internal arc-faults inside PSC-assemblies. Therefore, it is necessary to verify the correct operation of the selected IAMS with the arc initiated at the most likely place(s) to occur, as a system test.

To demonstrate correct functioning of an IAMS the following verifications are necessary:

– correct detection of an internal arc-fault by the IACD (10.101.2);
– prevention of unintended operation of the IACD by switching arcs in the PSC-assembly (10.101.3);
– correct functioning of the whole IAMS consisting of IACD and IARD and determination of the remaining arc-fault energy (10.101.4);