

TECHNICAL SPECIFICATION

**Low-voltage switchgear and controlgear assemblies - Internal arc-fault
protection of low-voltage switchgear and controlgear assemblies in accordance
with the IEC 61439 series**

CONTENTS

FOREWORD	4
INTRODUCTION	6
1 Scope	8
2 Normative references	9
3 Terms and definitions	9
3.1 General terms	9
3.6 Insulation characteristics	10
3.8 Characteristics	10
3.101 Types of protection under arcing conditions	12
3.102 Zones classification	12
3.103 Types of devices	13
4 Symbols and abbreviations	14
5 Interface characteristics	14
5.101 Arcing classification with regard to the type of protection	14
5.102 Characteristics for arcing class zones	15
5.103 Classification with regard to persons who have access	16
6 Information	16
6.1 Assembly designation marking	16
6.2 Documentation	17
6.2.1 Information relating to the assembly	17
6.2.2 Instructions for handling, installation, operation and maintenance	17
7 Service conditions	18
8 Constructional requirements	18
8.5 Incorporation of switching devices and components	18
8.5.3 Selection of switching devices and components	18
8.5.101 Quantity and location of sensors of an IAMS	18
8.5.102 Connection of an AQD	18
8.101 Constructional requirements of an arc ignition protected zone	19
8.102 Constructional requirements of an IAMS in assemblies	19
9 Performance requirements	19
9.101 Assembly with arcing class zones	19
10 Design verification	20
10.1 General	20
10.3 Degree of protection of assemblies (IP Code)	20
10.3.101 Degree of protection (IP code) test of arc ignition protected zones	20
10.9 Dielectric properties	20
10.9.101 Dielectric test of arc ignition protected zones	20
10.10 Temperature-rise	21
10.10.1 General	21
10.11 Short-circuit withstand strength	21
10.11.1 General	21
10.101 Verification of internal arc-fault protection	21
10.101.1 General	21
10.101.2 Parameters for internal arc-fault verification	23
10.101.3 Verification of internal arc-fault detection by test	24

10.101.4	Verification by test that unintended operation will not occur.....	26
10.101.5	Verification of internal arc-fault detection and unintended operation by comparison with a reference design	27
10.101.6	Verification of the performance of an assembly under conditions of an internal arc-fault by test.....	28
10.101.7	Verification of the performance of an assembly under conditions of an internal arc-fault by comparison with a reference design	38
10.101.8	Verification of performance after powering or re-powering.....	38
10.101.9	Device substitution.....	39
10.101.10	Verification of methods to obtain arcing class I zone.....	39
11	Routine verification	39
11.10	Wiring, operational performance and function	39
Annexes		40
Annex AA (informative) User guide to internal arc-fault mitigation		41
AA.1	General	41
AA.2	Items for classification of internal arcing class zones.....	42
AA.3	Use of this document	42
Annex BB (informative) Guidance for the user of an assembly if specifying an assembly with an integrated IAMS		43
BB.1	General information	43
BB.2	Influence of the electrical parameters of the supply	44
BB.2.1	General.....	44
BB.2.2	Operational voltage.....	45
BB.2.3	Short-circuit current.....	45
BB.3	Interaction with other devices/systems in the assembly	45
BB.3.1	Interaction of IACD with other devices and systems.....	45
BB.3.2	Interaction of AQD with other devices and systems	46
Annex CC (informative) Guidance for the original manufacturer of an assembly if incorporating an integrated IAMS		47
CC.1	Selection of devices forming parts of an IAMS	47
CC.2	Installation of switching devices and components.....	47
CC.2.1	General.....	47
CC.2.2	Supply of IAMS.....	47
CC.2.3	Selection and connection of the AQD	47
CC.2.4	Interaction of AQDs with other devices and systems.....	47
CC.3	Accessibility	48
Annex DD (informative) Description of the extinction of an internal arc-fault in an assembly by an IAMS using an AQD during testing		49
DD.1	General	49
DD.2	Circuit diagram and event description	49
DD.3	Selected oscillograms	50
DD.3.1	Currents at the incoming terminals.....	50
DD.3.2	Currents in the AQD circuit	52
DD.3.3	Currents in the arc-fault circuit	53
DD.3.4	Voltages at the incoming terminals	55
DD.3.5	Arc-fault energy E_{arc}	56
Annex EE (informative) Additional information		57
EE.1	Overview of IAMS components.....	57
EE.2	Arc-fault test parameters	57

EE.2.1	General.....	57
EE.2.2	Parameters for internal arc-fault test.....	59
EE.2.3	Backward compatibility	63
Annex FF (informative)	Comparison of verification clauses in IEC TS 61641:2026, IEC TS 63107:2020 and IEC TR 61641:2014	66
Annex GG (informative)	List of notes concerning certain countries.....	70
Bibliography.....		71
Figure 101	– Mounting frame for indicators	30
Figure 102	– Examples of installation positions of the indicators.....	31
Figure BB.1	– Time/current characteristic curves NH-fuse-links Size 000 – 3 gG AC 400 V based on IEC 60269-2.....	44
Figure DD.1	– AQD test circuit diagram	49
Figure DD.2	– Incoming currents at the beginning of the sequence.....	50
Figure DD.3	– Currents and voltages at the incoming terminals at the end of the sequence.....	51
Figure DD.4	– Currents in the AQD circuit.....	52
Figure DD.5	– Currents in the arc-fault circuit.....	53
Figure DD.6	– Currents in the arc-fault circuit, curves magnified.....	54
Figure DD.7	– Voltages at the incoming terminals.....	55
Figure DD.8	– Electrical energy caused by the arc-fault currents and the voltages at the incoming terminals with t_0 as the start point for calculation.....	56
Figure EE.1	– Overview of IAMS components.....	57
Figure EE.2	– Concept of a black box testing	58
Figure EE.3	– Parameters of short-circuit test with a current limiting device linked to a black box testing concept.....	58
Figure EE.4	– Parameters for internal arc-fault test in case when current is not limited and arc does not self-extinguish or arc duration not limited.....	60
Figure EE.5	– Parameters for internal arc-fault test in case when current is not limited but arc self-extinguishes	61
Figure EE.6	– Parameters for internal arc-fault test in case when both current and arc duration are limited.....	62
Table 101	– Symbols and abbreviated terms	14
Table 102	– Overview of arcing classification with regard to the protection level	15
Table 103	– Overview of arcing class zones and assessment of the test	20
Table 104	– Sizes of the copper ignition wire without current-limiting protective device.....	32
Table 105	– Sizes of the copper ignition wire with current-limiting protective device	33
Table EE.1	– Overview regarding currents, arc duration and device operation	63
Table EE.2	– Parameters of TR 61641:2014 vs this document	63
Table FF.1	– Verification clauses	67

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**Low-voltage switchgear and controlgear assemblies -
Internal arc-fault protection of low-voltage switchgear and
controlgear assemblies in accordance with the IEC 61439 series**

FOREWORD

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IEC TS 61641 has been prepared by subcommittee SC 121B: Low-voltage switchgear and controlgear assemblies, of IEC technical committee TC 121: Switchgear and controlgear and their assemblies for low voltage. It is a Technical Specification.

This edition cancels and replaces IEC TR 61641:2014 and IEC TS 63107:2020. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- a) Introduction of the term "arcing class zone", using the term "arcing classes" from the previous document IEC TR 61641:2014.

- b) Structured using of the terms "zone" and "area". "Area" is used to describe the place of installation and the accessibility of the assembly (macro-environment). "Zone" is used in this document to describe a defined space within the assembly (micro-environment).
- c) Assembly protection is classified into two levels.

The text of this Technical Specification is based on the following documents:

Draft	Report on voting
121B/228/DTS	121B/232/RVDTS

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 Technical Specification 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.

This document is to be used in conjunction with the IEC 61439 series.

It supplements or modifies the corresponding clauses in the IEC 61439 series.

The following numbering system is used:

- subclauses, tables and figures that are numbered starting from 101 are additional to those in the IEC 61439 series;
- unless notes are in a new subclause or involve notes in the IEC 61439 series, they are numbered starting from 101, including those in a replaced clause or subclause;
- additional annexes are lettered AA, BB, etc.

The reader's attention is drawn to the fact that Annex GG lists all of the "in-some-country" clauses on differing practices of a less permanent nature relating to the subject of this document.

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

- reconfirmed,
- withdrawn, or
- revised.

INTRODUCTION

This document deals with the internal arc-fault protection of low-voltage switchgear and controlgear assemblies.

The IEC 61439 series of documents identifies rules and requirements for the interface characteristics, service conditions, construction, performance and verification of low-voltage switchgear and controlgear assemblies, hereafter called an assembly. The main objective of the IEC 61439 series of documents is to provide assemblies that operate safely under normal operating conditions. An internal arc-fault is not considered as a normal operating condition. Therefore, no characteristics, design and verification requirements are given dealing with an internal arc-fault within an assembly.

Assemblies built, operated and maintained according to the IEC 61439 series cannot exclude the risk of occurrence of an internal arc-fault. On the rare occasions that they do occur, internal arc-faults result from circumstances including:

- foreign objects inadvertently left in the assembly during manufacture, installation or maintenance operations, e.g. a tool;
- faults in construction materials and components;
- entry of small animals like mice, snakes, etc.;
- use of an inappropriate assembly for the application resulting in incorrect operation, overheating, accelerated ageing of insulation;
- unforeseen operating conditions or lack of maintenance;
- human error, poor or faulty workmanship whether under energized or de-energized conditions.

Avoiding all of the above and similar circumstances results in a remote possibility of an internal arc-fault. Any of these circumstances creates a higher possibility of an internal arc-fault, which should be considered in a risk assessment.

The ignition of an internal arc-fault within an assembly generates various phenomena, such as extreme overheating resulting in high overpressure inside the assembly and emission of hot materials, gases and flame which may endanger people in close proximity to the assembly causing burns from the potential projection of these hot materials and/or gases from the assembly as well as impacts from suddenly opening doors, and damage to the assembly.

Due to the risk of personal injury, damage and loss of power availability because of an arc-fault there is a demand for internal arc-fault verified assemblies.

There are various methods of mitigating the effects of internal arc-faults. Assemblies often use several methods for protection against the risk of injury, damage and loss of power availability as a consequence of an arc-fault.

This document describes the verification of an assembly under conditions of arcing in air due to an internal failure where the mechanical construction of the assembly provides arc-fault resistance, commonly called "passive" arc-fault protection, and an assembly which is fitted with an internal arc-fault mitigation system (IAMS), commonly called "active" arc-fault protection.

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

- improve the ability of assemblies to reduce the risk of injury to personnel;
- reduce the consequential damage to assemblies;
- improve the power availability from assemblies for further service after an internal arc-fault.

The above-mentioned improvements are related only to an assembly complying with certain parts of the IEC 61439 series.

The ability of an assembly to pass tests according to this document is only one aspect when assessing the potential risk due to an internal arc-fault within an assembly. Risk assessments should be carried out considering for example, the skill of personnel having access to the assembly, any protective measures required, the working procedures applied and the conditions in the location where the assembly is installed.

General information about internal arc-fault considerations and possible protective measures from the perspective of the user of an assembly is given in IEC TR 61439-0:2022, Clause D.2 and Annex AA and Annex BB of this document.

1 Scope

This document identifies methods used to verify the ability of the assembly:

- to limit the risk of injury to personnel during an internal arc-fault;
- to limit the damage to an acceptable level as a result of an internal arc-fault;
- to improve the power availability following an internal arc-fault.

This document takes into consideration:

- the effects of the internal overpressure acting on covers, doors, etc.;
- the thermal effects of the internal arc-fault or its roots on the enclosures and of ejected hot gases and glowing particles.
- the correct function of the IAMS within the assembly;
- the prevention of unintended operation of the IAMS within the assembly, for example caused by switching arcs;
- the functioning behaviour of the IAMS immediately after the assembly is energized.

This document describes different methods to assess the performance of an assembly or zones of an assembly in respect of arcing in air due to an internal failure:

- with "passive" arc-fault protection (provided by mechanical construction, e.g. suitable door locks, hinges, pressure relief devices, barriers);

NOTE 1 This approach corresponds to the method according to IEC TR 61641:2014.

- with "active" arc-fault protection (with the integration of IAMS);

NOTE 2 This approach corresponds to the method according to IEC TS 63107:2020.

- with the use of an arc ignition protected zone (to make the ignition of an arc-fault an extremely remote possibility).

NOTE 3 This approach corresponds to the method according to IEC TR 61641:2014.

IAMS consist of internal arc-fault control devices (IACD), e.g. optical-based IACD's in accordance with IEC 60947-9-2 and internal arc-fault reduction devices (IARD), e.g. arc quenching devices (AQDs) in accordance with IEC 60947-9-1 and short-circuit protection devices SCPD's in accordance with IEC 60947-2 (see Figure EE.1). IAMS can be provided by a combined-type device according to IEC 60947-9-2.

IEC 60364-4-42:2024 (Clause 427) provides guidance on the need for internal arc-fault protection.

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.

Informative Annex AA gives guidance for the user (see IEC 61439-1:2020, 3.11) on internal arc-fault mitigation.

Informative Annex BB gives guidance for the user (see IEC 61439-1:2020, 3.11) of assemblies with "active" arc-fault protection (with the integration of IAMS).

Informative Annex CC gives guidance for the original manufacturer of an assembly when incorporating an integrated IAMS.

This document does not consider other effects which can constitute a risk, such as emission of toxic gases, loud noises and/or intense light. Furthermore, this document does not consider conditions during maintenance work and the personal protective equipment used.

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 60529, *Degrees of protection provided by enclosures (IP Code)*

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

IEC 60947-9-2:2021, *Low-voltage switchgear and controlgear - Active arc-fault mitigation systems - Part 9-2: Optical-based internal arc-detection and mitigation devices*

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

IEC 61439 (all parts), *Low-voltage switchgear and controlgear assemblies*

Bibliography

The bibliography of IEC 61439-1:2020 is applicable except as follows.

Addition:

IEC 60269-2:2013, *Low-voltage fuses - Part 2: Supplementary requirements for fuses for use by authorized persons (fuses mainly for industrial application) - Examples of standardized systems of fuses A to K*
IEC 60269-2:2013/AMD1:2016

IEC 60364-4-42:2024, *Low-voltage electrical installations - Part 4-42: Protection for safety - Protection against thermal effects*

IEC 60947-6-1:2021, *Low-voltage switchgear and controlgear - Part 6-1: Multiple function equipment - Transfer switching equipment*

IEC TR 61439-0:2022, *Low-voltage switchgear and controlgear assemblies - Part 0: Guidance to specifying assemblies*

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

IEC 62606, *General requirements for arc fault detection devices*

IEC TS 63107:2020, *Integration of internal arc-fault mitigation systems in power switchgear and controlgear assemblies (PSC-assemblies) according to IEC 61439-2*

IEC TR 63482:2024, *Maintenance of low voltage switchgear and controlgear and their assemblies*

EN 50110 (all parts), *Operation of electrical installations*

IEEE C37.20.7 - IEEE Guide for Testing Switchgear Rated Up to 52 kV for Internal Arcing Faults