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Interested committees:

Title: Draft BS EN 60947-9-2 Low-voltage switchgear and controlgear - Active arc-fault mitigation systems. Part 9-2: Optical-based internal arc-detection and mitigation devices.

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Full document details: 18/30363445 DC

Introduction

This draft standard is based on national and international discussions. Your comments on this draft are invited and will assist in the preparation of the consequent standard.

For international standards, comments will be reviewed by the relevant UK national committee before sending the consensus UK vote and comments to the international committee, which will then decide appropriate action. If the international standard is approved, it is usual for the text to be published as a British Standard.

For national standards, comments will be reviewed by the relevant UK national committee and the resulting standards published as a British Standard.

UK Vote

Please indicate whether you consider the UK should submit a negative (with supporting technical reasons) or positive vote on this draft. Please indicate if you are aware of any reason why this draft standard should not be published as a British Standard.

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Template for comments and secretariat observations

Date: xx/xx/20xx	Document: ISO/DIS xxxx
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1	2	(3)	4	5	(6)	7
MB	Clause No./ Subclause No./Annex (e.g. 3.1)	Paragraph/Figure/ Table/Note	Type of comment	Commend (justification for change) by the MB	Proposed change by the MB	Secretariat observations on each comment submitted
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	



121A/193/CD

COMMITTEE DRAFT (CD)

PROJECT NUMBER:

IEC 60947-9-2 ED1

DATE OF CIRCULATION:

2017-12-22

CLOSING DATE FOR COMMENTS:

2018-03-16

SUPERSEDES DOCUMENTS:

121A/141/NP, 121A/158A/RVN

IEC SC 121A : LOW-VOLTAGE SWITCHGEAR AND CONTROLGEAR

SECRETARIAT:

France

SECRETARY:

Mr Eric Betttega

OF INTEREST TO THE FOLLOWING COMMITTEES:

SC 23E, SC 121B

PROPOSED HORIZONTAL STANDARD:

☐

Other TC/SCs are requested to indicate their interest, if any, in this CD to the secretary.

FUNCTIONS CONCERNED:

☒ EMC

☐ ENVIRONMENT

☐ QUALITY ASSURANCE

☐ SAFETY

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Recipients of this document are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation.

TITLE:

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

NOTE FROM TC/SC OFFICERS:

Secretary note: NC experts are kindly requested to refer their comments to line numbers.

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

LOW-VOLTAGE SWITCHGEAR AND CONTROLGEAR

ACTIVE ARC-FAULT MITIGATION SYSTEMS –

Part 2:

OPTICAL-BASED ARC-DETECTION AND MITIGATION DEVICES

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International Standard 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

The text of this standard is based on the following documents:

FDIS	Report on voting
XX/XX/FDIS	XX/XX/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

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

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

- 203 • reconfirmed,
- 204 • withdrawn,
- 205 • replaced by a revised edition, or
- 206 • amended.

207

208 The National Committees are requested to note that for this publication the stability date
209 is 2022

210 THIS TEXT IS INCLUDED FOR THE INFORMATION OF THE NATIONAL COMMITTEES AND WILL BE
211 DELETED AT THE PUBLICATION STAGE.

212

213

INTRODUCTION

214 Low-voltage switchgear and controlgear, as well as complementary protective and measuring
215 devices, are essentially installed in assemblies, which are usually complying to standards (for
216 example IEC 61439 series) which gives rules and requirements for interface characteristics,
217 service conditions, construction, performance and verification of proper integration of
218 products.

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

223 The case of an arc-fault inside LV assembly is currently considered only by the following
224 publications:

- 225 – IEC TR 61641 (Enclosed low-voltage switchgear and controlgear assemblies – Guide for
226 testing under conditions of arcing due to internal fault), which specify tests requirements
227 for assemblies under internal arc-fault.
- 228 – IEC TR 61439-0 (Low-voltage switchgear and controlgear assemblies – Part 0: Guidance
229 to specifying assemblies), which identify arc-fault containment in Annex C.

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

- 232 – conducting materials inadvertently left in during manufacture, installation or maintenance;
- 233 – faults in materials or workmanship;
- 234 – inadvertent contact to live conductor under maintenance;
- 235 – entry of small animals such as mice, snakes, etc.;
- 236 – use of an incorrect assembly for the application resulting in overheating and subsequently
237 an internal arcing fault;
- 238 – inappropriate operating conditions (for example water, fungus, or dust);
- 239 – incorrect operation; or,
- 240 – lack of maintenance.

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

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

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

259 This document is intended to cover devices and functions dedicated to detect an arc-fault
260 internal to an assembly by processing optical effects of an internal arc-fault, and to signal and
261 trigger devices intended to mitigate the internal arc-fault, or (alternatively) to detect and
262 mitigate the effects of the internal arc-fault.

263 NOTE Even when both terms are related to ASSEMBLIES in which an arc occurs between conductors, arc-flash is
264 a wording mainly used in NFPA 70E, CSA Z462 and IEEE 1584, which usually describes effects of direct exposure

265 of workers to radiations emitted, when wording (internal) arc-fault describes the hot gases flow phenomena which
266 could injury people in the vicinity.

LOW-VOLTAGE SWITCHGEAR AND CONTROLGEAR

ACTIVE ARC-FAULT MITIGATION SYSTEMS –

Part 2:

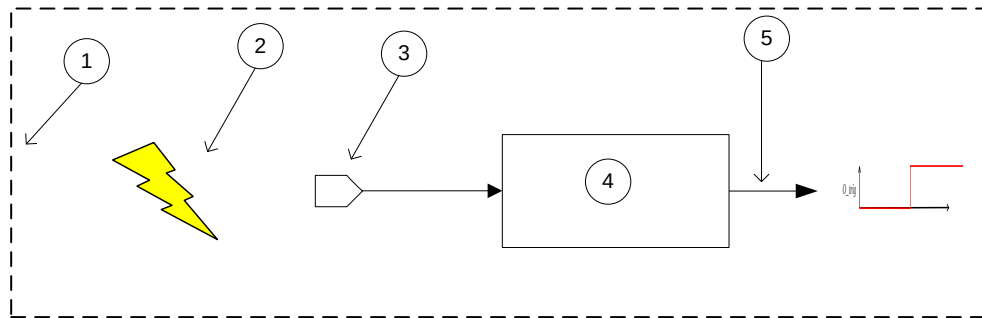
OPTICAL-BASED ARC-DETECTION AND MITIGATION DEVICES

1 Scope

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

- detect internal arc-faults in a low-voltage assembly, busbars trunking systems (essentially defined by IEC 61439 series), by processing (at least) 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).

NOTE 1 Other low-voltage applications can be equipped supposed agreement between manufacturer and customer.



Key

- 1 ASSEMBLY boundary
- 2 Internal arc-fault
- 3 Optical sensor
- 4 Processing unit
- 5 Trigger output

Figure 1 – IACD schematic (stand-alone type, no secondary sensor)

Therefore, this document covers the following:

- arc-detection unit (stand-alone, embedded or combined);
- (at least one) associated sensor used to detect optical effect of the internal arc-fault;
- sensor(s), sensing another physical effect, to confirm the default;
- associated or combined mitigation device.

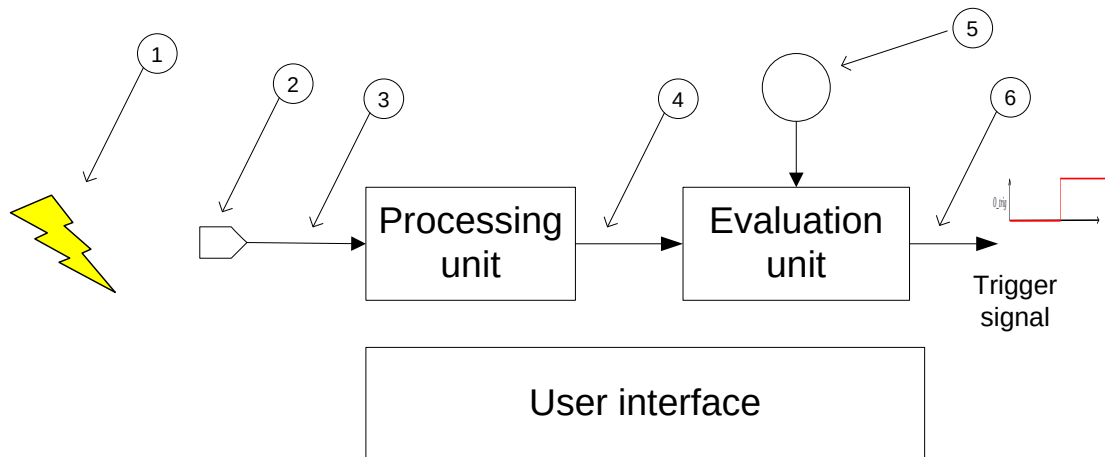
The arc-detection can consist of different functional parts (see Figure 2 below) such as:

- sensor(s) for detecting optical effect to identify an arc-fault event;
- modules for processing the measured quantity into a digital signal;
- evaluation module which process the signals to trigger the mitigation device;
- user interface to monitor and/or operate the detection unit.

An IACD is not intended to trigger under normal operation of low-voltage switchgear and controlgear (i.e. absence of internal arc-fault), including normal arcing associated with operation of disconnecting and switching devices.

This document is covering only the following methods:

- 307 – optical detection of the physical effect of internal arc-fault;
 308 – (optional) confirmation of internal arc-fault by current measurement.
 309 Many different conductive materials could be used in LV assemblies (e.g. steel, copper,
 310 aluminium). Nevertheless, tests specified in this document are deemed to represent the most
 311 critical conditions for arc-detection and cover all combination of materials.
- 312 NOTE 2 Compared to other materials (e.g. steel, aluminium), copper leads to the lower radiation energy.
 313 NOTE 3 Internal arc-faults in the field can arise from other causes (e.g. mice, ants, lubricants, paint, loose
 314 parts).
 315 The rated voltage of the assembly in which IACD is installed shall not exceed 1 000 V AC.



316

317 **Key**

- 318 1 Internal arc-fault
 319 2 Optical sensor
 320 3 Electrical or optical input signal
 321 4 Analog or digital signal
 322 5 Current sensor (CT)
 323 6 Analog, digital, optical output signal(s) and/or NO/NC contacts

324 **Figure 2 – IACD detailed schematic (stand-alone type, with secondary sensor)**

325 Such devices are designed to be operated and maintained by skilled persons only.

326 This document does not cover:

- 327 – other use phases of IACD than operation;
 328 – DC internal arc-fault control;
 329 – overcurrent relays,
 330 – AFDD (arc-fault detection devices) as defined by IEC 62606;
 331 – selection of current sensors used in conjunction with IACD (unless embedded);
 332 – guidance on installation and optimization within assemblies.

333 NOTE 1 The former is considered by IEC SC121B, in the framework of project IEC TS 63107 (Integration of
 334 arcing fault mitigation devices into power switchgear and controlgear assemblies (PSC-ASSEMBLIES) according to
 335 IEC 61439-2).

336 NOTE 2 Even when dealing with internal arc-fault mitigation device, this document is not superseding any
 337 other relevant product standard (e.g. IEC 60947-2 or -future- IEC 60947-9-1).

338 NOTE 3 DC arc-faults detection are under consideration. Even when DC-arcs spectra supposed to be close
 339 to AC-ones, more material is needed for. In addition, availability of DC sensors needs to be confirmed as well.

340 **2 Normative references**

341 The following documents are referred to in the text in such a way that some or all of their
 342 content constitutes requirements of this document. For dated references, only the edition
 343 cited applies. For undated references, the latest edition of the referenced document (including
 344 any amendments) applies.

- 345 IEC 60947-1:2007, *Low-voltage switchgear and controlgear – Part 1: General rules*
 346 IEC 60947-1:2007/AMD1:2010
 347 IEC 60947-1:2007/AMD2:2014
- 348 IEC 60947-2:2016, *Low-voltage switchgear and controlgear - Part 2: Circuit-breakers*
- 349 IEC 60947-9-1:20XX¹, *Low-voltage switchgear and controlgear - Part 9-1: Arc quenching*
 350 *device*
- 351 IEC 61439 (series), *Low-voltage switchgear and controlgear assemblies*
- 352 IEC 61439-1:2011, *Low-voltage switchgear and controlgear assemblies - Part 1: General*
 353 *rules*
- 354 IEC 61439-2:2011, *Low-voltage switchgear and controlgear assemblies - Part 2: Power*
 355 *switchgear and controlgear assemblies*
- 356 IEC TR 61641:2014, *Enclosed low-voltage switchgear and controlgear assemblies – Guide for*
 357 *testing under conditions of arcing due to internal fault*
- 358 IEC 61482-1-2, *Live working - Protective clothing against the thermal hazards of an electric*
 359 *arc - Part 1-2: Test methods - Method 2: Determination of arc protection class of material and*
 360 *clothing by using a constrained and directed arc (box test)*

361 **3 Terms and definitions**

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

363 ISO and IEC maintain terminological databases for use in standardization at the following
 364 addresses:

- 365 • IEC Electropedia: available at <http://www.electropedia.org/>
- 366 • ISO Online browsing platform: available at <http://www.iso.org/obp>

367 **3.1**

368 **arc**

369 thermal plasma established by electric current flowing through ionized gases in air between
 370 two conductive parts

371 [SOURCE: Webster dictionary, modified]

372 Note 1 to entry: this phenomenon is accompanied (for example) by thermal, magnetic, radiation and luminescent
 373 effects.

374 **3.2**

375 **(Internal) arc-fault**

376 unintentional arc arising from a short-circuit between live parts of different potential and/or
 377 between live parts and other conductive parts within an assembly

378 **3.3**

379 **internal arc-fault control device**

380 **IACD**

381 device intended to detect an internal arc-fault, which provide a signal for operation of a
 382 separate mitigation device, or automatically mitigate the arc-fault

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

385 **3.4**

386 **arc-fault detection time**

387 interval of time between the ignition of the internal arc-fault, and the transition of the IACD
 388 output signal to “triggered” state

¹ Project IEC 60947-9-1 is currently at ACDV stage.

3.5**arc-fault mitigation time**

interval of time between the ignition of the internal arc-fault and the complete extinction of the same

Note 1 to entry: extinction of the arc can be detected (for example) by line current and/or mitigation device pole voltage analysis.

3.6**mitigation device**

device intended to reduce the effects of the internal arc-fault

Note 1 to entry: mitigation devices can be fuses, circuit-breakers, switches, arc-quencher, or a combination of any of these devices.

3.7**arc quenching device**

switchgear intended to eliminate arcing faults in a low-voltage assembly, by creating a lower impedance current path, to cause the arcing current to transfer to the new current path

[SOURCE: IEC 60947-9-1:201X, 3.1, modified – “Device” replace with “switchgear”, introduction of “low-voltage assembly”.]

3.8**optical sensor****os**

sensor used to detect the optical emission of an internal arc-fault

3.9**secondary sensor****ss**

sensor used in addition to optical sensor(s) to confirm indication by sensing another physical effect of the arc, and to support additional function

Note 1 to entry: secondary sensor(s) are optional.

Note 2 to entry: current sensors are the only secondary sensor-type considered in this document.

3.10**latch-up time**

steady-state duration value of the output (triggering) signal value after detection

Note 1 to entry: not applicable to combined-type IACD.

3.11**arc-setting current (I_{as})**

rated value of instantaneous arc-current enabling arc-detection function

Note 1 to entry: this value can be expressed as an absolute value (in ampere) or as a ratio of current value.

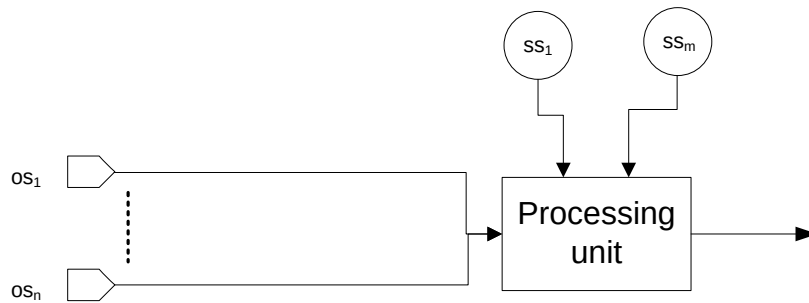
3.12**arc-setting current range**

current setting range between the minimum and maximum values over which the arc-detection current function is enabled

Note 1 to entry: this setting can be expressed as an absolute value (in ampere) or as a ratio of current value.

4 Classification**4.1 According to the IACD type****4.1.1 Stand-alone type IACD**

IACD with no function other than internal arc-fault detection and signalling (see Figure 3).

**Key**

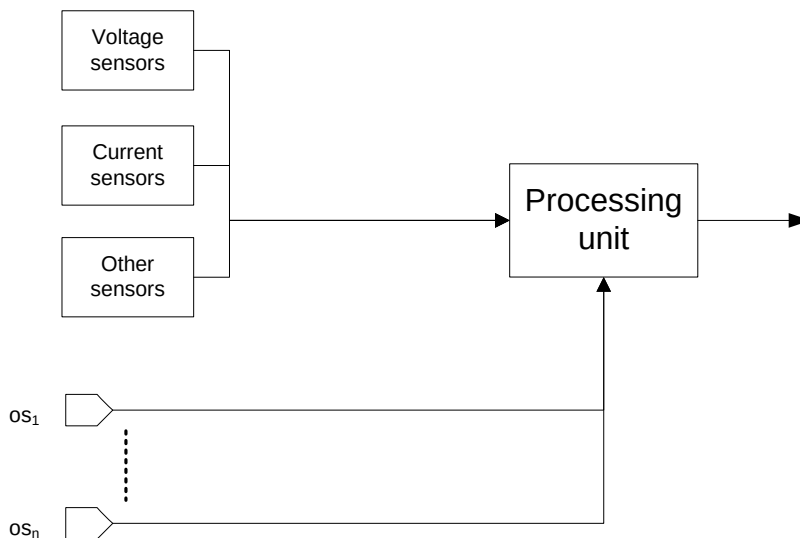
os1 to osn Optical sensor 1 to n
 ss1 to ssm (Optional) secondary current sensor 1 to m

Figure 3 - Stand-alone type IACD architecture overview

NOTE Essential performance of such class of IACD is arc-fault detection time.

4.1.2 Multifunction-type IACD

A device in which an IACD is an integrated function of a measurement or protective device or relay (see Figure 4).

**Key**

os1 to osn Optical sensor 1 to n

Figure 4 – Multifunction-type IACD architecture overview

NOTE Essential performance of such class of IACD is arc-fault detection time.

4.1.3 Combined-type IACD

Device or combination of devices, including IACD function, designed to detect and mitigate internal arc-fault (see Figure 5).