IEC 60947-5-7

Edition 2.0 2024-04

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Low- voltage switchgear and controlgear –
Part 5-7: Control circuit devices and switching elements – Proximity devices with analogue output

Appareillage à basse tension –
Partie 5-7 : Appareils et éléments de commutation pour circuits de commande – Détecteurs de proximité à sortie analogique

IEC 60947-5-7:2024-04(en-fr)

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LOW-VOLTAGE SWITCHGEAR AND CONTROLGEAR –

Part 5-7: Control circuit devices and switching elements – Proximity devices with analog output

FOREWORD

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IEC 60947-5-7 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.

This second edition cancels and replaces the first edition published in 2003. This edition constitutes a technical revision.

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

a) New structure;
b) Update and expansion of definitions on analog output properties;
c) Expanded performance requirements on analog output;

d) Update and new normative references;

e) Update of EMC requirements;

f) Harmonization with IEC 62828 series;

g) Harmonization with IEC 62683 and IEC 61987 definitions;

h) Harmonization with IEC 61131-2 requirements;

i) Update of the Annex A (former Annex G), Example of the determination of the conformity;

j) New Annex B, Overview tests and influence quantities;

k) New Annex C, Additional requirements for proximity switches with analog output incorporating a built-in communication interface complying with IEC 61131-9;

l) New Annex D, Main characteristics for proximity devices with analog output.

This International Standard is to be read in conjunction with IEC 60947-5-2:2019.

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

Draft	Report on voting
121A/592/FDIS	121A/604/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/publications.

A list of all the parts in the IEC 60947 series, under the general title *Low-voltage switchgear and controlgear*, can be found on the IEC website.

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.

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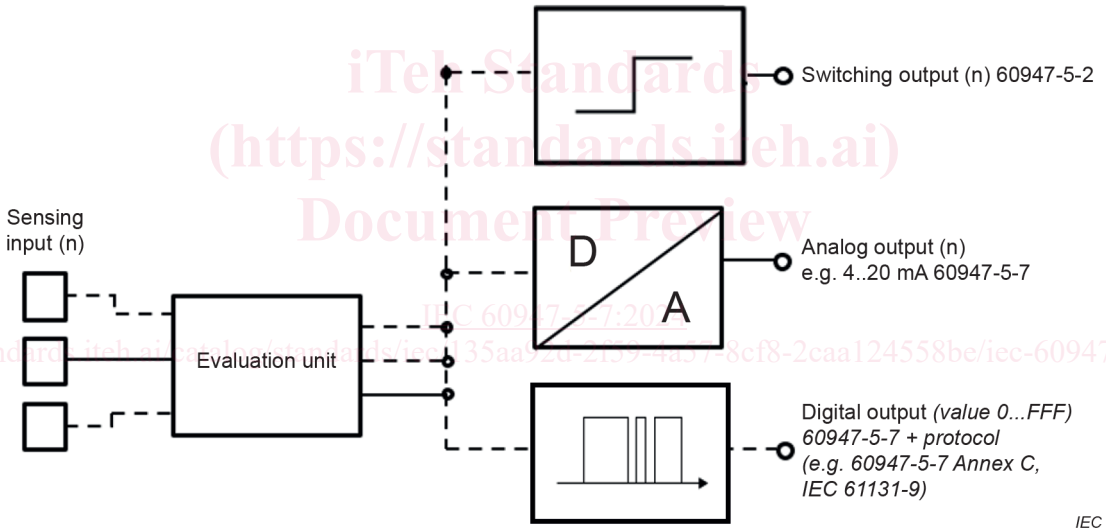
LOW-VOLTAGE SWITCHGEAR AND CONTROLGEAR –

Part 5-7: Control circuit devices and switching elements – Proximity devices with analog output

1 Scope

This part of IEC 60947 states the requirements for proximity devices that correspond to the scope of IEC 60947-5-2:2019 with analog output (PDAO) and/or a digital output to transmit a corresponding digital value representing the detected sensing input. These devices can provide additional parameters. Figure 1 shows the schematic principle of such a device. They might consist of one or more parts.

The requirements of IEC 60947-5-2, *Low-voltage switchgear and controlgear – Part 5-2: Control circuit devices and switching elements – Proximity switches,* apply with the additions and modifications as stated in this document. The clause numbering in this document follows the clause numbering of IEC 60947-5-2, modified where necessary.



Key

evaluation unit Evaluating electronic circuitry, e.g. MCU, ASIC component...

Figure 1 – Proximity device with analog output (PDAO), schematic block diagram structure

This document does not apply to industrial process measurement transmitters according to IEC 62828 series.

Examples of typical applications for in-scope products:

- factory automation and machinery industry;
- logistic and packaging industry;
- conveyor belts, lifts;
- process industry;
- power plants.

Special applications (e.g. corrosive atmosphere) can cause additional requirements.

Products covered by the scope of this document are expected to be selected, installed, and maintained by skilled personnel only.

NOTE 1 Analog proximity devices can be linear or non linear.

NOTE 2 The specific requirements, characteristics, and test procedures for an analog output interface which are described in Clauses 5, 6 and 9 of this document, are based on requirements written in IEC 61131-2:2017.

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 60947-5-2:2019, *Low-voltage switchgear and controlgear – Part 5-2: Control circuit devices and switching elements – Proximity switches*

IEC 61131-9:2022, *Programmable controllers – Part 9: Single-drop digital communication interface for small sensors and actuators (SDCI)*

IEC 62443 (all parts), *Industrial communication networks – Network and system security*

IEC TS 63208:2020, *Low-voltage switchgear and controlgear – Security aspects*

3 Terms, definitions and list of abbreviated terms

For the purposes of this document, the terms and definitions given in IEC 60947-5-2:2019 and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- IEC Electropedia: available at https://www.electropedia.org/
- ISO Online browsing platform: available at https://www.iso.org/obp

3.1 Basic definitions

3.1.1
proximity device with analog output
PDAO
device producing an output signal which varies continuously depending on the physical quantity (e.g. distance, speed, rotation, etc.) detected/calculated by the proximity device in relation to its target object(s)

3.1.2
lower range value
minimum stated input value above which the output signal varies continuously

3.1.3
upper range value
maximum stated input value below which the output signal varies continuously

3.1.4
range of input values
range defined by lower range value and upper range values of the sensing element detection capability, or calculated value (e.g. distance, speed, r/min, etc.), within which the limits of uncertainty of the proximity device are specified

Note 1 to entry: A principle diagram describing the terms of 3.1.2 to 3.1.4 is given in Figure 3.

3.1.5
span
range of input values
algebraic difference between the values of the upper and lower limits of the measuring range

Note 1 to entry: Upper and lower limits do not reflect the sensing capabilities of the device, but the relevant upper and lower values for the application.

Note 2 to entry: The CDD code of this entry for Electronic Data Exchange is ABB785, modified ("other variables" removed).

[SOURCE: IEC 60050-311:2001, 311-03-13, modified — Notes to entry added]

3.2 Operation of a proximity device

3.2.1
linearity
ability of a proximity device to provide an indication having a linear relationship with a defined quantity other than an influence quantity

Note 1 to entry: The method of expression of lack of linearity is different for different kinds of device and is established in each particular instance.

[SOURCE: IEC 60050-311:2001, 311-06-05, modified – "measuring instrument" replaced by "proximity device"]

3.2.2
conformity of the output signal curve
ability of a proximity device to provide an indication having a specified characteristic curve which can be linear, logarithmic, parabolic, etc.

3.2.3
non-linearity
deviation from ideal behaviour for devices that have a linear input/output relationship, determined from the curve plotted using the overall average of corresponding upscale and downscale errors

Note 1 to entry: Non-linearity can be calculated and expressed in one of three ways: – independent: line positioned so as to minimize the maximum deviation; – terminal-based: line positioned so as to coincide with the actual characteristic curve at the upper and lower range-values; – zero-based: line positioned so as to coincide with the actual characteristic curve at the lower range-value.

Note 2 to entry: The corresponding properties can be found in the CDD.

Note 3 to entry: Linearity is defined in IEC 60050-300:2001, 311-06-06.

Note 4 to entry: Non-linearity does not include hysteresis.

Note 5 to entry: Conformity is often used in conjunction with non-linear curves.

[SOURCE: IEC 61987-13:2016, modified — Notes to entry added]

3.2.4
non-conformity of the output signal curve
deviation from ideal behaviour for devices that have a non-linear input/output relationship, determined from the curve plotted using the overall average of corresponding upscale and downscale errors

Note 1 to entry: The non-conformity is defined as the closeness with which an average error curve approximates to a specified characteristic curve (which can be linear, logarithmic, parabolic, etc.).

3.2.5
true value
<of a physical quantity value> value consistent with the definition of a given particular quantity

Note 1 to entry: This term is used in the "true value" approach.

Note 2 to entry: Value that would be obtained by a perfect measurement.

Note 3 to entry: True values are by nature indeterminate.

Note 4 to entry: The indefinite article "a", rather than the definite article "the", is used in conjunction with "true value" because there can be many values consistent with the definition of a given particular quantity.

[SOURCE: IEC 60050-311:2001, 311-01-04]

3.2.6
conventional true value
<of a physical quantity value> value attributed to a particular quantity and accepted, sometimes by convention, as having an uncertainty appropriate for a given purpose

Note 1 to entry: This term is used in the "uncertainty" approach.

Note 2 to entry: The "conventional true value" is sometimes called "assigned value", "best estimate of the value", "conventional value" or "reference value". The term "reference value", in this sense, should not be confused with "reference value" in the sense used in IEC 60050-311:2001, 311-07-01.

Note 3 to entry: Frequently, a large number of results of measurement of a quantity are used to establish a conventional true value.

Note 4 to entry: An alternative concept of measurement uncertainty used for measurement instruments is described in IEC Guide 115:2021, *Application of uncertainty of measurement to conformity assessment activities in the electrotechnical sector*.

3.2.7
inaccuracy
maximum positive and negative deviation from the specified characteristic curve observed in testing a device under specified conditions and by a specified procedure

Note 1 to entry: Accuracy is defined in IEC 60050-311:2001, 311-06-08.

[SOURCE: IEC 61298-1:2008, 3.5]

3.2.8
long term drift
drift in output monitored for 30 days at 90 % of span

[SOURCE: IEC 61987-1:2008, 3.22]

3.2.9
long term stability
drift of zero output signal in percent of full scale limit after a given period of normal operating conditions

Note 1 to entry: The long term stability can be evaluated over a different period of time, e.g. 6 months, 1, 2 or 5 years. Sometimes manufacturers declare a life-time stability.

Note 2 to entry: Depending the type of a proximity device, the drift can be referred to an upper range limit, a fixed value, a full scale, etc.

3.2.10
repeatability
value of variation of the output signal under specified conditions expressed as a percentage of the span

Note 1 to entry: This definition is more general and not equal to the definition in IEC 60947-5-2:2019.

3.2.11
resolution value
resolution of the value of the physical quantity

Note 1 to entry: The resolution value from the digital output value and the analog output value can be different.

3.2.12
error
discrepancy between a computed, observed or measured value or condition, and the true, specified or theoretically correct value or condition

Note 1 to entry: An error within a system may be caused by failure of one or more of its components, or by activation of a systematic fault.

[SOURCE: IEC 60050-192:2015, 192-03-02]

3.2.13
linearity error of the digital output
maximum deviation between the real and the ideal curve of the digital output

3.2.14
linearity error of the analog output
maximum deviation between the real and the ideal curve of the analog output

3.2.15
reference base for linearity error
basis for stating the linearity error for analog output

Note 1 to entry: The reference base can be output span, full scale or definition by the manufacturer.

3.2.16
upscale error
arithmetic mean of the errors at each value of each measurement cycle with increasing input value

3.2.17
downscale error
arithmetic mean of the errors at each value of each measurement cycle with decreasing input value

3.2.18
average error
arithmetic mean of all upscale and downscale readings at each value

3.2.19
maximum measured error
largest positive or negative value of errors of the average upscale or downscale values at each point of measurement

Note 1 to entry: Synonymous to measured error expressed as percentage ABB652 of IEC 61987.

[SOURCE: IEC 61298-1:2008]

3.2.20
total probable error
TPE
number obtained by taking the square root of the total sum of the squares of the individual error factors, adopted to consistently compare the performances of two (or more) devices

Note 1 to entry: It is assumed that the variables of the individual errors are independent of each other.

Note 2 to entry: When combining all the error factors, the units of measure shall all be the same.

3.3 Output element characteristics

3.3.1
analog current signal
current signal which varies in a continuous manner within its range

3.3.2
analog voltage signal
voltage signal which varies in a continuous manner within its range

3.3.3
range of an analog signal
all values of the signal between and including defined limits

3.3.4
output span
algebraic difference between the values of the upper and the lower limits of the output signal

3.3.5
lower limit output signal
specified minimum value of the range

Note 1 to entry: The lower limit may be either zero or a finite value; when zero is used, this is called "true zero"; when a finite value is used, this is called "live zero".

3.3.6
upper limit output signal
specified maximum value of the range

3.3.7
load impedance
<maximum load (current), minimum load (voltage)> impedance or impedances for which the output characteristics of the proximity device are specified

3.3.8
ripple content
ratio between the peak-to-peak value of the AC component and the upper limit of the signal value