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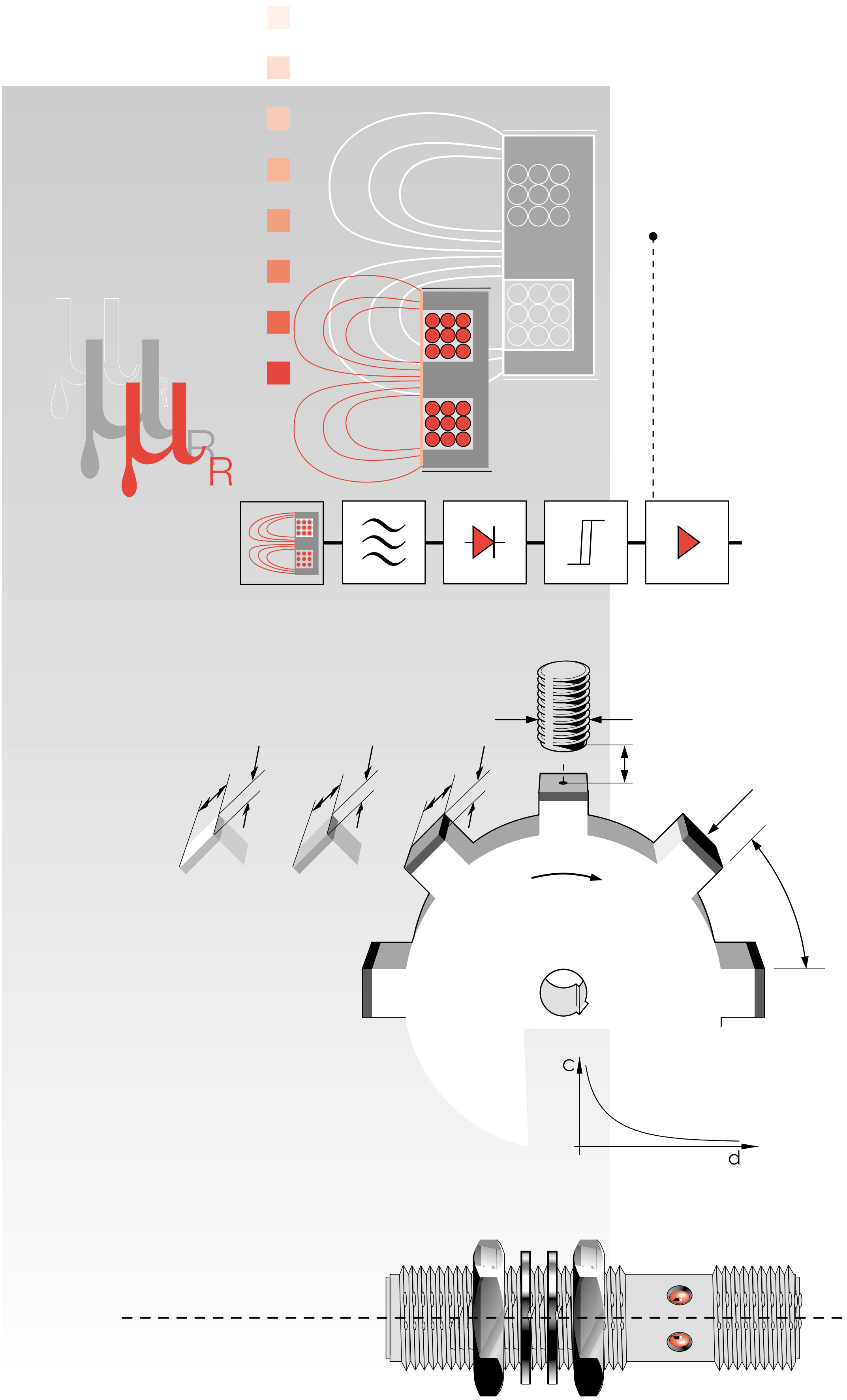


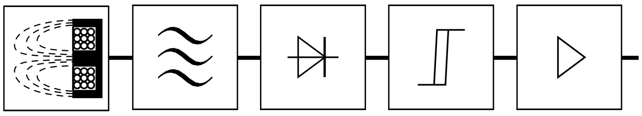
In this section you will learn about the basic concepts, technical details, application conditions, standards, etc. for the inductive sensor group.

Principle

... of inductive proximity sensors is based on the interaction between metallic conductors and an electromagnetic alternating field. Eddy currents are induced in the metallic damping material, which removes energy from the field and reduces the height of the oscillation amplitude. This change is processed in the inductive sensor, which changes its output state accordingly.

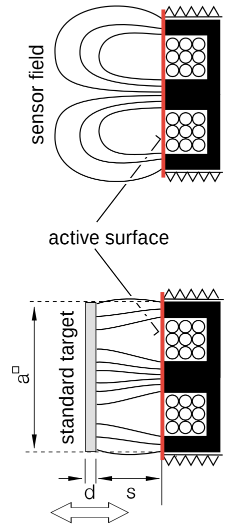
Function groups

... of the Balluff proximity switch are:



Active surface

... is the area through which the high-frequency sensor field enters the air gap. It is determined primarily by the base of the shell core and corresponds roughly to the surface area of the shell core cap.



Standard target

...is a square plate of Fe 360 (ISO 630: 1980), used to define sensing distances per EN 60947-5-2. The thickness is d = 1 mm; and the side length a corresponds to

- the diameter of the circle of the "active surface" or
- 3 s_n, if the value is greater than the given diameter.

Correction factor

... gives the reduction in sensing distances for target materials which are not made of Fe 360.

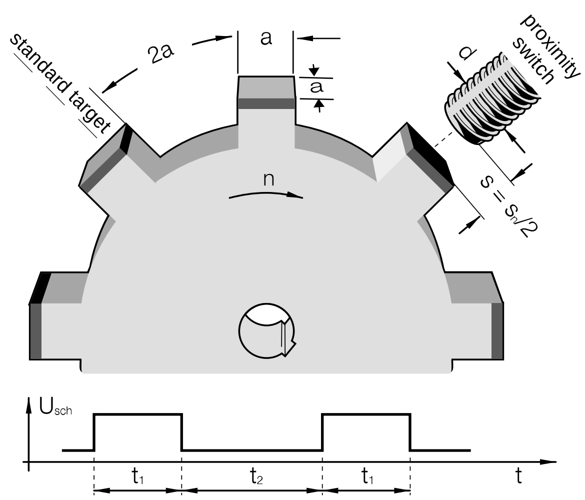
Material	Factor
steel	1.0
copper	0.25...0.45
brass	0.35...0.50
aluminum	0.30...0.45
stainless steel	0.60...1.00
nickel	0.65...0.75
cast iron	0.93...1.05

Switching frequency f

... refers to the maximum number of switching operations per second.

Damping is per EN 60947-5-2 with standard targets on a rotating, non-conducting disk. The surface area ratio of iron to non-conductor must be 1 : 2.

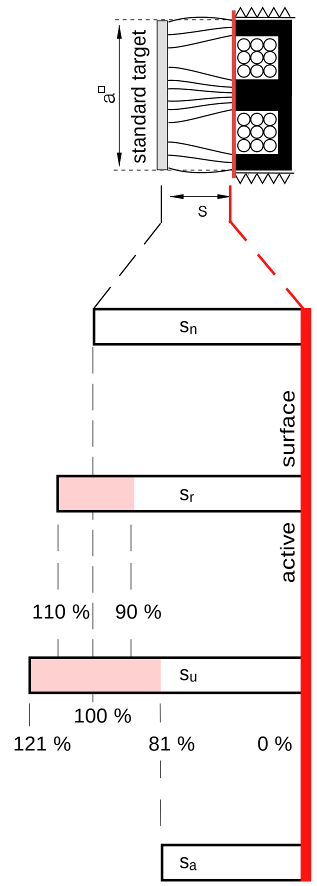
The measured value of the switching frequency is
- the turn-on signal t_1= 50 µs or
- the output signal t_2 = 50 µs.



Switching distances

Switching distance s

... is the distance between the standard target and the active surface of the proximity switch at which a signal change is generated (per EN 60947-5-2).
For NO this means from OFF to ON and for NC from ON to OFF.



Rated operating distance s_n

... is a theoretical value, which does not take into account manufacturing tolerances, operating temperatures, supply voltages, etc.

Effective operating distance s_r

... is the switching distance of an individual proximity switch as measured under specified conditions (installation, voltage, temperature).
T_a = +23 °C ±5
($0.9\ s_n \le s_r \le 1.1\ s_n$).

Useful switching distance s_u

... is the switching distance of a single proximity switch under specified temperature and voltage conditions ($0.81\ s_n \le s_u \le 1.21\ s_n$).

Assured operating distance s_a

... is any switching distance for which an operation of the proximity switch within the permissible operating conditions (temperatures, voltages) is guaranteed ($0 \le s_a \le 0.81\ s_n$).

Switching distance-identifier
(in sections **1.1**, **1.2**, **1.5**, and **5**)

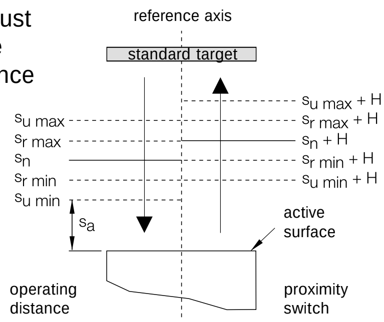
		Housing	Switching distance
none	standard switching distance per IEC 60947-5-2		
switching distance ■■	**"double"** the switching distance vs. standard	≤ M12	2 ×
switching distance ■■■	**"triple"** the switching distance vs. standard	≥ M18 ≤ M12	1.5 × 2.2...3 ×
switching distance ■■■■	**"quadruple"** the switching distance vs. standard	≥ M18	model dependent

Repeatability R

... of s_r at measuring supply voltage U_e is given under the following conditions:
Temperature: T = +23 °C ±5
Relative humidity: ≤ 90 %
Test duration: t = 8 h.
Per EN 60947-5-2,
$R \le 0.1\ s_r$.

Hysteresis H
(switching hysteresis when target is backed off)

... is given as a percentage of the effective operating distance s_r. It is measured at an ambient temperature of +23 °C ±5 and at the rated operational voltage. It must be less than 20 % of the effective operating distance (s_r).
$H \le 0.2\ s_r$



Delay times

Start-up delay t_v

... is the time from when the supply voltage is applied, the proximity switch assumes the ready state and the correct signal is present on the output.

Response delay

... is the time required for the proximity switch to respond when the standard target enters or leaves the sending zone.

Temperature effects and limits

Temperature drift

... is the deviation of the effective operating distance with the temperature range of –25 °C $\leq T_a \leq$ +70 °C. Per EN 60947-5-2 it is: $\Delta s_r/s_r \leq 10$ %

Ambient temperature range T_a

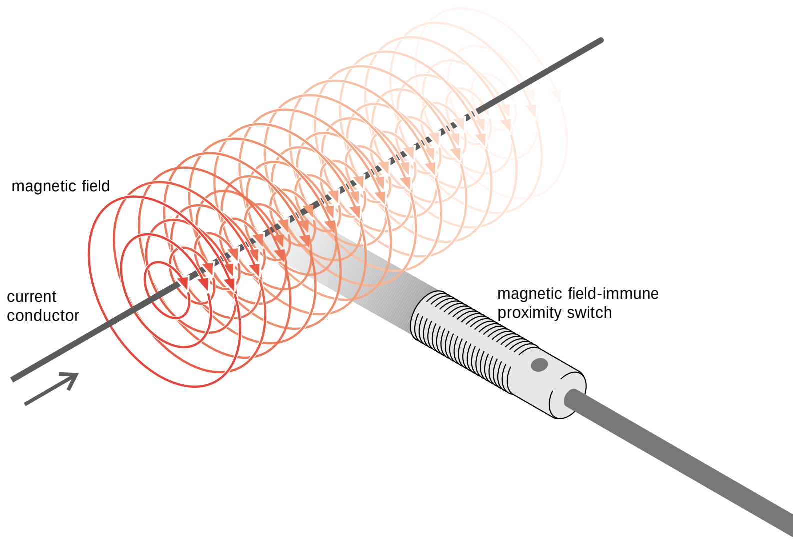
... is the temperature range over which the function of the switch is guaranteed.

Magnetic field immunity

Principle

Error-free function depends on the magnitude of the welding current and the distance of the sensor from the current carrying line.

Design and circuitry techniques ensure that magnetic field immune proximity switches remain unaffected by magnetic fields.



Additional definitions – sensors with analog output

Analog sensors

... are sensors that generate a continuous, varying output signal which is a function if the distance between their active surface and the corresponding target.

Linearity range s_l

... is the working range in which the analog sensor exhibits a defined linearity.

Repeatability R

... is the value of the output signal changes under specified conditions, expressed as a percent of the upper distance. Measurements must be made however in the lower, upper and center areas of the linear range. It corresponds to the repeatability R of proximity switches and is determined under the same standard conditions (EN 60947-5-2).

Rated sensing distance s_e

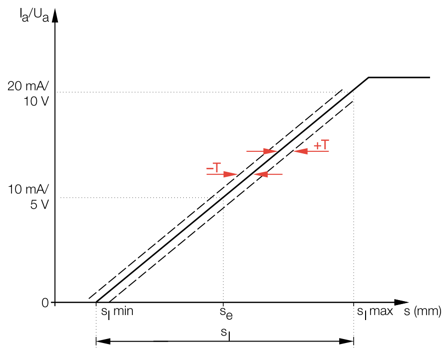
... is the point in the middle of the linear range, used as a reference point for other specifications.

Max. working point shift T (sample variance)

... is a parameter that defines the tolerance band of the characteristic curve and thereby specifies the sample variance.

Sample variance by sensor size

Housing	"T" for flush sensors	"T" for non-flush sensors
M8	±0.1 mm	
M12	±0.125 mm	±0.25 mm
M18	±0.3 mm	±0.5 mm
M30	±0.6 mm	±0.8 mm
80×80×40	±1.0 mm	
PG 36	±0.1 mm	



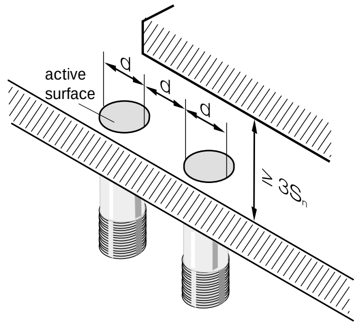
Temperature drift

... is the shift that a point on the actual characteristic curve can experience at various temperatures. With out newest analog sensors this is compensated by a proprietary, multi-stage procedure.

Installation in metal and side-by-side

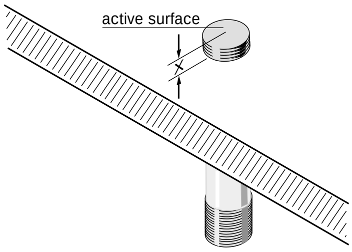
Flush mountable proximity switches

... can be installed with their sensing faces flush to the metal. The distance to opposing switches must be ≥ $3s_n$, and the distance between adjacent switches (side-by-side) must be ≥ d.



Quasi-flush mountable proximity switches

... require a space behind the active surface which is free of conducting materials. Under this condition the specified switching distance is available without limitation. Dimension "×" (see fig.) indicates the shortest distance between the active surface and the conducting material behind it.



Dimension "×" for quasi-flush sensors

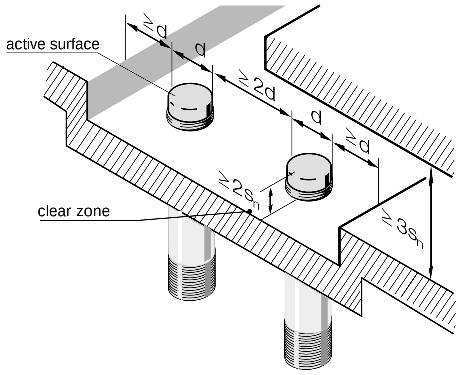
housing	Switching distance ■■■ installation in ferromagnetic materials	Switching distance ■■■ installation in other metals	Switching distance ■■■■ installation in ferromagnetic materials	Switching distance ■■■■ installation in other metals
∅ 6.5, M8	2.0 mm	1.0 mm	3.0 mm	2.0 mm
M12	2.5 mm	2.0 mm	4.0 mm	3.0 mm
M18	4.0 mm	2.5 mm		
M30	8.0 mm	4.0 mm		

Installation medium

Ferromagnetic materials:	Iron, steel or other magnetizable materials.
Other metals	Brass, aluminum or other non-magnetizable materials.

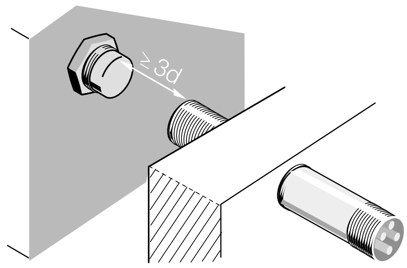
Non-flush mountable proximity switches

... can be identified by their "caps", since they have no metal housing surrounding the area of the active surface.
The active surface must extend ≥ $2s_n$ from the metallic installation medium.
The distance from opposing metal surfaces must be ≥ $3s_n$ and the distance between two adjacent proximity switches ≥ 2d.



Opposing installation

... requires for all inductive proximity switches a minimum distance of ≥ 3d between the active surfaces.



Tightening torque

Permissible tightening torque

... for proximity switches with metal housing:

M5×0.5	1.5 Nm	
M8×1	6 Nm	around the shell core
	15 Nm	otherwise
M12×1	15 Nm	threaded brass tube
	40 Nm	threaded steel tube
M18×1	40 Nm	
M30×1.5	40 Nm	

... for proximity switches with plastic housings:

M18	1.5 Nm
M30×1.5	1.5 Nm

Supply voltage U_B

... is the permissible voltage range in which certain operation of the switch is guaranteed (including ripple σ). It is indicated in the catalog section for each product.

Rated operational voltage U_e

... is the supply voltage used for testing without tolerances.

For DC switches
U_e = 24 V_{DC}
For AC and AC/DC switches
U_e = 110 V_{AC}

Voltage drop U_d

... is the voltage measured across the load of a closed (conducting) sensor at load current I_e.

Rated insulation voltage U_i

... of a proximity switch is the voltage to which the isolation tests and the creep distances are referenced.

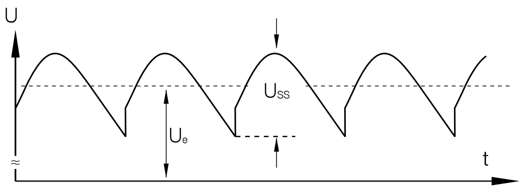
For proximity switches the highest rated operating voltage must be considered as the rated isolation voltage.

Rated supply frequency

... of the power supply for AC devices is 50 to 60 Hz.

Ripple σ (%)

... is the AC voltage (peak-to-peak of U_e) overlaid on the DC voltage U_e given in percent. To operate DC switches a filtered DC voltage having a ripple of max. 15 % (per DIN 41755) is required.



U_e = rated operational voltage
U_{ss} = oscillation width

$$\text{Ripple } \sigma = \frac{U_{ss}}{U_e} \times 100\ [\%]$$

Rated operational current I_e

... is the permissible constant output current that may flow through the load R_l.

Off-state current I_r

... is the residual current flowing through the load when a proximity switch is not conducting (open).

Inrush current I_k

... in the case of alternating current indicates the current I_k which is permitted to flow for a short time during an indicated turn-on time t_k and at a frequency f.

- I_k in $A_{(eff)}$
- t_k in ms
- f in Hz

Short circuit current

... is 100 A, i. e., per EN 60947-5-2 the power supply during testing in short circuit mode must be able to provide at least 100 A for a short duration. This current is prescribed in the standard in order to test the short circuit resistance of proximity switches.

No-load supply current I_0

... is the current consumed by a 3 or 4 wire sensor from a power supply when the outputs are not connected to a load.

Minimum operational current I_m

... is the smallest load current required for function of the switch when ON.

Output resistance R_a

... is the resistance in the collector circuit of the output transistor. The output resistance is in parallel with the external load resistance.

Load capacity

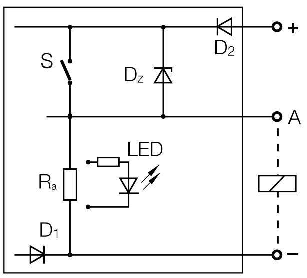
... is the permissible total capacitance on the output of the switch, including line capacitance.

Output circuits

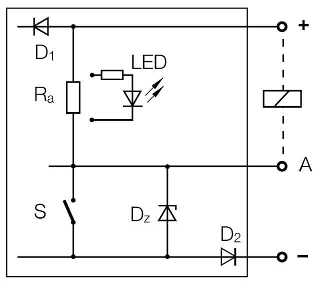
Driver stages

3-Wire DC switch

PNP, sourcing (current source)



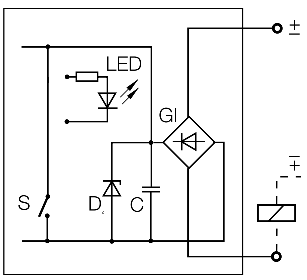
NPN, sinking (current sink)



S = semiconductor switch
R_a = output resistance
D_z = Z-Diode, limiter
D_1 = pol. rev. protect. diode
D_2 = pol. rev. protect. diode in load current circuit (for short protection types only)
LED = light emitting diode

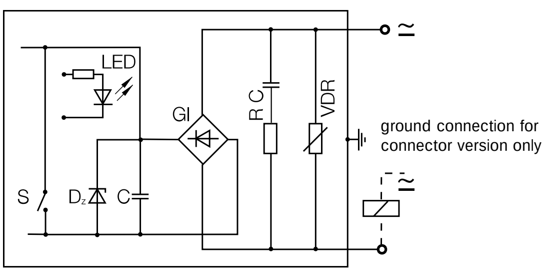
2-Wire DC switch

Non-polarized



S = semiconductor switch
D_z = Z-Diode, limiter
C = capacitor
Gl = bridge rectifier
LED = light emitting diode

2-Wire AC and AC/DC switches



S = semiconductor switch
D_z = Z-Diode, limiter
C = filter capacitor
RC = HF-Peak-limiter
Gl = bridge rectifier
LED = light emitting diode
VDR = voltage spike limiter

Polarity reversal

... protected against any possible lead reversal for sensors with short circuit protection.

... against reversal of +/– leads for sensors without short circuit protection.

Cable break protection

... in 3-wire sensors prevents improper function. A diode prevents the current from flowing on the output line A.

Short circuit protection
(sensors with a maximum voltage of 60 V DC)

... is achieved in Balluff sensors using pulsing or thermal short circuit protection circuits. The output stage is thereby protected against overload and short circuit. The threshold current of the short circuit protection is greater than the rated operating current I_e.
Currents from switching and load capacitance do not trigger this function, but rather are masked by a short delay time.

Short circuit/overload protected
(universal AC/DC sensors)

... AC or AC/DC sensors are often operated with a relay or contactor as the load.
AC switching devices (contactors/relays) create a significantly higher load (6...10 × rated current) when they are first energized as compared with their static operation due to the fact that the core is still open.
The static value of the load (current) is not reached until several milliseconds later.
Not until the magnetic field is closed does the max. permissible rated operating current I_e flow through the sensor.

This means that the threshold value for a short circuit condition in these sensors must lie significantly higher and would, if for example the contactor is prevented for mechanical or electrical reasons from fully closing, result in an overload on the sensors. This is where the overload protection comes into play. It is designed with a time delay, and its threshold is just slightly higher than the max. permissible I_e.
A response (i. e. turn-off) is delayed depending on the magnitude of the overload by more than 20 milliseconds.

This ensures that properly working relays and contactors can be switched normally, while defective devices will not destroy the Balluff sensor.
The short circuit/overload protection is generally of a bi-stable design, which means that it must be reset by turning off the supply voltage to the sensor.

Axial and radial damping

When damping in an **axial direction** the standard target is moved concentric to the system axis.
The switch point is thus determined only by the distance "s" from the "active surface". When damping in **radial direction**, the location of the switch point is additionally affected by the radial distance "r" from the system axis.

The diagram shows the **response curves**, which show the relationship between the switch point of "s" and "r".

Standardization

The curves are shown in **standardized form**, i. e. the axis sections are referenced to a generally valid nominal value (rated switching distance s_n and radius of the "active surface" r).
This means that the curves for various switch diameters and switching distances are to a large degree compensated.
The primary purpose of this drawing is to show the possibility of damping from lateral approach and the difference compared with axial approach.

Application

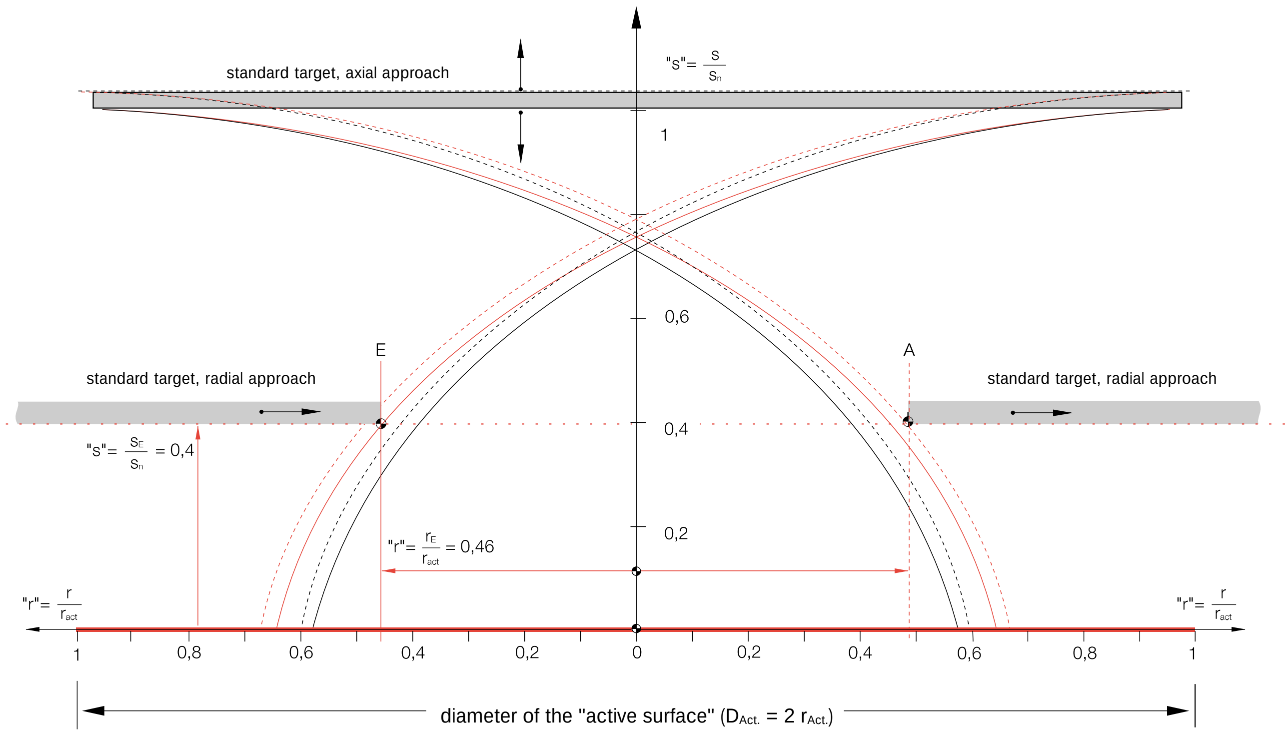
Due in part to manufacturing tolerances within a production run, the exact switch point must in any case be established on site.
The solid lines represent the respective switch point (E), the dashed lines indicate the turn-off point (A). The red lines apply to switches with a clear zone, and the black lines for flush mount types.
Since the switching operation can be induced from either direction, the curves are shown mirrored from the system axis.

Examples

Passing objects on conveyor lines generate a signal change when their front edge crosses the turn-on curve on the entry side.
The signal reverses again when the back edge of the passing object crosses the turn-off curve on the opposite side.

In the case of **reversing parts** (e. g. end of travel), the signal reversal occurs at the turn-off curve on the same side.

Approaching curves standardized



The **vertical axis** in the diagram shows the distance of the switch point from the active surface. It is referenced to the nominal sensing distance s_n (see page **1.0.**3). For an M18 switch, for example, with a nominal sensing distance s_n = 8 mm, the number 0.4 corresponds to a switching distance of 0.4 × 8 mm = 3.2 mm.
At this distance, a laterally approaching target reaches the solid line turn-on curve at point "E" and leaves the turn-off curve at point "A".

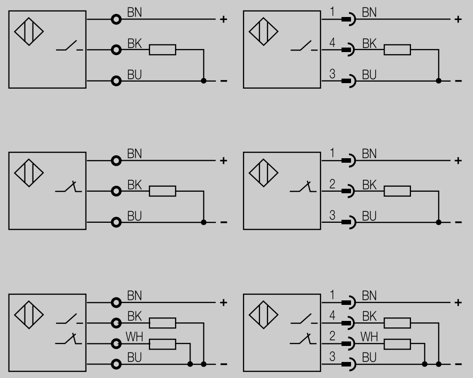
The **horizontal axis** in the diagram is referenced to the radius of the active surface (see page **1.0.**2). The zero point of this axis lies in the center of the shell core cap. In our example for the M18 switch, the radius is r = 9 mm.

The standardized distance of the turn-on and turn-off points (from the system axis) is:
"E" ~ 0.46 resp. "A" ~ 0.49.
The absolute values of the points are calculated as:
E = 9 mm × 0.46 = 4.14 mm,
A = 9 mm × 0.49 = 4.41 mm.

DC 3/4-Wire

Cable/terminals **Connector**

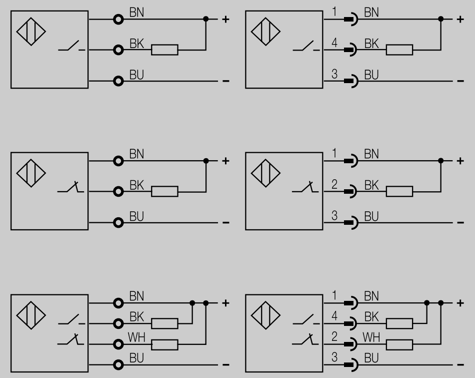
PNP (+) sourcing



- Normally-open ①
- Normally-closed ②
- Complementary ③

Cable/terminals **Connector**

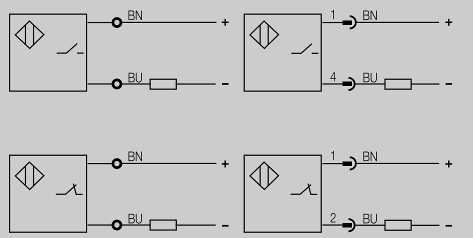
NPN (–) sinking



- Normally-open ④
- Normally-closed ⑤
- Complementary ⑥

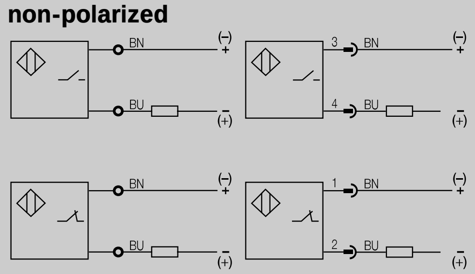
DC 2-Wire

polarized



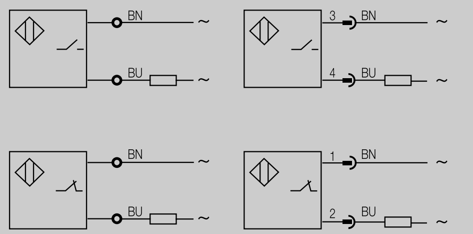
- Normally-open ⑦
- Normally-closed ⑧

non-polarized



- Normally-open ⑨
- Normally-closed ⑩

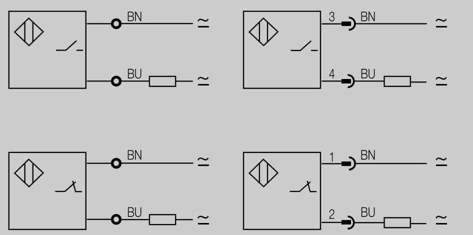
AC-Switches



- Normally-open ⑪
- Normally-closed ⑫

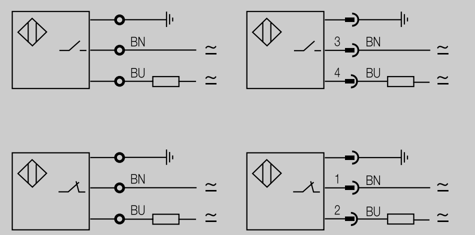
AC/DC-Switches

safety insulated (insulation class II, ⧈)



- Normally-open ⑮
- Normally-closed ⑯

with protection ground (insulation class I)



- Normally-open ⑰
- Normally-closed ⑱

Wire colors
per DIN IEC 60757

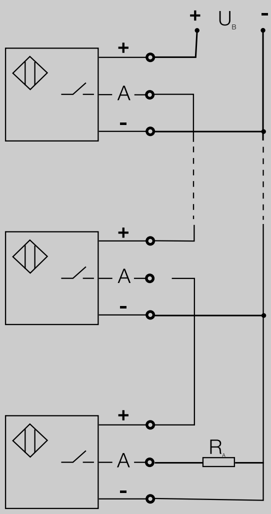
BN	brown
BK	black
BU	blue
WH	white

Series connection

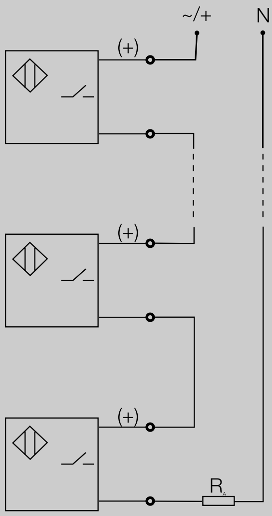
... can cause a time delay (e. g. start-up delay). The number of connected proximity switches is limited by the total voltage drop (sum of all U_d). For 3-wire switches, the load capacity of the output stage represents a further limitation, since the current consumption I_0 of all switches is added to the rated current I_e.

The ready delay time t_v is the ready delay of a sensor × (number of sensors n – 1).

3-wire DC switch



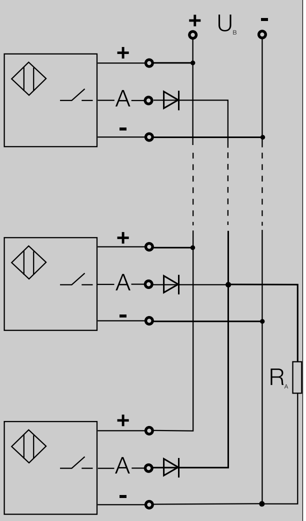
2-wire DC switch (AC/DC)



For parallel connection

... of proximity switches with LED it is recommended that the outputs of the individual switches be decoupled using diodes (as shown). This prevents all LED's from turning on when the output stage of one switch is active.

3-wire DC switch



2-wire DC switch

Parallel wiring of 2-wire proximity switches is not recommended, since spurious pulses can be caused by the ready delay when the oscillators are building up.

Utilization categories
per IEC 60947-5-2/
EN 60947-5-2/
VDE 0660 part 208

Category		Typical load applications
AC 12	AC-switch	resistive and semiconductor loads, optocouplers
AC 140	AC-switch	small electromagnetic load $I_a \leq 0.2$ A; e. g. contactor relay
DC 12	DC-switch	resistive and semiconductor loads, optocouplers
DC 13	DC-switch	electromagnets

	Materials	Use and characteristics
Metals	**Al** Aluminum wrought alloy	Standard aluminum for cut shaping. Can be anodized. Used for housings and fastening parts.
	CuZn Brass	Standard housing material. Nickel plated for surface protection.
	Stainless steel	Excellent corrosion resistance and strength.
	Quality 1.4034, 1.4104:	Standard material.
	Quality 1.4305:	Standard material for food grade applications.
	Quality 1.4401, 1.4404, 1.4571:	For food grade applications with heightened requirements for chemical resistance at elevated temperatures.
	GD-Al Cast aluminum	Low specific gravity. Good strength and wear characteristics. Some types can be anodized.
	GD-Zn Cast zinc	Good strength and wear characteristics. Usually with protective surface coating.
Plastics	**ABS** Acrylnitril-Butadien-Styrol	Impact resistant, stiff, limited chemical resistance. Some types are flame retardant. Used for housings.
	AES/CP Acrylonitrile-Ethylene-propylene-Styrene	Impact resistant, stiff, limited chemical resistance. Used for housings.
	EP Epoxy resin	Duromer, moulding resin, highest mechanical strength and temperature resistance. Very good dimensional stability. Non-melting.
	LCP Liquid Crystalline Polymer	High mechanical strength and temperature resistance. Very good chemical resistance. Inherently non-flammable.
	PA 6, PA 12 Polyamide	Good mechanical strength, temperature resistance. PA 12 approved for food industry applications.
	PA transp. Transparent polyamide	Transparent, hard, stiff. Good chemical resistance.

	Materials	Use and characteristics
Plastics	**PBT** Polybuteneterephthalate	High mechanical strength and temperature resistance. Some types flame-retardant. Good chemical resistance. Good oil resistance.
	PC Polycarbonate	Clear, hard, elastic and impact resistant. Good temperature resistance. Limited chemical resistance.
	PEEK Polyetheretherketone	Thermoplastic. Very high strength and temperature resistance. Good chemical resistance. Can be sterilized, good resistance to ionizing radiation.
	PMMA Polymethylmetharcrylate	Clear, transparent, hard, scratch-resistant, UV-resistant. Also for optical applications.
	POM Polyoxymethylene	High impact resistance, good mechanical strength. Good chemical resistance.
	PTFE Polytetraflourethylene	Best temperature and chemical resistance.
	PUR Polyurethane	Elastic, abrasion-resistant, impact-resistant. Good resistance to oils, greases, solvents (used for gaskets and cable jackets).
	PVC Polyvinylchloride	Good mechanical strength and chemical resistance (cable).
	PVDF Polyvinylidenfluoride	Thermoplastic High temperature resistance and mechanical strength. Good chemical resistance (similar to PTFE).
Other	**Glass**	Good chemical resistance and strength. Used primarily in optical applications (lenses, covering panes).
	Ceramic	Very good strength and chemical resistance. Electrically insulating. Excellent temperature resistance.

Relevant standards for our sensors

Proximity switches	Low-voltage equipment	EN 60947-5-2 IEC 60947-5-2	
EMC (Electromagnetic Compatibility)	Radiated electromagnetic field	DIN EN 55011	
	Static discharge immunity (ESD)	IEC 61000-4-2	
	Radio frequency immunity (RFI)	IEC 61000-4-3	
	Immunity to fast transients (burst)	IEC 61000-4-4	
Environmental simulation	Shock Vibration Temperature change	DIN EN 60068-2-...	
Insulation class	II ⧈	IEC 60947-5-2/ EN 60947-5-2/ VDE 0660 part 208	
Degree of protection	IP 60...67	IEC 60529 (DIN 40050)/ DIN VDE 0470-1	
	IP 68 per BWN Pr. 20	Balluff factory standard (BWN): Temperature storage 48 h at 60 °C, 8 temperature cycles per IEC 60068-2-14 between reference temperatures shown on the data sheet, 1 h under water,	insulation test, 24 h under water, insulation test, 8 temperature cycles per IEC 60068-2-14 between reference temperatures shown on the data sheet, 7 days under water, insulation test.
	IP 68 per BWN Pr. 27	Balluff factory standard (BWN):	Testing for products used in the foods industry.
	IP 69K	DIN 40050 part 9	Protection against ingress of water under pressure or steam cleaning.
NAMUR	Proximity switches and switching amplifiers (NAMUR)	EN 60947-5-6	
Analog sensors	Proximity switches with analog output	EN 50319	
Hazardous zone	Electrical equipment for explosive atmospheres, general requirements.	EN 50014	
	Electrical equipment for explosive atmospheres, intrinsically-safe "i".	EN 50020	

The QM-System ...
(Quality Management)

Balluff company	Standard	Certified since
Balluff GmbH, Germany	DIN EN ISO 9001	1993
Balluff Elektronika KFT, Hungary	EN ISO 9001	1993
Nihon Balluff Com. Ltd., Japan	ISO 9001	1996
Balluff U.K. Ltd., Great Britain	BS EN ISO 9002	1991
Balluff Automation S.r.l., Italy	UNI EN ISO 9002	1997
Balluff Inc., USA	ISO 9001	1999
Gebhard Balluff Vetriebsgmbh, Austria	ÖNORM EN ISO 9002	1999
Balluff CZ, Czech Republic	ISO 9002	2000
Hy-Tech AG, Switzerland	EN ISO 9001	1999

Environmental protection

Protecting the environment and sensible use of energy and raw materials are among the precepts our company lives by. Our Environmental Management System is certified since 2000 by the DQS in accordance with DIN EN ISO 14001.

Testing laboratory

The Balluff testing laboratory works in accordance with ISO/IEC 17025 and is accredited by the DATech for Testing of Electromagnetic Compatibility (EMC).

Balluff products meet the EMC directives

Our EMC laboratory attests that Balluff products meet the EMC directives of the product standard EN 60947-5-2. The CE-marking confirms that our products conform to the EU directive 89/336/EWG (EMC directive) and the EMC law.

Approvals

... are granted by national and international institutions. Their symbols affirm that our products meet the specifications of these institutions. "US Safety System" and "Canadian Standards Association" under the auspices of Underwriters Laboratories Inc. (cUL).

Balluff is a member of ALPHA

ALPHA, an association for testing and certification of low-voltage devices, promotes self-responsibility of the manufacturer of such devices by means of uniform test procedures per current standards and thereby supports the attainment of high product quality. ALPHA also grants nationally recognized product certificates when certain prerequisites are met. Through ALPHA's membership in LOVAG (Low Voltage Agreement Group), its certificates are also recognized in other european countries.

FMS approval for NAMUR sensors and switching amplifiers

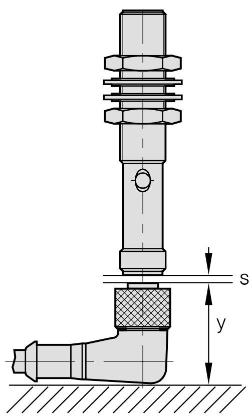
FMS: Factory Mutual System. Factory Mutual Research Corp. (FMRC) researches, tests and creates standards designed to prevent property loss through fire or other hazards. The FMS logo and the "APPROVED" approbation indicate that the manufacturer's product meets the current FM requirements for this product class. Declarations of conformity: J.I. OR1HO.AX and J.I. 4V9A4.AX.

	No. × cross section of the conductors [mm²]	Type	Stranding	Cable outside diameter
PUR cable (PUR jacketed)	2 × 0.14	LIFY-11Y-0	18 × 0.10	3.2 ±0.2
	2 × 0.14	LIYI8-11Y-0	18 × 0.10	3.2 ±0.2
	2 × 0.14	LIFY-11Y-0	72 × 0.05	3.2 ±0.2
	2 × 0.14	LIFY-Y-11Y-0	72 × 0.05	3.9 ±0.2
	2 × 0.34	LIY-Y-11Y-0	42 × 0.10	4.9 ±0.2
	2 × 0.34	LIFY-Y-11Y-0	42 × 0.10	4.9 ±0.2
	2 × 0.34	LIFY-D-11Y-0	182 × 0.05	4.5 ±0.3
	2 × 0.34	LIFY-CY-0	182 × 0.05	5.0 +0.4
	3 × 0.14	LIFY-11Y-0	72 × 0.05	2.9 ±0.2
	3 × 0.14	LIFY-Y-11Y-0	72 × 0.05	3.5 –0.2
	3 × 0.34	LIFY-Y-11Y-0	42 × 0.10	4.9 ±0.2
	3 × 0.34	LIYI8-Y-11Y-0	42 × 0.10	4.9 ±0.2
	3 × 0.75	LIFY-Y-11Y-0	384 × 0.05	6.7 ±0.2
	3 × 0.75	LIFY-Y-11Y-J	384 × 0.05	6.7 ±0.2
	4 × 0.14	LIFY-Y-11Y-0	72 × 0.05	3.7 ±0.2
	4 × 0.25	LIY-Y-11Y-0	32 × 0.10	5.0 ±0.2
	4 × 0.25	LIFY-Y-11Y-0	32 × 0.10	5.0 ±0.2
PVC cable (PVC jacketed)	2 × 0.14	LIYY-0	18 × 0.10	3.0 ±0.2
	2 × 0.14	LIFYY-0	72 × 0.05	3.0 ±0.2
	2 × 0.34	LIYY-0	7 × 0.25	4.9 ±0.2
	3 × 0.14	LIYY-0	18 × 0.10	2.9 ±0.2
	3 × 0.14	LIYY-0	18 × 0.10	3.5 ±0.2
	3 × 0.14	LIYI8-Y-0	18 × 0.10	3.5 ±0.2
	3 × 0.14	LIYY-0	18 × 0.10	3.8 ±0.2
	3 × 0.14	LIYY-0	18 × 0.10	4.2 ±0.2
	3 × 0.34	LIYY-0	7 × 0.25	4.9 ±0.2
	3 × 0.34	LIYY-0	42 × 0.10	5.0 ±0.2
	3 × 0.34	LIFYY-0	42 × 0.10	5.0 ±0.2
	4 × 0.25	LIYY-0	14 × 0.15	5.1 ±0.2

	With tension	Without tension	Drag chain and roll deflection
Smallest bending radius	4 × D	3 × D	4 × D...7.5 × D "SP" only

Removal clearance

The removal clearance refers to the clearance which must be allowed for removing the connector without difficulty. It results from the connector height "y" plus a space "s", which is determined mainly by the spatial conditions.



SP-, silicon-, Teflon cable

SP cable is a cross irradiated PUR cable that is drag chain suitable while also exhibiting good resistance to weld splatter.

A silicon or Teflon connection cable is used for sensors that need to be used at higher ambient temperatures.