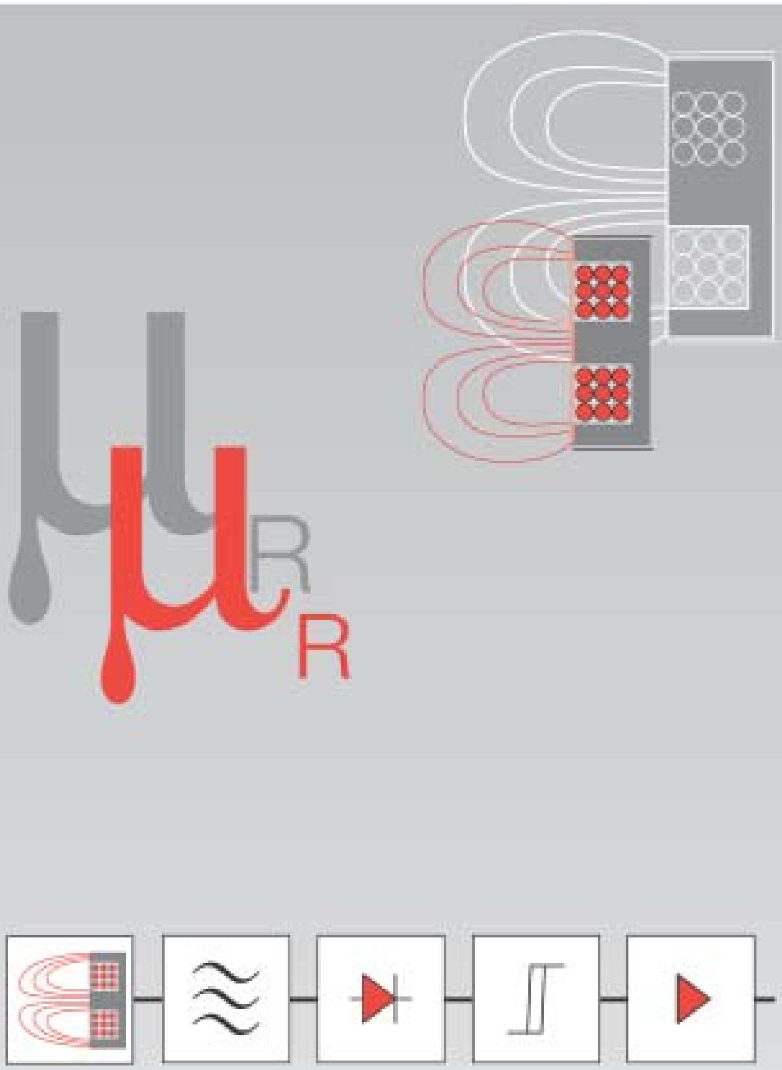
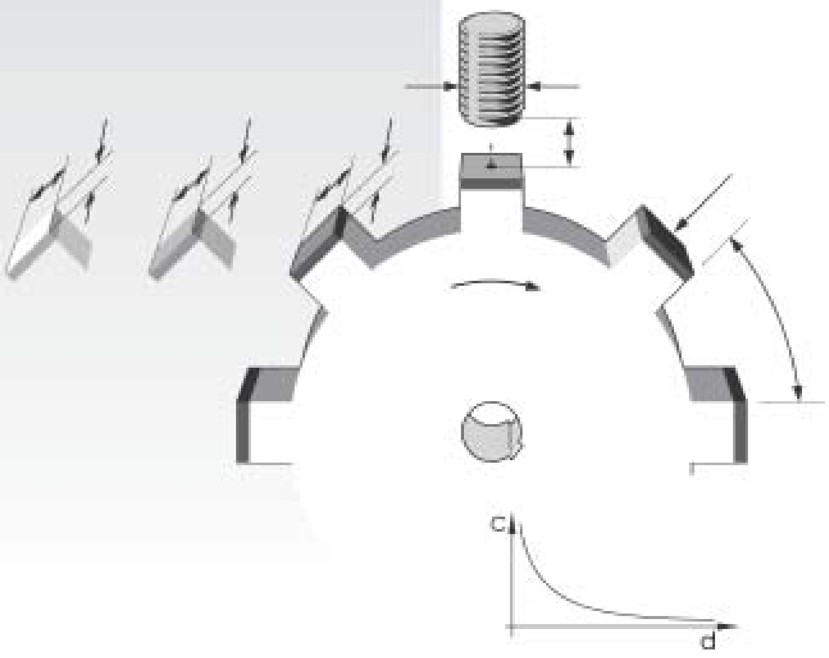


Principles

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

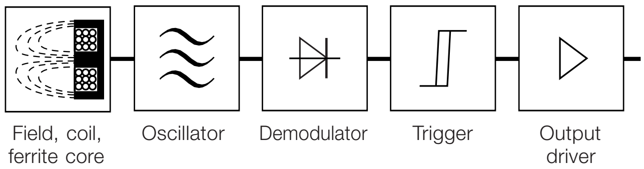


Principle

... 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.

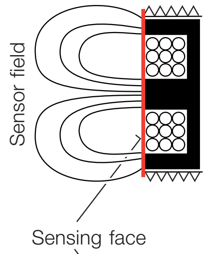
Function groups

... of the Balluff proximity switch are:



Sensing face

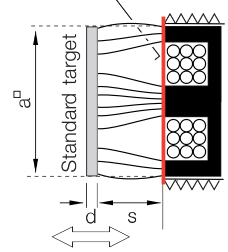
... is the area through which the high-frequency sensor field enters the air gap. It is determined primarily by the base of the shell core and corresponds roughly to the surface area of the shell core cap.



Standard target

... is a square plate of Fe 360 (ISO 630), 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 "sensing face" 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.

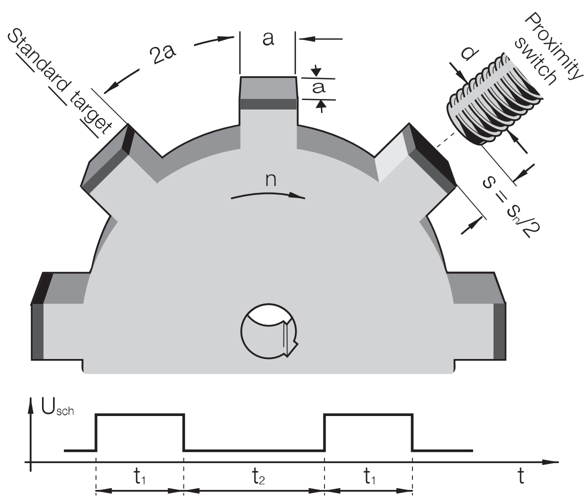
Material	Factor
steel	1.0
copper	0.25...0.45
brass	0.35...0.50
aluminum	0.30...0.45
stainless steel	0.60...1.00
nickel	0.65...0.75
cast iron	0.93...1.05

Frequency of operating cycles 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.



Delay times

Start-up delay t_v

... is the time from when the supply voltage is applied, the proximity switch assumes the ready state. This time may not be longer than 300 ms. During this time a no faulty signal may be present for longer than 2 ms.

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

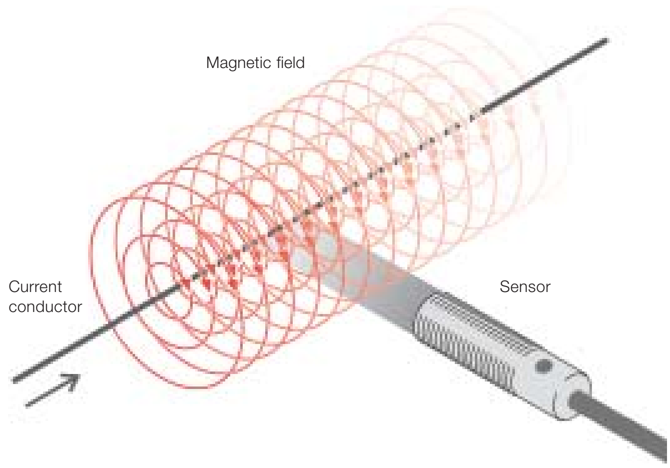
... is the temperature range over which the function of the switch is guaranteed.

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.



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

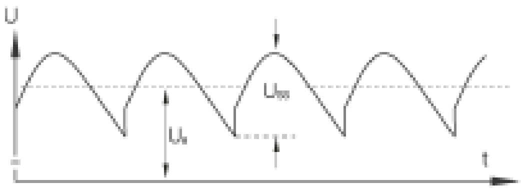
... of a proximity switch is the voltage to which the isolation tests and the creep distances are referenced. For proximity switches the highest rated operating voltage must be considered as the rated isolation voltage.

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 (A_{eff}) which is permitted to flow during a given turn-on time t_k (ms) and at a given frequency (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.

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 between the output and the supply voltage which is built into the switch; see "Output circuits".

Load capacitance

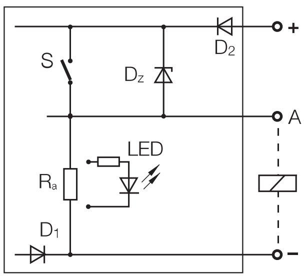
... is the permissible total capacitance on the output of the switch, including line capacitance.

Output circuits

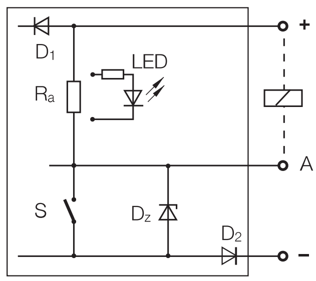
Driver stages

3-wire DC switch

PNP, sourcing (current source)



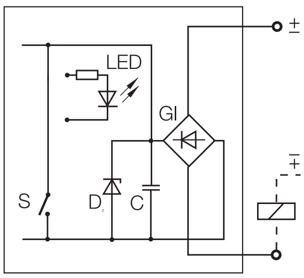
NPN, sinking (current sink)



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

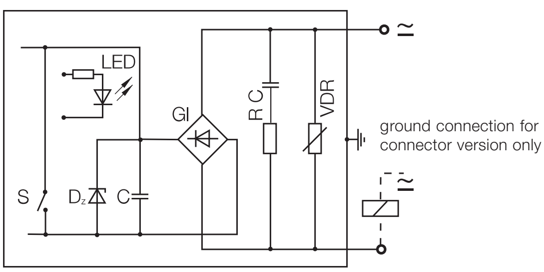
2-wire DC switch

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

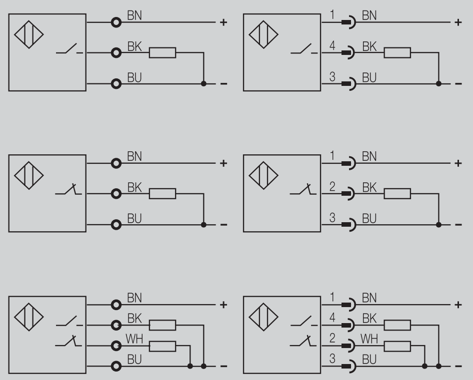
Wiring diagrams

Cable/terminals **Connector** **Cable/terminals** **Connector**

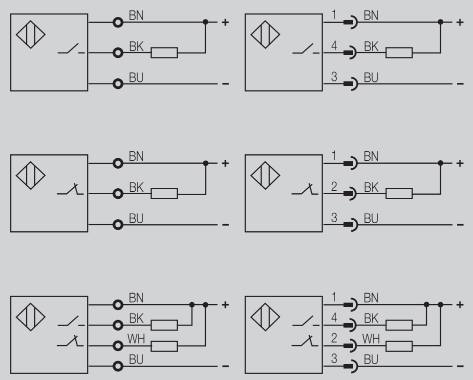
DC 3/4-wire

Normally-open ① ④
Normally-closed ② ⑤
Complementary ③ ⑥

PNP (+) sourcing



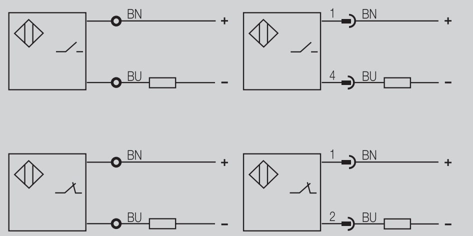
NPN (–) sinking



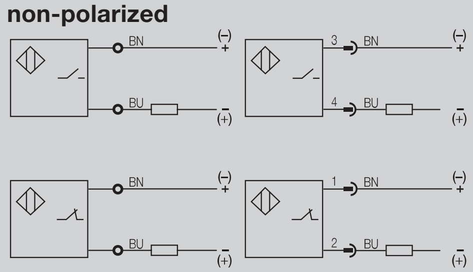
DC 2-wire

Normally-open ⑦ ⑨
Normally-closed ⑧ ⑩

polarized

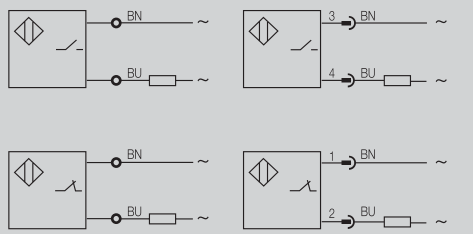


non-polarized



AC-switches

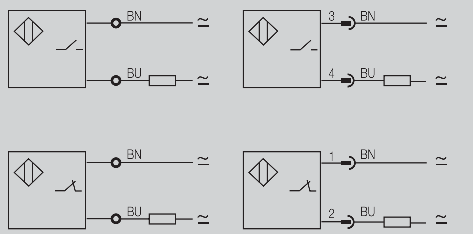
Normally-open ⑪
Normally-closed ⑫



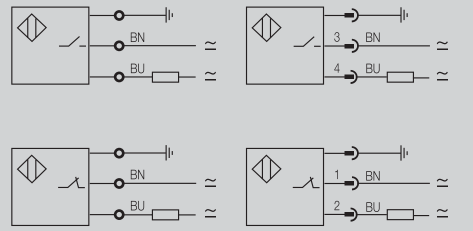
AC/DC-switches

Normally-open ⑮ ⑰
Normally-closed ⑯ ⑱

safety insulated (insulation class II, ⧈)



with protection ground (insulation class I)



Wire colors
per DIN IEC 60757

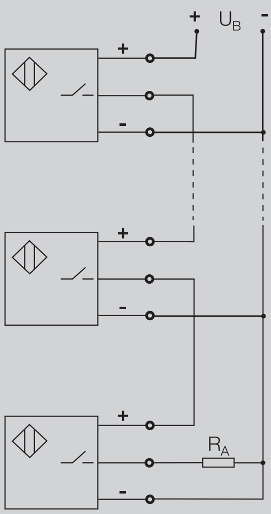
BN	brown
BK	black
BU	blue
WH	white

Series connection

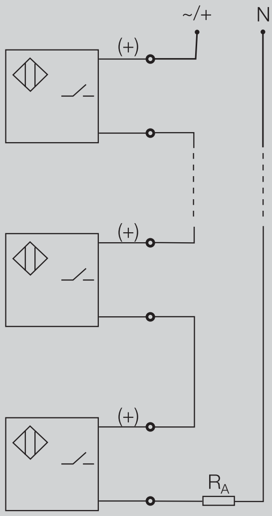
... can cause a time delay (e. g. start-up delay). The number of connected proximity switches is limited by the total voltage drop (sum of all U_d). For 2-wire sensors it is limited by the addition of the minimum supply voltages. For 3-wire switches, the load capacity of the output stage represents a 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



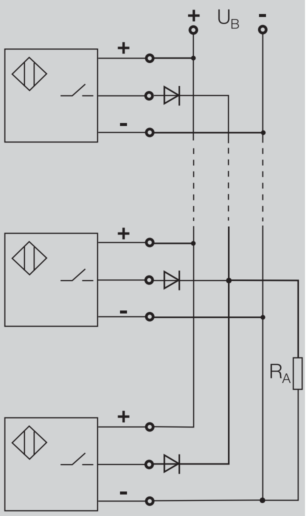
2-wire DC switch (AC/DC)



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

Polarity reversal protected

... 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 protected
(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 switchpoint is thus determined only by the distance "s" from the "sensing face". When damping in **radial direction**, the location of the switchpoint is additionally affected by the radial distance "r" from the system axis.

The diagram shows the **response curves**, which show the relationship between the switchpoint 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 "sensing face" 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

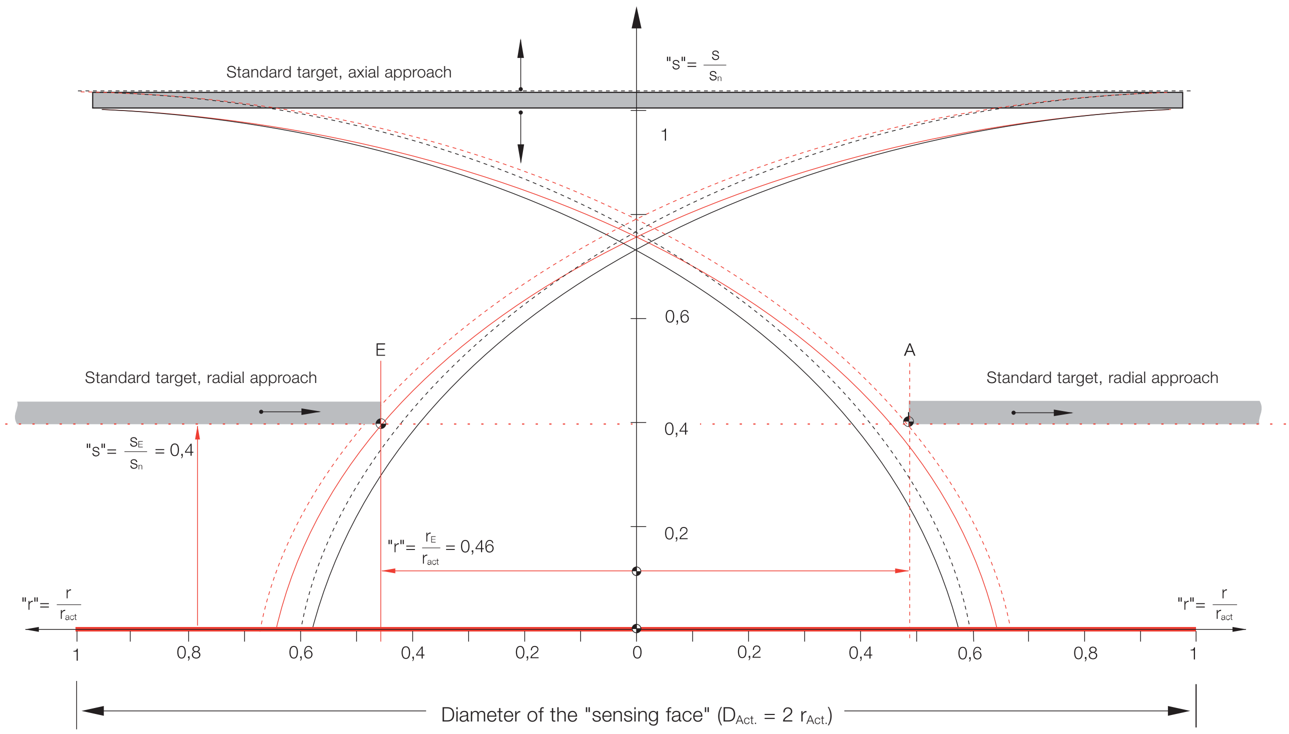
Due in part to manufacturing tolerances within a production run, the exact switchpoint must in any case be established on site.
The solid lines represent the respective switchpoint (E), the dashed lines indicate the turn-off point (A). The red lines apply to switches with a clear zone, and the black 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.

Approach curves standardized

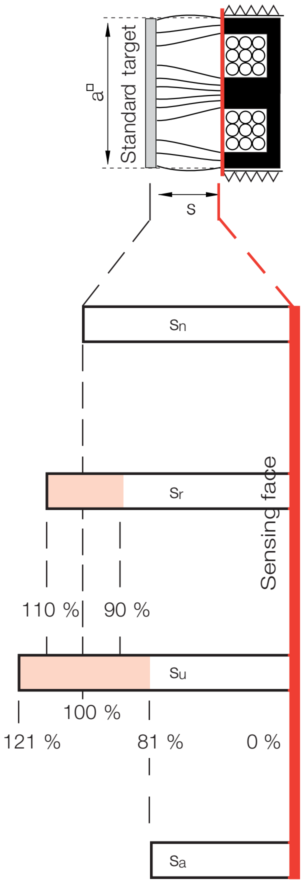


The **vertical axis** in the diagram shows the distance of the switchpoint from the sensing face. It is referenced to the nominal sensing distance s_n (see page **1.0.**10). For an M18 switch, for example, with a nominal sensing distance s_n = 8 mm, the number 0.4 corresponds to a switching distance 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 sensing face (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.

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**, **1.4**, and **5**)

		Housing	Switching distance
none	standard switching distance per IEC 60947-5-2		
switching distance ■■	**"double"** the switching distance vs. standard	Ø 3 mm*	1 mm flush
			3 mm non-flush
		Ø 4 mm/M5*	1.5 mm flush
		Ø 6.5 mm...M30	1.5...2×
switching distance ■■■	**"triple"** the switching distance vs. standard	≤ M12	2.2...3×
		≥ M18	depending on version
switching distance ■■■■	**"quadruple"** the switching distance vs. standard		

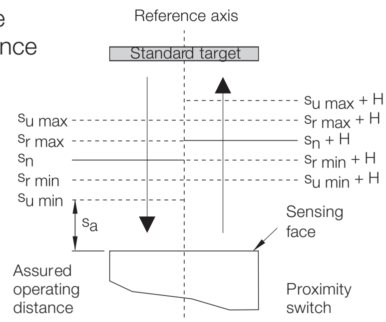
*Switching distance in mm. The switching distances for these sensors are not standardized.

Repeat accuracy 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.
The permissible deviation is specified by EN 60947-5-2 as $R \le 0.1\ s_r$.

Hysteresis H
(switching hysteresis when target is backed off)

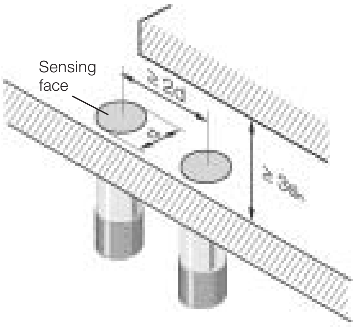
... is given as a percentage of the effective operating distance s_r. It is measured at an ambient temperature of +23 °C ±5 and at the rated operational voltage. It must be less than 20 % of the effective operating distance (s_r). $H \le 0.2\ s_r$



Installation in metal
Sensors with standard switching distance

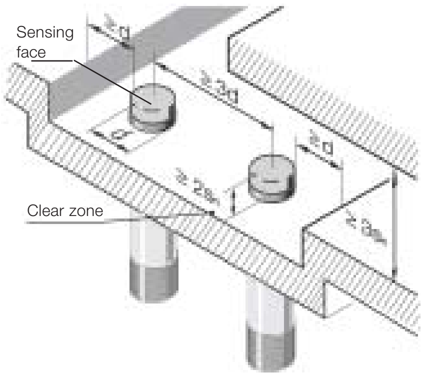
Flush mountable proximity switches

... 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 ≥ 2d.



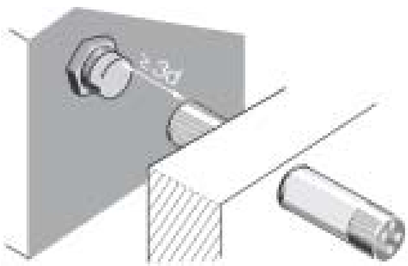
Non-flush mountable proximity switches

... can be identified by their "caps", since they have no metal housing surrounding the area of the sensing face. The sensing face 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 ≥ 3d.



Opposing installation of 2 sensors

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



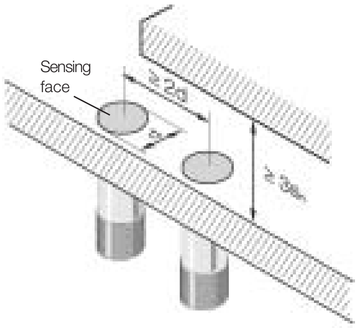
Installation medium

Ferromagnetic materials:	Iron, steel or other magnetizable materials.
Alloys:	Brass, aluminum or other non-magnetizable materials.
Other materials:	Plastics, electrically non-conducting materials.

Installation in metal
Sensors with switching distance indicator ■■

Flush mountable proximity switches

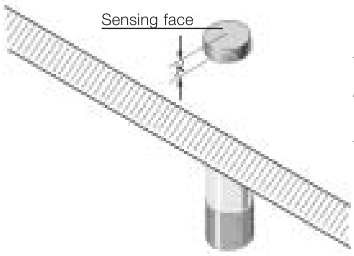
... can be installed with their sensing faces flush to the metal. The distance to opposing switches must be $\geq 3s_n$, and the distance between adjacent switches (side-by-side) must be ≥ 2d. In order to install the sensor in ferromagnetic materials, the following guidelines are used for dimension "×".



Size	Dimension "×"
Ø 3 mm	1.0 mm
Ø 4 mm, M5	1.5 mm
Ø 6.5 mm, M8	0 mm
M12	1.5 mm
M18	2.5 mm
M30	3.5 mm

For section **1.2**:

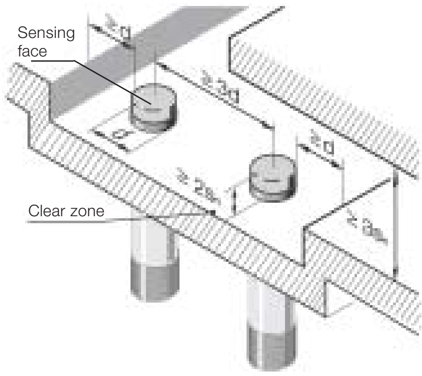
Size	Dimension "×"
M8	0 mm
M12	0 mm
M18	0,7 mm
M30	3,5 mm



For sensors in the Proximax family (page **1.4.**45), *DESINA* (page **1.4.**17) and Factor 1 (page **1.4.**5) the dimension "×" is not needed for installing in metal.

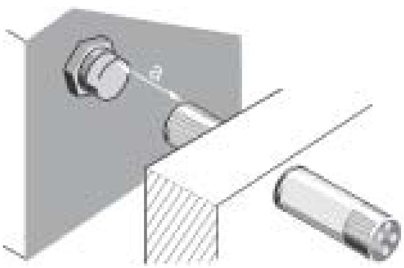
Non-flush mountable proximity switches

... can be identified by their "caps", since they have no metal housing surrounding the area of the sensing face. The sensing face must extend $\geq 2s_n$ from the metallic installation medium. The distance from opposing metal surfaces must be $\geq 3s_n$ and the distance between two adjacent proximity switches ≥ 3d. Exception: For BES 516-3048-G-E4-C- the clear zone and lateral distance from metallic surfaces ≥ 10 mm. The distance between two sensors is 30 mm.



Opposing installation of 2 sensors

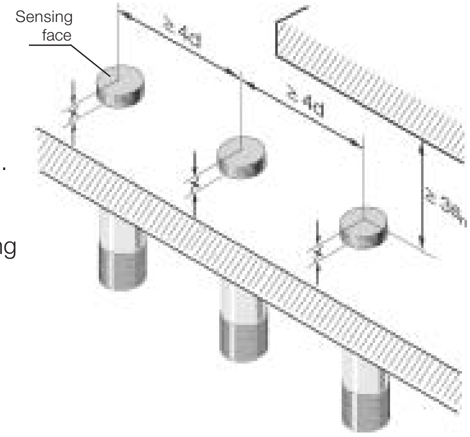
... requires for all inductive proximity switches a minimum distance of ≥ 3d between the sensing face. For BES 516-3048-G-E4-C- dimension a ≥ 20 mm.

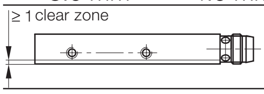


Installation in metal
Sensors with switching distance indicator ■■■ and ■■■■

Quasi-flush mountable proximity switches

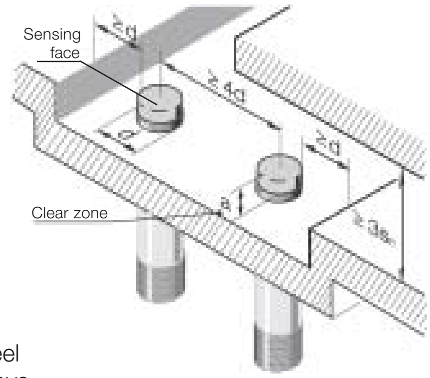
... require a space behind the sensing face which is free of conducting materials. Under this condition the specified switching distance is available without limitation. Dimension "×" (see fig.) indicates the shortest distance between the sensing face and the conducting material behind it.



Size	Switching distance ■■■ Dimension "×" for installation in ferromagnetic materials	other metals	Switching distance ■■■■ installation in ferromagnetic materials	other metals
Ø 6.5 mm, 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		
8×8 mm	≥ 1 clear zone 			

Non-flush mountable proximity switches

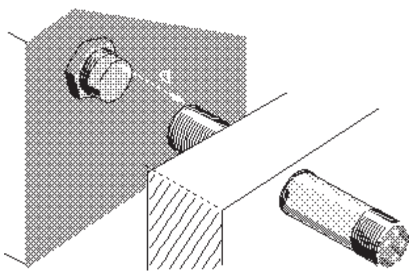
... can be identified by their "caps", since they have no metal housing surrounding the area of the sensing face.
The active surface must extend ≥ $2s_n$ from the metallic installation medium.
Exception: Sensors designated ■■■. For these sensors:
M8: a ≥ 8 mm
M12: a ≥ 10 mm
M18: a ≥ 20 mm
M30: a ≥ 35 mm installation in steel
a ≥ 25 mm installation in alloys
a ≥ 20 mm installation in stainless



The distance from opposing metal surfaces must be ≥ $3s_n$ and the distance between two adjacent proximity switches ≥ 4d.

Opposing installation of 2 sensors

... requires a minimum distance of ≥ 5d between the sensing face.



Additional definitions – sensors with analog output
BAW Section 1.6 and BIL Section 1.7

Displacement sensors with analog output

... are sensors that generate a continuous, varying output signal which is a function if the distance between their sensing face and the corresponding target (BAW) or the position of the marker element relative to the sensor (BIL).

Working range s_a

... is the usable travel distance for position sensing.

Rated sensing distance s_e

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

Linear range s_l

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

Non-linearity

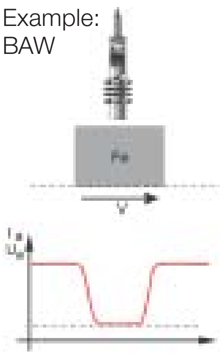
… indicates the maximum deviation of the curve from a reference line. This value applies to the linear range.

Measuring speed

… indicates the ability to reliably detect the distance (for BAW) or the position (for BIL) of a linear moving object.

Here the direction of motion of the object is parallel to the sensor's sensing face.

Example: BAW



Response time

... is the time a sensor requires in order to reliably and stably change the output signal. The specified time, which was determined at maximum measuring speed, includes both the electrical response time of the sensor and the time for the mechanical change of the damping state.

Slope

… is a measure of the sensitivity of the sensor with respect to a distance change. This physical relationship can be calculated for displacement sensors as follows:

BAW

$$\text{Slope S [V/mm]} = \frac{U_a max - U_a min}{s_l max - s_l min}$$

or

$$\text{Slope S [mA/mm]} = \frac{I_a max - I_a min}{s_l max - s_l min}$$

BIL

$$\text{Slope S [V/mm]} = \frac{U_a max - U_a min}{s_a max - s_a min}$$

or

$$\text{Slope S [mA/mm]} = \frac{I_a max - I_a min}{s_a max - s_a min}$$

Temperature drift

... is the shift which a point on the actual characteristic curve experiences at various temperatures. The temperature drift is described by the temperature coefficient.

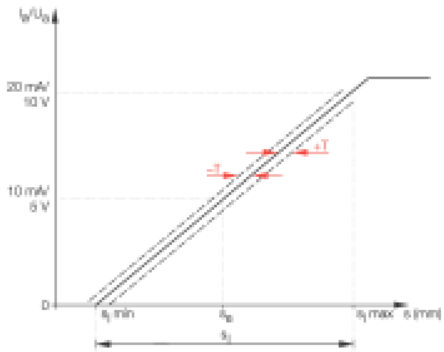
Temperature coefficient TK

… describes the deviation of the sensor output under the influence of a temperature change and is therefore a quality criterion of the sensor.

Tolerance T

... is a quantity which defines the tolerance band of the characteristic curve and thereby specifies the sample variance.

Housing	"T" for flush sensors	"T" for non-flush sensors
Ø 6.5 mm	±0.125 mm	
M8	±0.1 mm	±0.15 mm
M12	±0.125 mm	±0.25 mm
M18	±0.3 mm	±0.5 mm
M30	±0.6 mm	±0.8 mm
20×30×8 mm	±0.125 mm	
80×80×40 mm	±1.0 mm	
PG 36	±0.1 mm	



Repeat accuracy 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). Displacement sensors with analog output achieve the value R ≤ 5 % defined in the standard.

Repeat accuracy R_{BWN}

… describes the precision an inductive distance sensor achieves when approaching a measuring point multiple times. The value determined according to the Balluff Factory Standard BWN Pr.44 describes the maximum deviation from this measuring point.

	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 66, 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.

Cable types

	No. of wires × cross-section [mm²]	Outside diameter [mm]
PUR cable (PUR jacketed)	2×0.08	3...4
	2×0.14	3...4.1
	2×0.34	4...5.5
	3×0.06	2...2.5
	3×0.09	2.5...3
	3×0.14	2.5...3.5
	3×0.25	3.5...4.5
	3×0.34	4...5.5
	3×0.75	6.5...7
	4×0.14	3...4
	4×0.25	4...5.5
	8×0.25	6...8
PVC cable (PVC jacketed)	2×0.14	2.5...3.5
	2×0.34	4.5...5.5
	3×0.14	2.7...4.5
	3×0.25	4...5
	3×0.34	4.5...5.5
	4×0.25	4.5...5.5

Least bending radius	tensioned	untensioned	drag chain and roll deflection
	4×D	3×D	4×D...7.5×D "SP" only

Special cable

SP cable is a cross irradiated PUR cable that is good resistant to weld splatter.

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

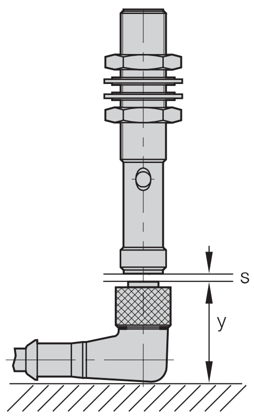
Tightening torques

Permissible tightening torque

See data sheets or sensor packaging

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.



QM-System
(Quality Management System per DIN EN ISO 9001:2000)

Balluff company	
Balluff GmbH	Germany
Balluff Elektronika KFT	Hungary
Nihon Balluff Com. Ltd.	Japan
Balluff U.K. Ltd.	Great Britain
Balluff Automation s.r.l.	Italy
Balluff Inc.	USA
Gebhard Balluff Vetriebsgmbh	Austria
Balluff CZ	Czech Republic
Hy-Tech AG	Switzerland
Balluff Sensortechnik AG	Switzerland
Balluff Controles Elétricos Ltda.	Brazil

Environmental Protection System
(per DIN EN ISO 14001:1996)

Balluff company	
Balluff GmbH	Germany
Balluff Elektronika KFT	Hungary

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 and the Generic Standards EN 61000-6-2 and EN 61000-6-4.

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).

CCC Marking by the Chinese CQC.

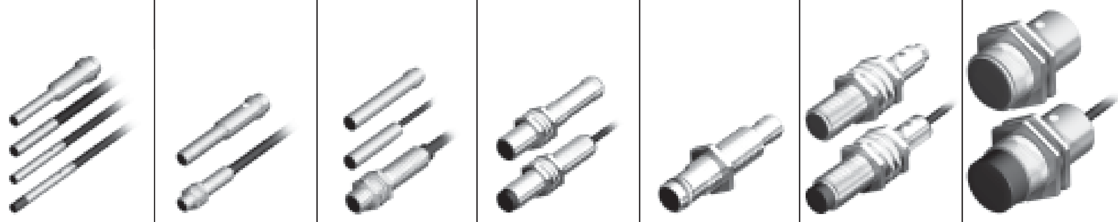
Balluff is a member of ALPHA

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.

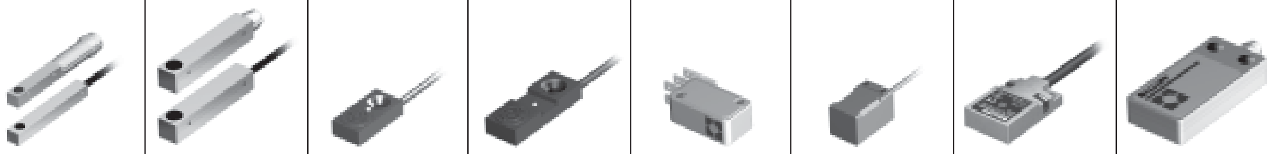
ALPHA also grants nationally recognized product certificates when certain prerequisites are met. Through ALPHA's membership in LOVAG (Low Voltage Agreement Group), its certificates are also recognized in other european countries.

Proximity switches	Low-voltage equipment	EN 60947-5-2	
Insulation class	II ⧈	EN 60947-5-2	
Degree of protection (enclosure rating)	IP 60...67	IEC 60529	
	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 of products for use in the foods industry.
	IP 69K	DIN 40050 Part 9	Protection against ingress of water under high pressure and steam cleaning.

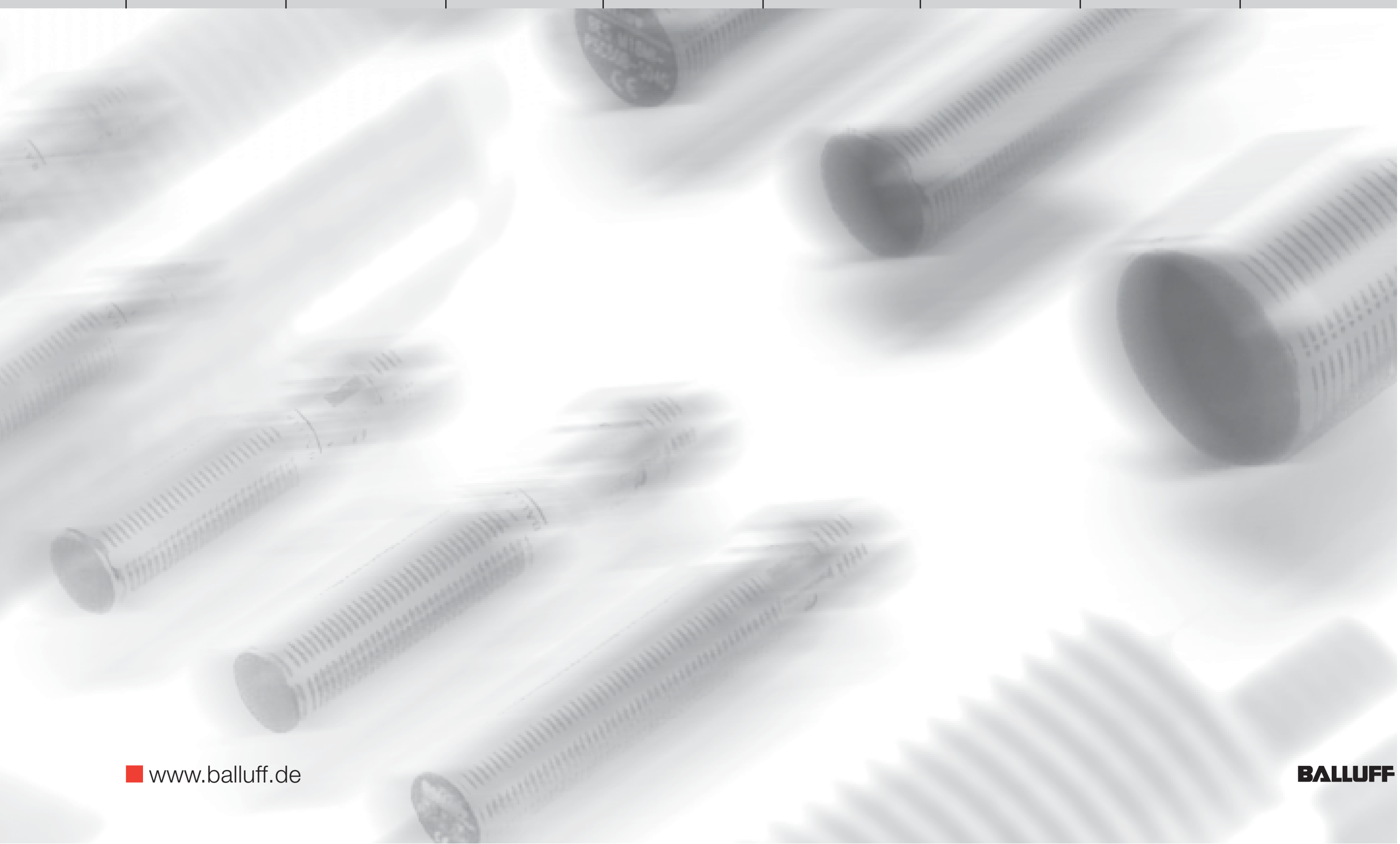
EMC (Electromagnetic Compatibility)	Balluff Factory Standard for EMC testing	BWN Pr. 33
	Radiated electromagnetic field	EN 55011
	Static discharge immunity (ESD)	EN 61000-4-2
	Radio frequency immunity (RFI)	EN 61000-4-3
	Immunity to fast transients (burst)	EN 61000-4-4
	immunity to line-carried noise induced by high-frequency fields	EN 61000-4-6
	Surge-voltage stability	EN 60947-5-2
Environmental simulation	Vibration, sinusoidal: 1. Frequency range: 10...2000 Hz Amplitude: 1 mm_{pk}/30 g (capacitive, inductive) 0.5 mm_{pk}/30 g (photoelectric) Duration: 40 sweeps (ca. 5 Std.) in 3 axes 2. Frequency: at resonant frequency or 55 Hz Amplitude: 1 mm_{pk}/30 g Duration: 30 min. in 3 axes	EN 60068-2-6
	Shock: Pulse shape: half-sine Peak acceleration: 30 g Pulse duration: 11 ms No. of shocks: 3 positive, 3 negative shocks in 3 Achsen	EN 60068-2-27
	Continuous shock: Pulse shape: half-sine Peak acceleration: 100 g Pulse duration: 2 ms No. of shocks: 4000 positive, 4000 negative Schocks in 3 axes	EN 60068-2-29
Inductive distance sensors	Proximity switches with analog output	EN 60947-5-7
	Characteristic data for analog sensors (BAW, BIL)	BWN Pr. 44
Hazardous areas	Electrical equipment for explosive atmospheres, general requirements.	EN 50014
	Electrical equipment for explosive atmospheres, intrinsically-safe "i".	EN 50020

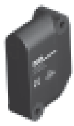
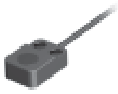
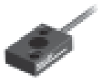
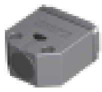
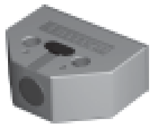


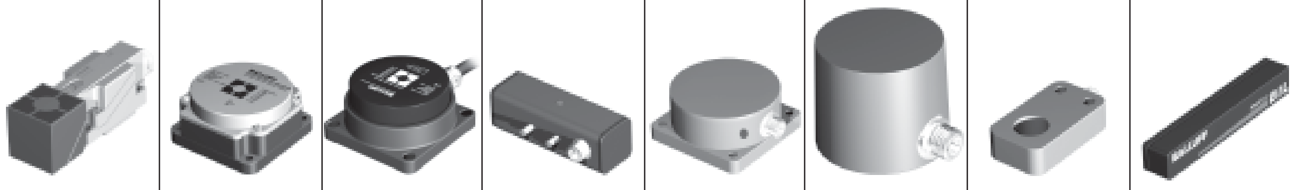
Housing	∅ 3 mm, ∅ 4 mm	M5	∅ 6.5 mm, M8, ∅ 8 mm	M12	M16	M18	M30
	starting **Section.**Page						
DC 3-/4-wire	**1.1.**2 ...	**1.1.**5 ...	**1.1.**8 ...	**1.1.**22 ...		**1.1.**30 ...	**1.1.**38
DC 2-wire			**1.2.**2 ...	**1.2.**4 ...		**1.2.**6 ...	**1.2.**8 ...
AC/DC 2-wire				**1.3.**2 ...		**1.3.**3	**1.3.**3
PROXINOX®			**1.4.**38	**1.4.**38 ...		**1.4.**40 ...	**1.4.**41 ...
PROXIMAX®				**1.4.**45		**1.4.**45	
Diagnostics				**1.4.**15 ...		**1.4.**17	
Pressure/high pressure rated			**1.4.**22 ...	**1.4.**23 ...	**1.4.**28 ...	**1.4.**23 ...	
Temperature rated		**1.4.**36	**1.4.**36	**1.4.**36		**1.4.**37	**1.4.**37
Weld and magnetic field immune			**1.4.**4 ...	**1.4.**5 ...		**1.4.**6 ...	**1.4.**7 ...
Magnetic field immune							
Remote			**1.5.**9 ...	**1.5.**9 ...		**1.5.**8 ...	**1.5.**8 ...
Inductive distance sensors			**1.6.**4	**1.6.**5 ...		**1.6.**7 ..., **1.6.**13	**1.6.**9



	5×5 mm	8×8 mm	8×16 mm	10×30 mm	16.5×30 mm	17.5×17.3 mm	20×32 mm	25×50 mm
	1.1.44	**1.1.**46 ...	**1.1.**45	**1.1.**45	**1.1.**48 ...	**1.1.**52	**1.1.**50	**1.1.**52 ...
								1.4.37
							1.4.12 ...	



							
Housing	**26×40 mm**	**30×20 mm**	**20×30 mm**	**42×48 mm**	**74×60.5 mm**	**40×40 mm Unicompact**	**40×40 mm**
	starting **Section.**Page						
DC 3-/4-wire	**1.1.**51	**1.1.**50		**1.1.**54	**1.1.**55	**1.1.**60 ...	
AC/DC 2-wire	**1.3.**4					**1.3.**7	
Factor 1						**1.4.**3	
Diagnostics						**1.4.**17	
Weld and magnetic field immune						**1.4.**9	
Magnetic field immune							
Extended switching distance							
Ring sensors							
Remote							**1.5.**14
Inductive distance sensors			**1.6.**9				
Magneto-inductive position sensors							



	40×40 mm Unisensor	80×80 mm Maxisensor	90×90 mm	35×35 mm	80×80 mm	∅ 80×67 mm	Ring sensor	
	1.1.56 ...	1.1.59						
	1.3.6	1.3.5						
	1.4.13							
				1.4.49		1.4.48		
							1.4.47	
		1.5.13 ...	1.5.15 ...					
					1.6.10		1.6.11	
								1.7.2 ...