Capacitive Sensors

Special accessories for capacitive sensors

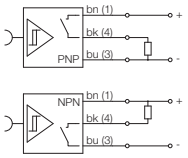
The numerous varieties of capacitive sensors for individual solutions are enhanced by custom matched accessories. For example, there are downstream switching devices for particular flexibility with varying voltage, in order to be able to attach the sensors optimally. These are for 24 V and, if the user does not have their own low voltage supply, for 230 V (115 V AC).
Precisely matched mounting elements ensure exact positioning right away.

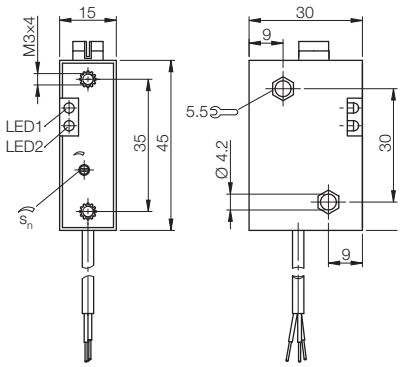
Accessories for Capacitive Sensors
Contents

Sensor amplifier for capacitive sensors without internal amplifier

Size			**45×30×15 mm**
PNP	NO	**Ordering code**	**BAE009E**
		Part number	BAE SA-CS-001-PS
PNP	NC	**Ordering code**	**BAE009F**
		Part number	BAE SA-CS-001-PO
NPN	NO	**Ordering code**	**BAE009H**
		Part number	BAE SA-CS-001-NS
NPN	NC	**Ordering code**	**BAE009J**
		Part number	BAE SA-CS-001-NO
Supply voltage U_B			12…35 V DC
Voltage drop U_d at I_e			0.8 V
Rated insulation voltage U_i			75 V DC
Output current max.			300 mA
No-load supply current I_0 max.			20 mA
Polarity reversal protected/transposition protected/short-circuit protected			Yes/Yes/Yes
Ambient temperature T_a			–30…+70 °C
Switching frequency f			100 Hz
Supply voltage/Output function indicator			Green LED/Yellow LED
Degree of protection as per IEC 60529			IP 67
Material		Housing	PC
Connection			2 m PUR cable 3×0.14 mm²

Pin assignments





Function overview

- LED 1: Switching state indicator
- LED 2: Shows supply voltage
- Item 1: Through-hole
  Ø 4.2 mm, hexagonal on both sides
  for inserting an M3 nut

Accessories for Capacitive Sensors

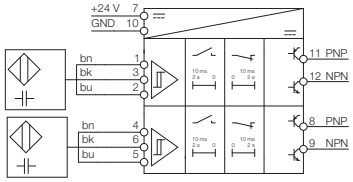
Sensor amplifier for two capacitive sensors, without internal amplifier

Technical details

- Two separate sensor amplifiers in one housing
- Connection for two capacitive sensors without internal amplifier
- PNP and NPN transistor output
- Function normally open/normally closed can be switched
- Actuation delay (normally open) selectable 10 ms/2 s
- Turn-off delay (normally closed) selectable 10 ms/2s
- Clamping terminal
- Switching distance for sensors separately adjustable
- Switching status indicated by two separate LEDs

Size		**98.5×75×22.5 mm**
Installation type		DIN rail (EN 60751)
PNP/NPN and NO/NC, can be coded	**Ordering code**	**BAE009P**
	Part number	BAE SA-CS-002-YP
Supply voltage U_B		10…35 V DC
Voltage drop U_d at I_e		0.8 V
Rated insulation voltage U_i		75 V DC
Output current max.		300 mA
No-load supply current I_0 max.		15 mA
Polarity reversal protected/transposition protected/short-circuit protected		Yes/Yes/Yes
Ambient temperature T_a		–30…+70 °C
Switching frequency f		100 Hz
Output function indicator		Yellow LED
Degree of protection as per IEC 60529		IP 40 (IP 20 at terminal box)
Material	Housing	PC
Connection		max. 2.5 mm² AWG 14

Pin assignments



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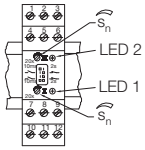
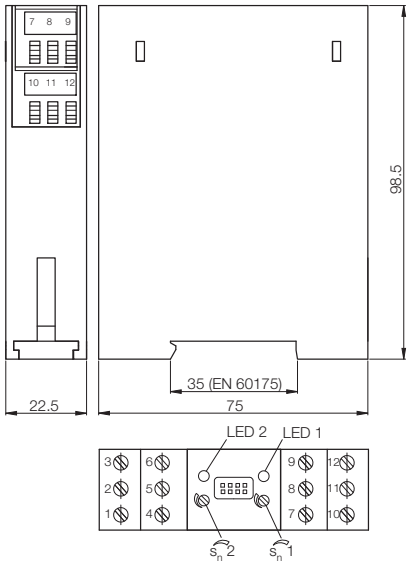




Sensor amplifier with logic for two capacitive sensors without internal amplifier

Sensor amplifier with logic

- Connection for two capacitive sensors without internal amplifier
- Two outputs each PNP/NPN for Q and Q
- Pick-up delay selectable 10 ms/2 s
- Function OR, AND, RS-FF, min/max selectable
- Clamping terminal
- Switching distance for sensors separately adjustable
- Switching status indicated by two separate LEDs

OR function
Output Q active when one or both sensors are damped.

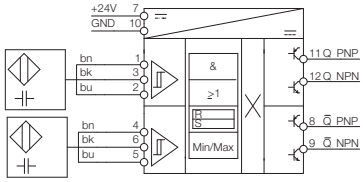
AND function
Output Q active only when both sensors are damped.

RS-FF function
Output Q active when the sensor is first damped on the Set input. This status is retained until the sensor is damped on the Reset input.

Function min/max
Output Q active when both sensors are damped. The output is only reset when both sensors are undamped.

Size		**98.5×75×22.5 mm**
Installation type		DIN rail (EN 60751)
PNP/NPN and NO/NC, can be coded	**Ordering code**	**BAE009R**
	Part number	BAE SA-CS-003-YP
Supply voltage U_B		10…35 V DC
Voltage drop U_d at I_e		0.8 V
Rated insulation voltage U_i		75 V DC
Output current max.		300 mA
No-load supply current I_0 max.		25 mA
Polarity reversal protected/transposition protected/short-circuit protected		Yes/Yes/Yes
Ambient temperature T_a		–30…+70 °C
Switching frequency f		100 Hz
Output function indicator		Yellow LED
Degree of protection as per IEC 60529		IP 40 (IP 20 at terminal box)
Material	Housing	PC
Connection		Max. 2.5 mm² AWG 14

Pin assignments



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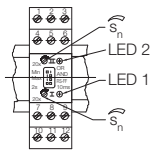
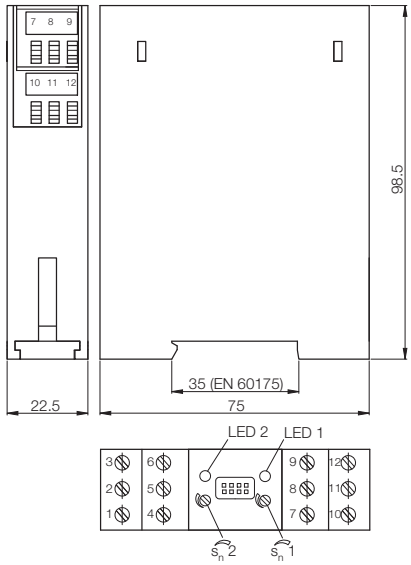


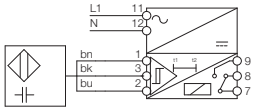


Accessories for Capacitive Sensors

Sensor amplifier for one capacitive sensor without internal amplifier

Size		**98.5×75×22.5 mm**	**98.5×75×22.5 mm**
Installation type		DIN rail (EN 60751)	DIN rail (EN 60751)
PNP/NPN and NO/NC, can be coded	**Ordering code**	**BAE009K**	**BAE009L**
	Part number	BAE SA-CS-006-XR	BAE SA-CS-007-XR
Supply voltage U_B		230 V AC	115 V AC
Rated insulation voltage U_i (protection class)		250 V AC (⧈)	250 V AC (⧈)
Output current max.		8 A	8 A
No-load supply current I_0 max.		20 mA	20 mA
Polarity reversal protected/transposition protected/short-circuit protected		Floating relay	Floating relay
Ambient temperature T_a		–30…+70 °C	–30…+70 °C
Switching frequency f		10 Hz	10 Hz
Output function indicator		Yellow LED	Yellow LED
Degree of protection as per IEC 60529		IP 20	IP 20
Material	Housing	PC	PC
Connection		Max. 2.5 mm² AWG 14	Max. 2.5 mm² AWG 14

Pin assignments



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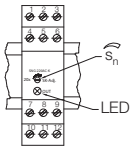
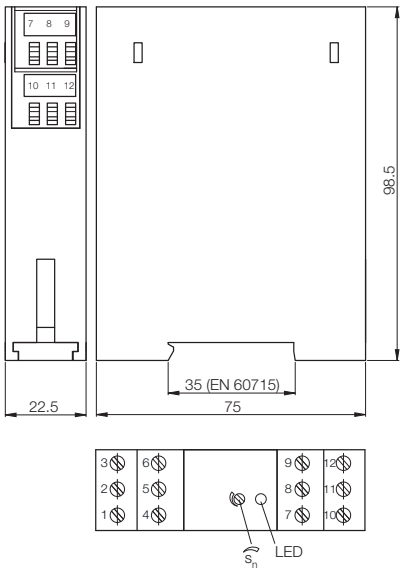
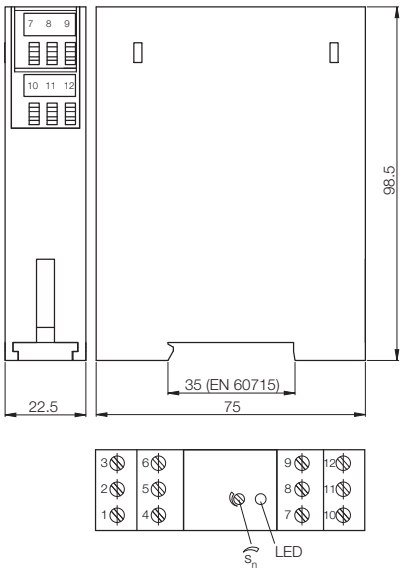




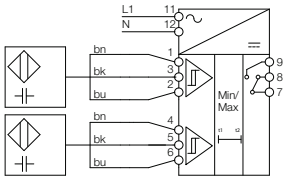


Accessories for Capacitive Sensors

Sensor amplifier with Min/Max level control for two capacitive sensors without internal amplifier

Size		**98.5×75×22.5 mm**	**98.5×75×22.5 mm**
Installation type		DIN rail (EN 60751)	DIN rail (EN 60751)
PNP/NPN and NO/NC, can be coded	**Ordering code**	**BAE009T**	**BAE009U**
	Part number	BAE SA-CS-004-XR	BAE SA-CS-005-XR
Supply voltage U_B		230 V AC	115 V AC
Rated insulation voltage U_i (protection class)		250 V AC (⧈)	250 V AC (⧈)
Output current max.		8 A	8 A
No-load supply current I_0 max.		20 mA	40 mA
Polarity reversal protected/transposition protected/short-circuit protected		Floating relay	Floating relay
Ambient temperature T_a		–30…+70 °C	–30…+70 °C
Switching frequency f		5 Hz	5 Hz
Output function indicator		Yellow LED	Yellow LED
Degree of protection as per IEC 60529		IP 40 (IP 20 terminal enclosure)	IP 40 (IP 20 terminal enclosure)
Material	Housing	PC	PC
Connection		Max. 2.5 mm² AWG 14	Max. 2.5 mm² AWG 14

Pin assignments



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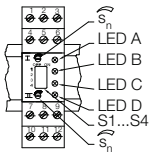
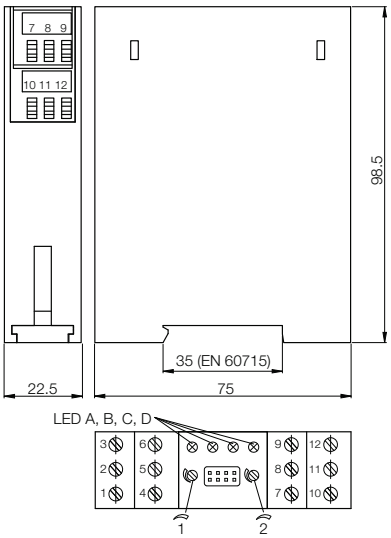
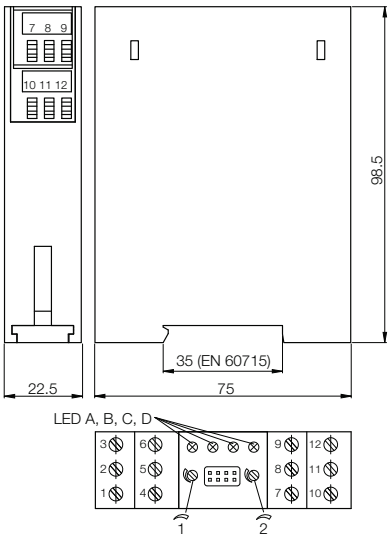






Function

When both sensors are undamped, the relay turns on - "LED" empty" lights up (contact 7/9 closed). If the Min sensor is damped, "Fill LED" lights up. When both sensors are damped, the relay turns off - "LED full" lights up (contact 7/9 open). If the Max sensor is damped, "LED empty" lights up. The relay does not turn on until both sensors are again undamped.
Other functions are selectable using the mini dip switches.

Dip switch functions

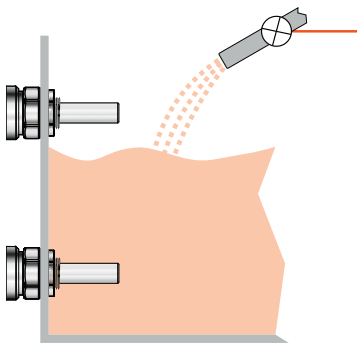
S1 – Time delay max-sensor (off: approx. 0.2 s; on: approx. 5 s)
S2 – Time delay min-sensor (off: approx. 0.2 s; on: approx. 5 s)
S3 – Power-on setup (off: fill; on: empty)
S4 – Output (relay inverse)

Function indicators

A – Full
B – Fill
C – Empty
D – Empty

Sensor adjustment

Max sensor: Pot I
Min sensor: Pot II



Applications

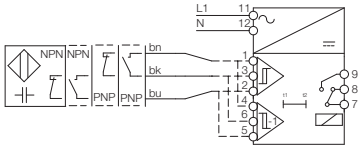
- Min and max level control
- Input for connecting two capacitive sensors for level sensing, adjustable separately using two potentiometers
- Switch-on delay for min and max sensor can be selected separately

Accessories for Capacitive Sensors

Sensor amplifiers with timer function and potential-free changeover contact for one capacitive sensor

Size		**98.5×75×22.5 mm**	**98.5×75×22.5 mm**
Installation type		DIN rail (EN 60751)	DIN rail (EN 60751)
Potential-free changeover contact	**Ordering code**	**BAE009W**	**BAE009Y**
	Part number	BAE SA-XE-010-XR	BAE SA-XE-011-XR
Supply voltage U_B		230 V AC	115 V AC
Rated insulation voltage U_i (protection class)		250 V AC (⧈)	250 V AC (⧈)
Output current max.		8 A	8 A
No-load supply current I_0 max.		20 mA	40 mA
Ambient temperature T_a		–30…+70 °C	–30…+70 °C
Switching frequency f		10 Hz	10 Hz
Pick-up delay		0.05...30 s	0.05...30 s
Release delay		0.05...30 s	0.05...30 s
Output function indicator		Yellow LED	Yellow LED
Degree of protection as per IEC 60529		IP 20	IP 20
Material	Housing	PC	PC
Connection		Screw terminals	Screw terminals

Pin assignments



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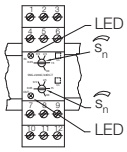
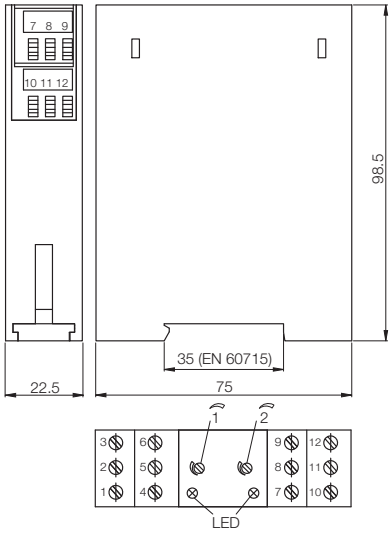
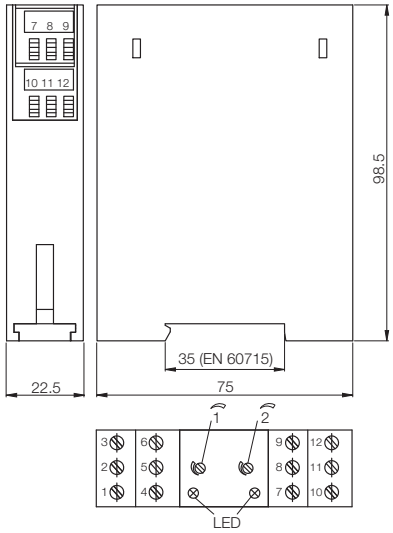


Not suitable for devices with a output stage that can be coded (e.g. BCS S4...)



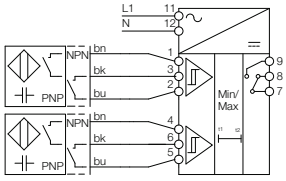


Accessories for Capacitive Sensors

Sensor amplifiers with Min/Max level control and potential-free changeover contact for two capacitive sensors

Size		**98.5×75×22.5 mm**	**98.5×75×22.5 mm**
Installation type		DIN rail (EN 60751)	DIN rail (EN 60751)
Potential-free changeover contact	**Ordering code**	**BAE009Z**	**BAE00A0**
	Part number	BAE SA-XE-012-XR	BAE SA-XE-013-XR
Supply voltage U_B		230 V AC	115 V AC
Rated insulation voltage U_i (protection class)		250 V AC (⧈)	250 V AC (⧈)
Output current max.		8 A	8 A
No-load supply current I_0 max.		20 mA	40 mA
Ambient temperature T_a		–30…+70 °C	–30…+70 °C
Switching frequency f		5 Hz	5 Hz
Output function indicator		Yellow LED	Yellow LED
Degree of protection as per IEC 60529		IP 20	IP 20
Material	Housing	PC	PC
Connection		Screw terminals	Screw terminals

Pin assignments



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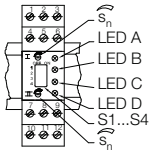
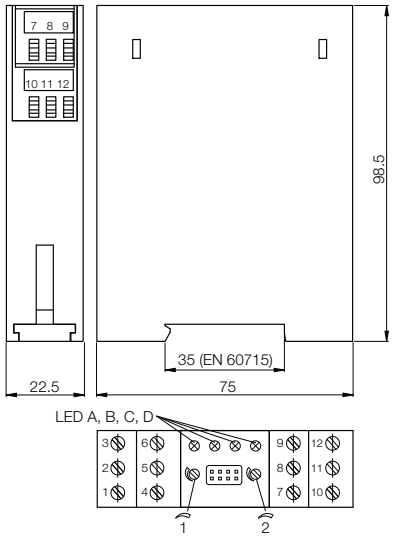
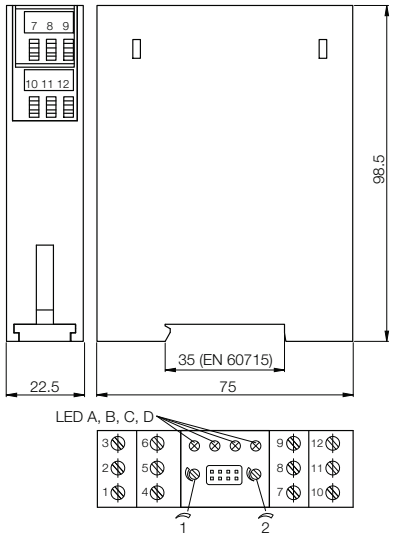
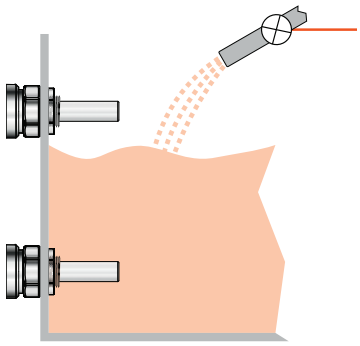






Not suitable for devices with codable final stage (e.g. BCS S4...)



Function

When both sensors are undamped, the relay turns on - "empty" LED lights up (contacts 7/9 are closed). If the Min sensor is damped, the "fill" LED lights up. When both sensors are damped, the relay turns off - "full" LED lights up (contacts 7/9 are open). If the Max sensor is damped, the "empty" LED lights up. The relay does not turn on until both sensors are again undamped.
Other functions are selectable using the mini dip switches.

Dip switch functions

S1 – Time delay max-sensor (off: approx. 0.2 s; on: approx. 5 s)
S2 – Time delay min-sensor (off: approx. 0.2 s; on: approx. 5 s)
S3 – Power-on setup (off: fill; on: empty)
S4 – Output (inverse relay)

Function indicators

A – Full
B – Fill
C – Empty
D – Empty

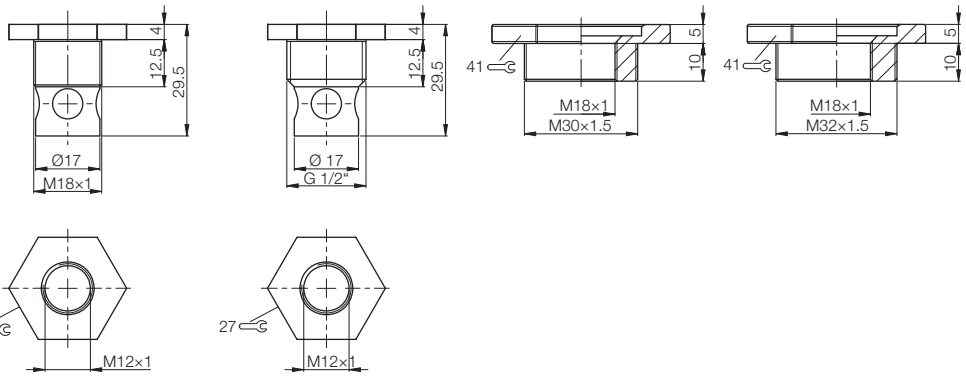
Applications

- Min and Max level control
- Automatic PNP and NPN input voltage for connecting two normally open sensors
- DC short-circuit protected
- Turn-on delay for Min and Max sensor selectable independently

Adapters

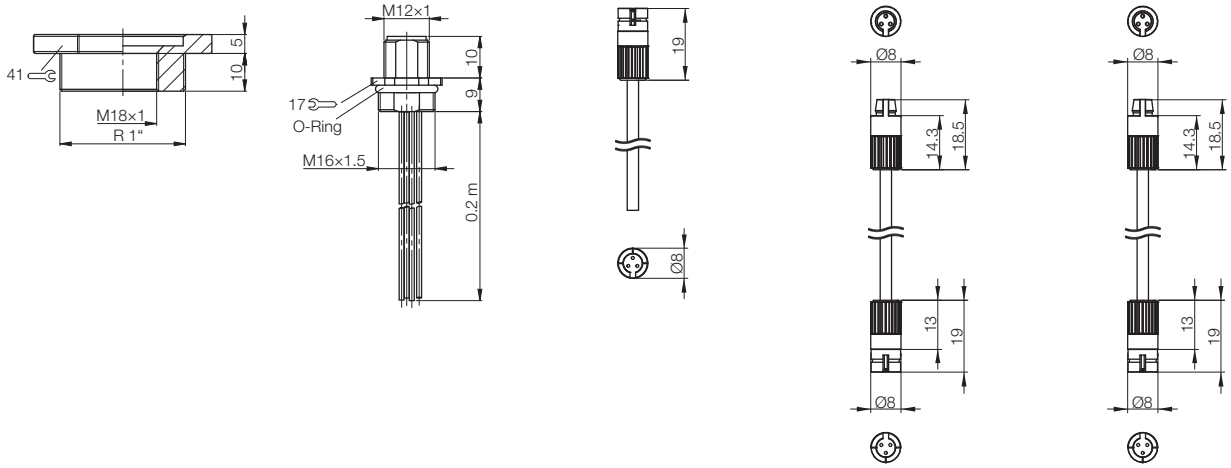



Description	Adapter for Micro-Level M12 to M18	Adapter for Micro-Level M12 to G 1/2"	Adapter for BCS S01/2/3 M18 to M30	Adapter for BCS S01/2/3 M18 to M32	
Ordering code	**BAM018J**	**BAM018K**	**BAM018E**	**BAM018F**	
Part number	BAM AD-XA-002-M12/M18-4	BAM AD-XA-002-M12/G1/2"-4	BAM AD-XA-001-M18/M30-4	BAM AD-XA-001-M18/M32x1,5-4	
Material	Stainless steel	Stainless steel	Stainless steel	Stainless steel	
Ambient temperature T_a					
Connection					

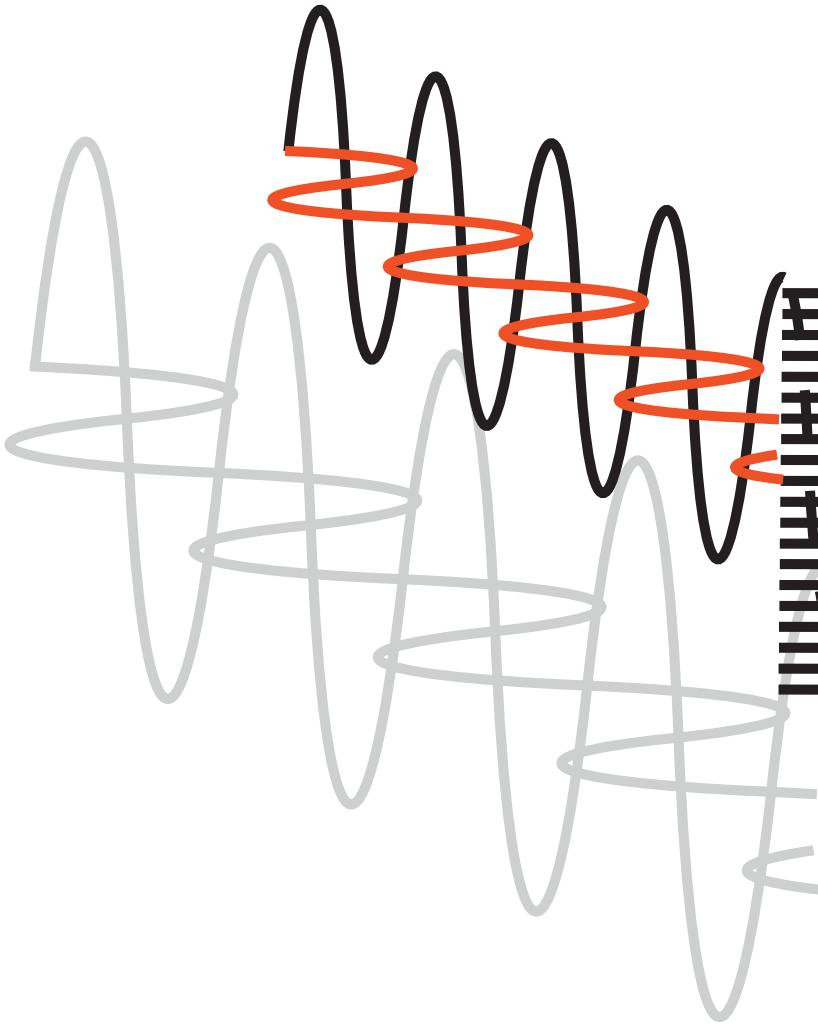


Adapters

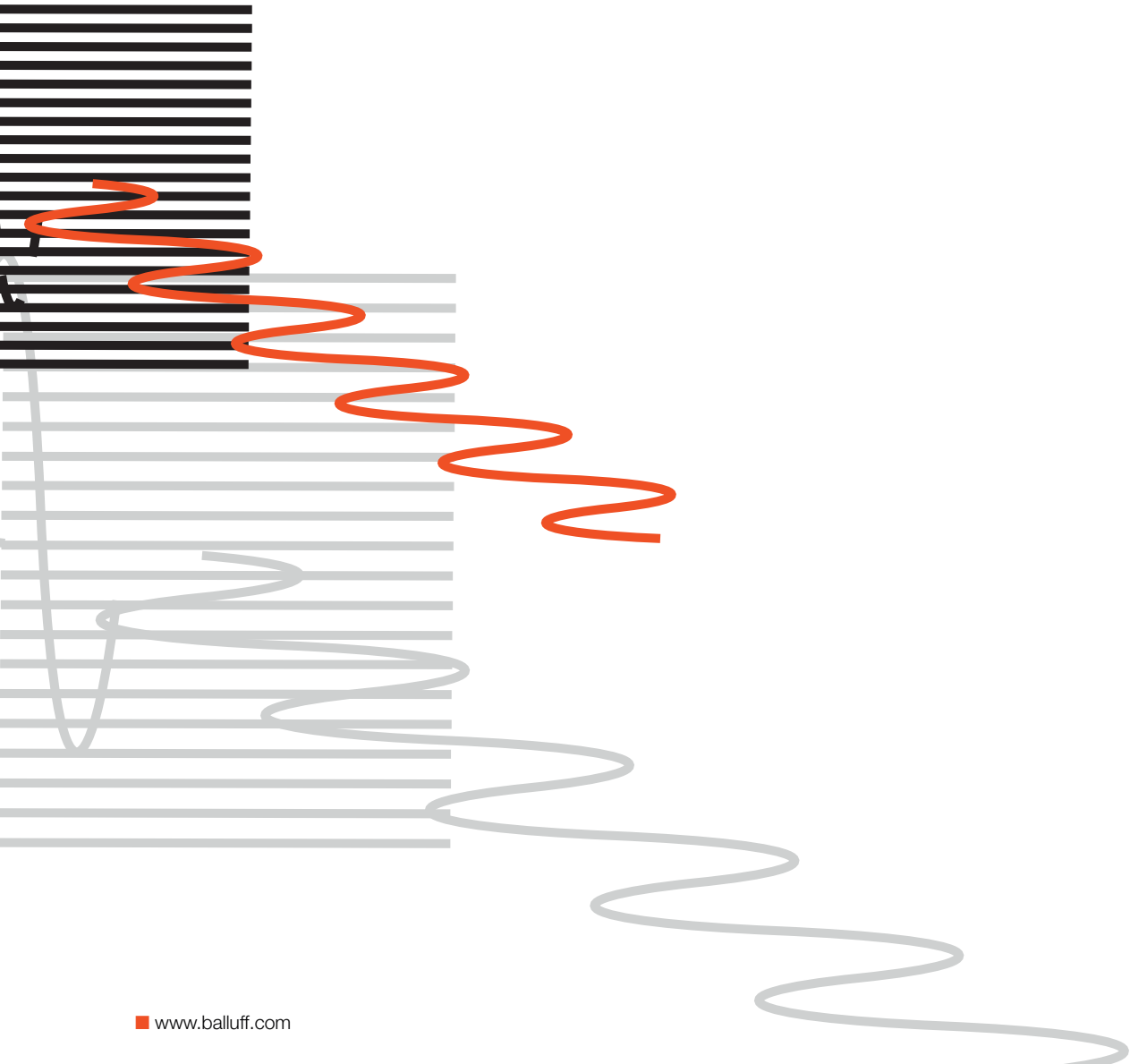
	Adapter for BCS S01/2/3 M18 to R 1"	Adapter for BCS S01/2/3 M16 to M12	Cable adapter for capacitive mini-sensors	Cable adapter for capacitive mini-sensors	Cable adapter for capacitive mini-sensors
	BAM018H	**BCC04JT**	**BCC04JU**	**BCC04JY**	**BCC04JZ**
	BAM AD-XA-001-M18/R1"-4	BCC M454-0000-2A-RM004-020	BCC Z001-002	BCC Z002-030	BCC Z002-080
	Stainless steel	MS-Ni/PA			
		–30...+70 °C			
		0.2 m PVC cable, 3×0.25 mm²	0.2 m PUR cable	3 m PUR cable	8 m PUR cable



Basic Information and Definitions



Contents



Cable properties

Cable types

PUR cable, PUR insulated

No. of wires × conductor cross-section	Outside diameter typical
2×0.08 mm²	3...4 mm
2×0.14 mm²	3...4.1 mm
2×0.34 mm²	4...5.5 mm
3×0.06 mm²	2...2.5 mm
3×0.09 mm²	2.5...3 mm
3×0.14 mm²	2.5...3.5 mm
3×0.25 mm²	3.5...4.5 mm
3×0.34 mm²	4...5.5 mm
3×0.75 mm²	6.5...7 mm
4×0.14 mm²	3...4 mm
4×0.25 mm²	4...5.5 mm
8×0.25 mm²	6...8 mm

PVC cable, PVC insulated

No. of wires × conductor cross-section	Outside diameter typical
2×0.14 mm²	2.5...3.5 mm
2×0.34 mm²	4.5...5.5 mm
3×0.14 mm²	2.7...4.5 mm
3×0.25 mm²	4...5 mm
3×0.34 mm²	4.5...5.5 mm
4×0.25 mm²	4.5...5.5 mm

Smallest bending radius

tensioned	untensioned	drag chain and roll deflection
4×D	3×D	4×D...7.5×D only with "SP" wire

Special cable

The SP- cable is a irradiated cross-linked PUR- cable that has good resistance to weld splatter. A special connection cable is used for sensors that need to be used at higher ambient temperatures.

Tightening torques

The permitted tightening torque is indicated in the data sheets or on the sensor packaging.

Quality and the environment

Quality management system as per DIN EN ISO 9001:2008

Balluff companies	
Balluff GmbH	Germany
Balluff SIE Sensorik GmbH	Germany
Balluff Controles Elétricos Ltda.	Brazil
Balluff Sensors (Chengdu) Co., Ltd.	China
Balluff Ltd.	Great Britain
Balluff Automation S.R.L.	Italy
Balluff Canada Inc.	Canada
Balluff de México S.A. de C.V.	Mexico
Balluff GmbH	Austria
Balluff Sp. z o.o.	Poland
Balluff Hy-Tech AG	Switzerland
Balluff Sensortechnik AG	Switzerland
Balluff S.L.	Spain
Balluff CZ, s.r.o	Czech Republic
Balluff Elektronika Kft.	Hungary
Balluff Inc.	USA

Reg.Nr.: 19279-03

Environmental management system as per DIN EN ISO 14001:2009

Balluff companies	
Balluff GmbH	Germany
Balluff Sensors (Chengdu) Co., Ltd.	China
Balluff Elektronika KFT	Hungary

Testing laboratory

The Balluff testing laboratory operates in accordance with ISO/IEC 17025 and is accredited by DAkks for testing electromagnetic compatibility (EMC).

DAkkS Deutsche Akkreditierungsstelle D-PL-12017-01-01

Balluff products comply with EU directives

Products that require labeling are subject to a conformity evaluation process according to the EU directive and the product is labeled with the CE marking.
Balluff products fall under the following EU directive:

2004/108/EC	EMC directive
2006/95/EC	Low Voltage Directive valid for products with supply voltage ≥ 75 V DC/≥ 50 V AC
94/9/EC	ATEX-directive valid for products with Ex-label

Product approvals

Product approvals are awarded by domestic 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-Code by the Chinese CQC.

Standards

Sensors	Low-voltage switchgear and controlgear	EN 60947-5-2/IEC 60947-5-2
	NAMUR-sensors	EN 60947-5-6/IEC 60947-5-6
Protection class	II ⧈	EN 60947-5-2/IEC 60947-5-2
Degree of protection	IP 60...67	EN 60529/IEC 60529
	IP 68 per BWN Pr. 20	Balluff factory standard (BWN): Temperature storage 48 h at 60 °C, 8 temperature cycles according to EN 60068-2-14/IEC 60068-2-14 between the benchmark temperatures according to the data sheet, 1 h storage in water, insulation inspection, 24 h storage in water, insulation test, 8 temperature cycles according to EN 60068-2-14 IEC 60068-2-14 between the benchmark temperatures according to the data sheet, 7 days storage in water, insulation test.
	P 68 according to BWN Pr. 27	Balluff Factory Standard (BWN): Testing products for use in the foods industry.
	IP 69K	DIN 40050 part 9: Protection against entry of water under high pressure- or steam jet cleaning.
EMC (Electromagnetic Compatibility)	Emissions, RF noise voltage and RF noise radiation from electrical equipment	EN 55011
	Interference immunity against discharging static electricity (ESD)	EN 61000-4-2/IEC 61000-4-2
	Radio frequency immunity against high-frequency electromagnetic fields (RFI)	EN 61000-4-3/IEC 61000-4-3
	Immunity to fast transients (bursts)	EN 61000-4-4/IEC 61000-4-4
	Interference immunity against conducted interference, induced by high-frequency fields	EN 61000-4-6/IEC 61000-4-6
	Immunity to voltage dips and voltage interruptions	EN 61000-4-11/IEC 61000-4-11
	Surge-voltage stability	EN 60947-5-2/IEC 60947-5-2
Environmental simulation	Vibration, sinusoidal	EN 60068-2-6/IEC 60068-2-6
	Shock	EN 60068-2-27/IEC 60068-2-27
	Continuous shock	EN 60068-2-29/IEC 60068-2-29
EX area	Electrical equipment for explosive atmospheres, general requirements.	EN 50014
	Succeeded by: Electrical equipment for gas explosive atmospheres, general requirements.	EN 60079-0
	Electrical apparatus for explosive areas – intrinsic safety "i".	EN 50020

For conformity, see product marking.

Mounting torques

The following torques are to be followed so that the sensors are not mechanically destroyed during installation, as long as no other information is indicated on the data sheet or the sensor packaging.

Size	Material	Tightening torque
M5×0.5	Stainless steel	3 Nm
M8 × 1	Stainless steel	15 Nm
M12×1	Stainless steel	40 Nm
M18×1	PBT	1 Nm
M18×1	Stainless steel	60 Nm
M30×1.5	PBT	3 Nm
M30×1.5	Stainless steel	90 Nm

Housing tolerances for unthreaded cylindrical sensors

Diameter	Tolerance
Ø 3 mm	–0.1
Ø 4 mm	–0.1
Ø 6.5 mm	–0.15
Ø 8 mm	–0.15

Degree of protection

The degrees of protection are given according to IEC 60529. Code letters IP (International Protection) designate protection for electrical equipment against shock hazard, ingress of solid foreign bodies and water.

IP 69K
Protection against ingress of water at high pressure and steam cleaning per DIN 40050 Part 9.

First digit:
2 Protection against penetration of solid bodies larger than 12 mm, shielding from fingers and objects
4 Protection against penetration of solid bodies larger than 1 mm, shielding from tools and wires
5 Protection against damaging dust deposits, complete contact protection
6 Protection against penetration of dust, complete contact protection

Second digit:
0 No special protection
4 Protection against water, which is sprayed from all directions against the equipment
5 Protection against a stream of water from a nozzle which hits the equipment from all directions
7 Protection against water, if the equipment (housing) is temporarily submerged
8 Protection against water when submerged for some time

Materials

Material	Use and characteristics
Plastics	
ABS Acrylonitrile-Butadiene-Styrene	Impact-resistant, stiff, limited chemical resistance. Some types flame-retardant. Used for housings.
AES/CP Acrylonitrile-Ethylene-Propylene-Styrene	Impact-resistant, stiff, limited chemical resistance. Used for housings.
EP Epoxy resin	Duromer, molded plastic material, highest mechanical strength and temperature resistance. Very good dimensional stability. Cannot be melted.
Epoxy resin - hollow glass spheres	Hollow glass spheres can be treated with epoxy resins. They are used for manufacturing converters with low thickness and high pressure rating.
Tetrafluorethylene-perfluorpropylene	High temperature resistance up to 180 °C, insulation material for cable.
LCP Liquid Crystalline Polymer	High mechanical strength and temperature resistance. Very good chemical resistance. Inherently non-flammable.
PA Polyamide	High impact resistance, good chemical resistance.
PA 6, PA 66, PA mod., PA 12 Polyamide	Good mechanical strength. Temperature resistance. PA 12 approved for food industry applications.
PA transp. Transparent polyamide	Transparent, hard, inflexible. Good chemical resistance.
PBT Polybutylene terephtalate	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.
PEI Polyetherimide	High mechanical strength and good temperature resistance. Good chemical resistance even with many solvents. Transparent with amber-yellow inherent color (not pigmented).
PET Polyethylene terephtalate	High resistance to breakage, good dimensional stability. Frequently used in the food industry.
PMMA Polymethylmethacrylate	Clear, transparent, hard, scratch-resistant, UV-resistant, mainly for optical applications.
POM Polyoxymethylene	High impact resistance, good mechanical strength. Good chemical resistance.

Mechanical properties

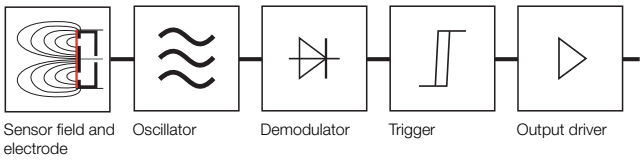
Material	Use and characteristics
Plastics	
PP Polypropylene	Very good electrical properties. Impact resistant, tough, mechanically resilient. Very low water uptake. Good to very good chemical resistance.
PPE Polyphenylene ether	Tough, inflexible, high mechanical strength over a wide temperature range. Good chemical resistance. Good hot water resistance.
PSU Polysulfone	High temperature resistance, high impact resistance, good chemical resistance, FDA approved (food grade).
PTFE Polytetrafluoroethylene	Best temperature and chemical resistance, FDA approved (food grade).
PUR Polyurethane	Elastic, abrasion-resistant, impact-resistant. Good resistance to oils, greases, solvents (used for gaskets and cable jackets).
PVC Polyvinyl chloride	Good mechanical strength and chemical resistance (cable).
PVDF Polyvinylidene fluoride	Thermoplastic. High mechanical strength and temperature resistance. Good chemical resistance (similar to PTFE).
Metal	
Wrought aluminum alloy	Standard-aluminum for machined cutting. Can be anodized. Used for housings and mounting components.
CuZn Brass	Standard-housing material with surface protection.
Stainless steel	Excellent corrosion resistance and strength. **Quality 1.4034, 1.4104:** Standard-material; **quality 1.4305, 1.4301:** Standard-material for the food industry; **quality 1.4401, 1.4404, 1.4571:** With increased requirements on chemical resistance at elevated temperatures for the food industry.
GD-Al die-cast aluminum-	Low specific gravity. Good strength and resistance. Some types can be anodized.
GD-Zn die-cast zinc-	Good resistance and strength. Usually with protective surface coating.
Other	
Glass	Good chemical resistance and strength. Used primarily in optical applications (lenses, cover lenses).
Ceramic	Very good strength and chemical resistance. Electrically insulating. Excellent temperature resistance.

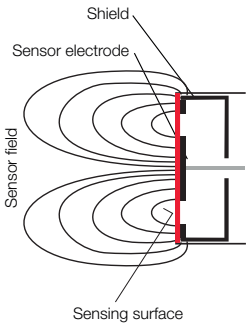
Operating principle

The non-contacting capacitive sensor converts a variable of interest in technical production terms (e.g. object or level) into a signal which can be processed further. The function is based on the alteration in the electrical field around its active zone. The sensor is comprised essentially of:

- Sensor electrode and shielding
- Oscillator
- Demodulator
- Trigger
- Output driver

These two electrodes form the open capacitor of the sensing surface. This is part of an RC oscillator.

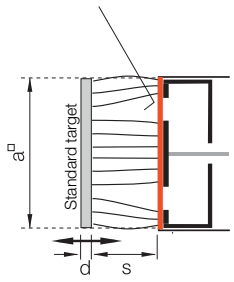




When metallic or non-metallic objects approach the sensing surface of the capacitive sensor, the capacitance changes and the oscillator begins to oscillate. This causes the trigger stage downstream of the oscillator to trip, and the switching amplifier to change its output status. The switching function at the output is either an N.O., N.C. or changeover contact, depending on the type of unit involved. The function of the capacitive sensor can be explained using the equation for capacitance:

$C = \varepsilon_0 \times \varepsilon_r \times F \times (1/S)$

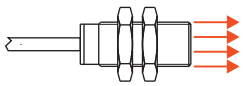
ε_r: Relative dielectric constant
(property of the target medium)
ε_0: Absolute dielectric constant, unchanging
F: Area
S: Distance



From the formula above it follows that objects which have a sufficiently large relative dielectric coefficient (ε_r) and area will be detected by the capacitive sensor. Besides the **standard (multi-purpose) sensor technology,** in which the sensor is a part of the oscillator circuit, there are also more modern processes designed to meet special application requirements.

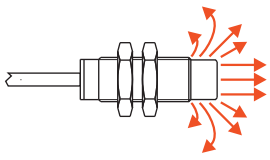
Sensors for object detection (flush)

These sensors have a straight-line electric field. They recognize fixed bodies (e.g. wafers, components, circuit boards, hybrids, cartons, stacks of paper, bottles, plastic blocks and boards), measure liquids through a separating wall (glass or plastic, thickness max. 4 mm) and, in individual cases, are to be pre-tested with samples.



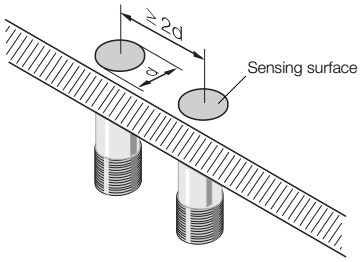
Sensors for level detection (non-flush/unshielded sensor version)

These sensors have a spherical electrical field. These units are designed to detect the product, bulk goods or liquids (e.g. granulate, sugar, flour, corn, sand, or oil and water) with their sensing surface, by touching the medium or through the container wall. The choice of the appropriate sensor depends on the operating conditions and the kind of medium and should in each case be tested beforehand with samples.



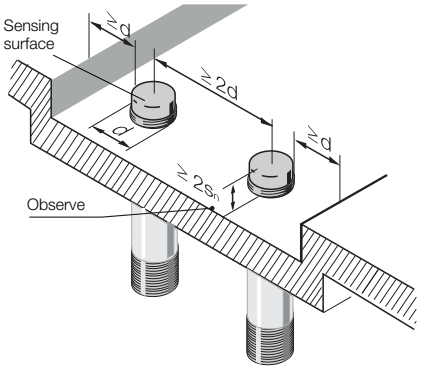
Flush-mount (shielded) Proximity switches

Flush mountable sensors can be installed with their sensing surface flush to the metal. The distance between two proximity switches (in row mounting) must be ≥ 2d.



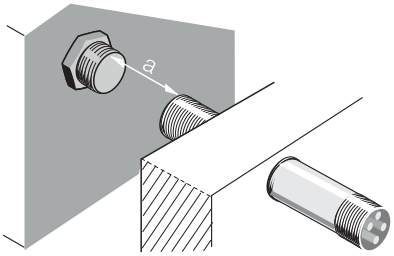
Unshielded proximity switches

The sensing surface must extend ≥ $2s_n$ from the metallic installation medium. The distance between two proximity switches must be ≥ 2d.



Opposing Installation of two sensors

The opposite installation of two sensors requires a minimum distance of a ≥ 4d between the sensing surfaces.



Sensing surface

The sensing surface is the area through which the high-frequency sensor field enters the air space. It is determined mainly by the surface area of the cover cap and corresponds approximately to the area of the outer sensor electrode.

Standard target

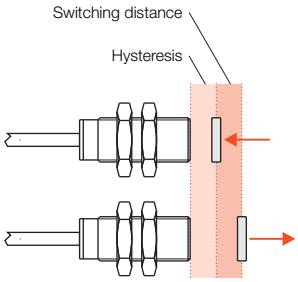
The standard target is a grounded, square plate made of Fe 360 (ISO 630), with the switching distance determined per EN 60947-5-2.
The thickness is d = 1 mm; and the side length a corresponds to
- The diameter of the registered circle of the "sensing surface" or
- 3 s_r, if the value is greater than the given diameter.

Rated switching distance s_n

The rated switching distance is a parameter without taking manufacturing tolerances, parameter scatter and external influences such as temperature and voltage into account.

Effective switching distance s_r

The real switching distance is the switching distance of a single proximity switch measured under specified conditions such as flush mounting, rated operating voltage U_e, temperature T_a = +23 °C ±5 °C. For capacitive sensors, the effective switching distance s_r can be set using a potentiometer.



Hysteresis

The hysteresis is the difference in distance between the switch-on point (for an object that is approaching) and the switch-off point (for an object that is receding).

Repeat accuracy

Repeatability is the maximum sensing distance differential between any two measurements, measured within 8 hours with multiple "approaches" to the object being scanned. The repeat accuracy generally lies between 2 and 5% of the effective switching distance s_r.

Switching frequency

The switching frequency is a succession of periodically repeated activation and de-activation of the sensor during an established interval (one second). Measuring method in conformity with IEC 60947-5-2.

Ambient temperature T_a

The ambient temperature determines the temperature range in which the sensor may be operated. Balluff manufactures both sensors for the standard temperature range –30...+70° C and sensors for more stringent temperature requirements up to max. +250° C.

Temperature drift

The temperature drift specifies the amount by which the switching distance can change based on the temperature. This lies between 15 and 20% of the real switching distance s_r (–5...+55 °C).

Switching function

NO — The switching output of the sensor is not switched through in its de-activated state.

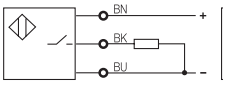
NC — The switching output of the sensor is switched through in its de-activated state.

DC 3/4 wire

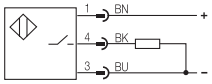
PNP (+) sourcing

Cable/terminals

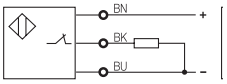
NO

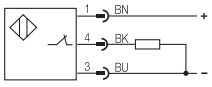


Connector



NC

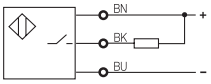




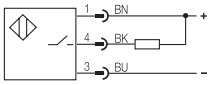
NPN (–) sinking

Cable/terminals

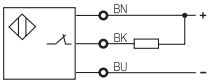
NO

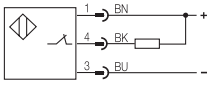


Connector



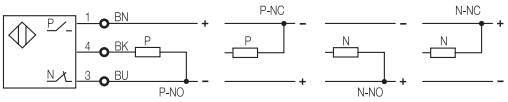
NC





PNP/NPN selectable

NO/NC user codable

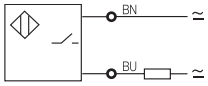


AC/DC 2-wire

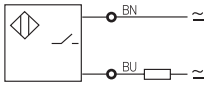
Protection isolated (Protection Class II ⧈)

Cable/terminals

NO



NC



Wire colors, marking per DIN IEC 60757

BN	Brown
BK	Black
BU	Blue
WH	White

Supply voltage U_S

The supply voltage is the voltage range in which flawless functioning of the sensor is assured. It includes all voltage tolerances and ripple.

Voltage drop U_d

The voltage drop is the voltage measured across the active output of the proximity switch when carrying the operational current flows under specified conditions.

Residual ripple

The residual ripple is the maximum permissible AC voltage which may be superimposed on the supply voltage U_S without affecting the function of the sensor.

Output current or operating current I_e

The output current is the maximum current with which the output of the sensor may be loaded in continuous operation.

Standby current

The no-load supply is the power consumption of the sensor with a maximum operating voltage U_O and with no connected load.

Short-circuit protection and overload protection

All DC sensors feature this protection device. In the event of overload or short-circuit at the output, the output transistor is automatically switched off. As soon as the malfunction has been corrected, the output stage is reset to normal functioning.

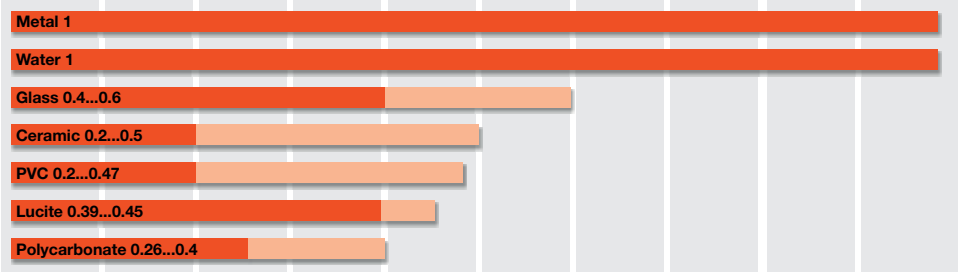
Polarity reversal protection

The sensor electronics are protected against possible polarity reversal or interchanging of the connection wires.

Operating conditions and correction factors

If an electrically non-conducting actuation element (target) enters the sensor field, the capacitance changes proportionally to ε_r and to the immersion depth or to the distance to the sensing surface.
Since the rated switching distance s_n is based on a grounded standard target made of Fe 360, the switching distances must be corrected when using other materials.

Correction factors for typical materials



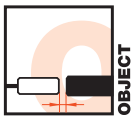
Correction factors should be determined using the target material directly.

Application range of SMART*LEVEL*-sensors with conductivity values

The media and conductivity values given here are only guide values and are for general orientation only. When in doubt, testing should be carried out, since factors such as temperature and media concentration can affect the conductivity values. Please contact us.
Conductivity values for other media on request.

Industrial waste water (select the sensor according to conductivity of the medium			
	Disinfectants (media containing chlorine)		
	Table salt solution		
Alcohol	Rinsing agents		
Marmalade	Milk/buttermilk/yogurt		
Deionized water	Fruit juice		
Mineral oils	Coolant/lubricants		Ketchup/ mayonnaise/mustard
Plant oils	Formic acid (30 %)		Phosphoric acid (10 %)
Ammonia (30 %)	Vinegar		Sulfuric acid (10 %)
Drinking water	Cola		Calcium chloride (30 %)
Sugar solution, diluted	Honey/glue	Blood	Hydrochloric acid (40 %)
Toothpaste	Beer	Seawater	Nitric acid (12 %)
BCS Standard up to approx. 0.7 mS	**SMART*LEVEL*** 15 approx. 0.7...15 mS	**SMART*LEVEL*** 50 approx. 15...50 mS	**SMART** *LEVEL* 500+ approx. 50...500 mS and greater

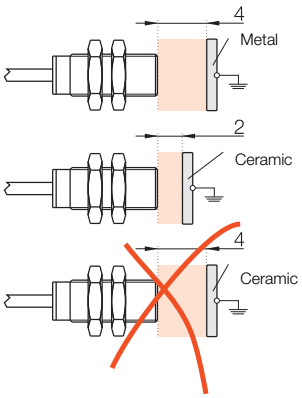
Shielded sensors
Normally, the rectilinear field of flush-mounted sensors scans objects from a distance. To ensure flawless switching of the sensor, the maximum switching distance must be checked before using the device. The following example applications show how you can do this.



Detecting solid bodies made of different materials
A shielded capacitive sensor will be used to detect a ceramic plate. The sensor is set to the maximum rated switching distance s_n of, for example, 4mm from metal or by approximation from your hand. With this preset distance of 4 mm, move the sensor towards the ceramic plate. The rated switching distance s_n to the ceramic plate has been reduced to approx. 2mm.

The distance of 2 mm is now the maximum permissible switching distance for the ceramic plate. You can also adjust for smaller sensing distances than 2mm.

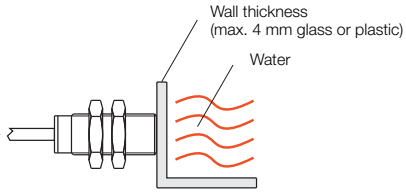
Important!
To ensure that our sensors work reliably within their technical specifications, they have a greater sensing distance than the indicated maximum rated switching distance s_n. If the user now adjusts the switching distance for the above described ceramic plate to 4mm, the sensor will operate outside the permitted range. This entails a risk that temperature and other environmental factors, plus electrical interference in the mains, may lead to faulty switching by the sensor.



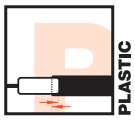
Sensing levels through container walls
A shielded capacitive sensor will be used to detect a liquid, e.g. water, through the container wall. This partition wall may only be made of glass or plastic. The basic calculation for the thickness of the wall thickness yields a value in millimeters of approx. 10 to 20% of the switching distance, but max.
4mm (for standard sensors).

The sensor's face (sensing surface) is now glued to the glass or plastic wall or mounted on it in a maximally form-fitting configuration. The tank is then filled with water until approx. 30 to 50% of the sensor's sensing surface is covered.

Particularly when small and ultra-small quantities of liquid are being scanned, and if the sensor has not been mounted in a form-fitting configuration (flat sensor surface on a tank wall with a small radius), 30% should be selected as the coverage area. Now turn the sensor's potentiometer counter-clockwise (lower sensitivity) until the sensor switches off (for NO versions "LED OFF"). Now turn the potentiometer clockwise again (higher sensitivity) just enough until the LED, and thus the output signal, switch on again. Using the calibration process described here ensures that the sensor does not detect the wall or the media residues on the wall, but only switches when the liquid has again reached the above-described level of 30 to 50%.

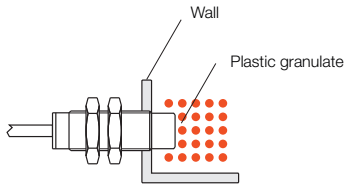


Unshielded sensors
These capacitive sensors with their spherical electrical field are especially suited as level detectors for liquids, granulates or powders.

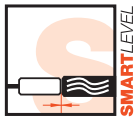


Sensing levels directly in the container
An unshielded capacitive sensor will be used to detect a granulate in a tank. The sensor is now installed in the tank with its sensing surface (clear zone at the head as described in the catalog), in a configuration ensuring that the head is completely covered by the product.

Now turn the sensor's potentiometer counter-clockwise (lower sensitivity) until the LED, and thus the output signal, switch off. Now turn the potentiometer clockwise again (higher sensitivity) just enough until the LED, and thus the output signal, switch on again. Then turn the potentiometer another ¼-turn (90°-rotation) clockwise. This is to compensate for possible temperature fluctuations or changes in the moisture level of the product being scanned. If a medium has a high ε_r, especially water, the sensor will react much more sensitively. Therefore, the adjustment should be made for around 50 to 80% coverage, or a sensor in the **SMART***LEVEL* series should be used.



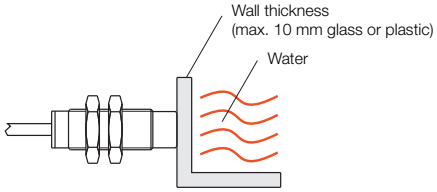
With level sensors in the MicroLevel housing, an adjustment is only necessary in exceptional cases. This potentiometer has a setting path of 270° and has to be carefully adjusted > no limit stop.



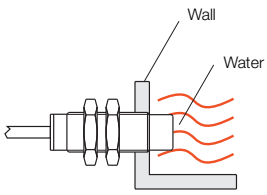
Detecting levels of conductive liquids directly in the container or through a container wall
The ideal level sensors **SMART***LEVEL* detect liquid media directly and all conductive or adhesive liquids through thicker container walls. And they do it without adjustment as long as the wall thickness does not exceed 6mm. For thicker walls the **SMART***LEVEL* will need to be adjusted. Adjustment is possible with the container empty or full.

Adjusting with a full container
First fill the container and install the sensor on the container wall. Now the **SMART***LEVEL* has contact and turns itself on.
Now turn the potentiometer slowly counter-clockwise until the sensor turns off. Now slowly turn the potentiometer (with the sensor switched off) clockwise until the sensor turns on again. At the turn-on point then turn the potentiometer another half-turn (approx. 180°) clockwise and the **SMART***LEVEL* sensor is adjusted.

Adjusting with an empty container
Install the **SMART***LEVEL* sensor on the container wall. Now the SMARTLEVEL has contact and turns itself on. Now turn the potentiometer slowly counter-clockwise until the sensor turns off. Now slowly turn the potentiometer (with the sensor switched off) clockwise until the sensor turns on again. At the turn-on point the potentiometer only needs to be turned 3 times by approx. 360° counter-clockwise and the **SMART***LEVEL* sensor is adjusted.



With level sensors in the MicroLevel housing, an adjustment is only necessary in exceptional cases. This potentiometer has a setting path of 270° and has to be carefully adjusted > no limit stop.



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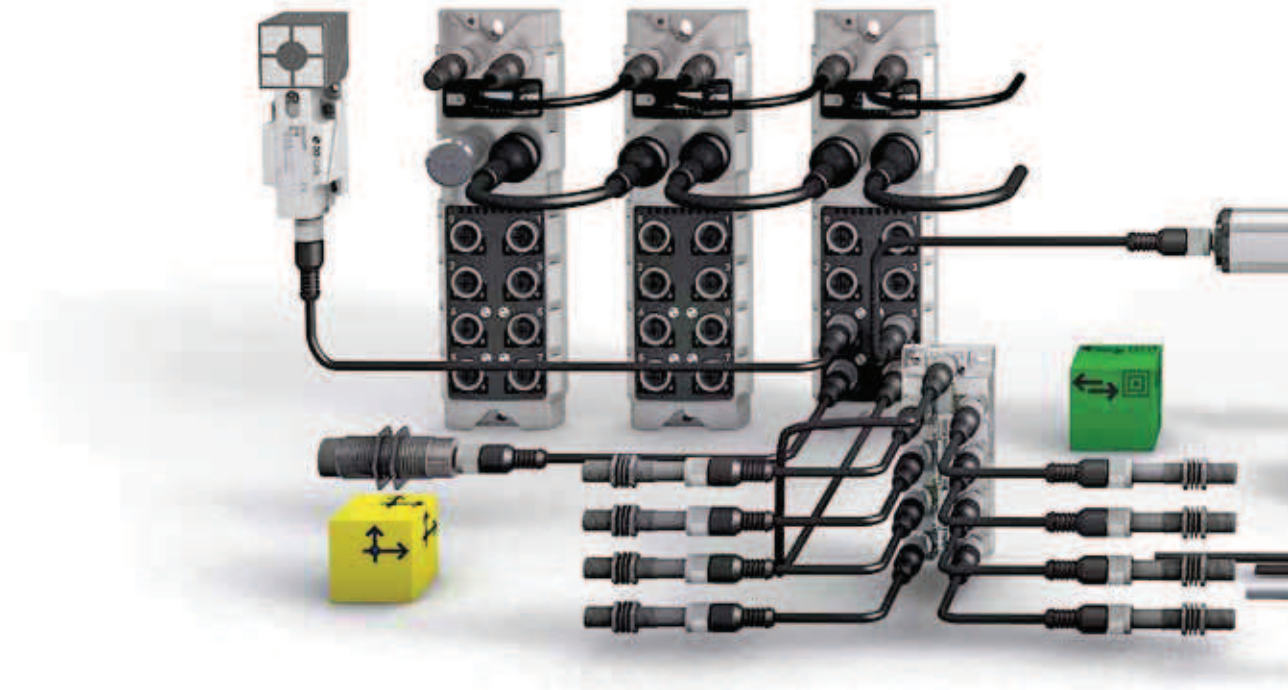

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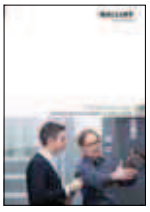
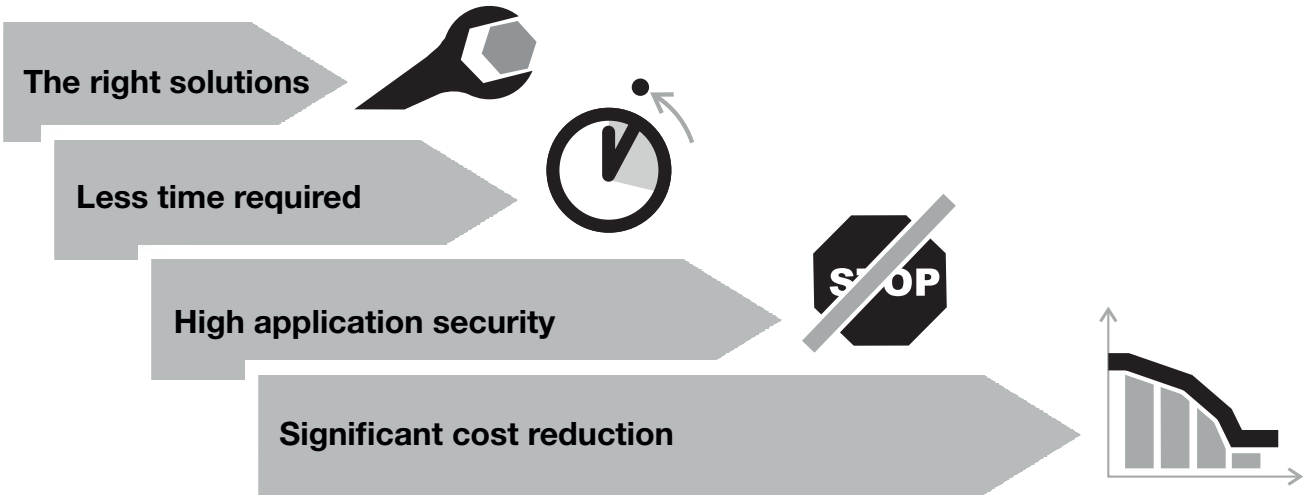


You can find more information in our Services brochure or send us an e-mail: tsm.de@balluff.com



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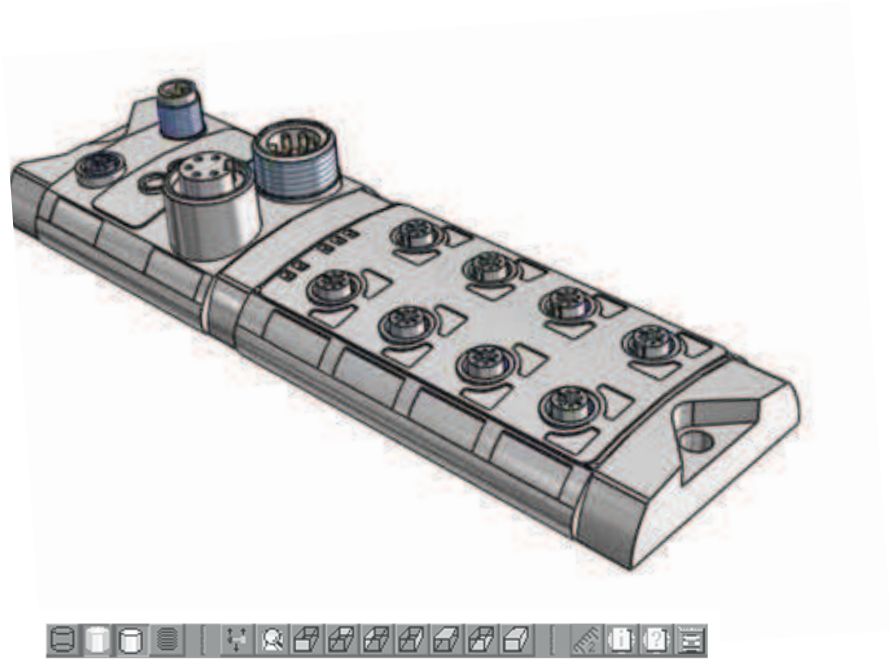
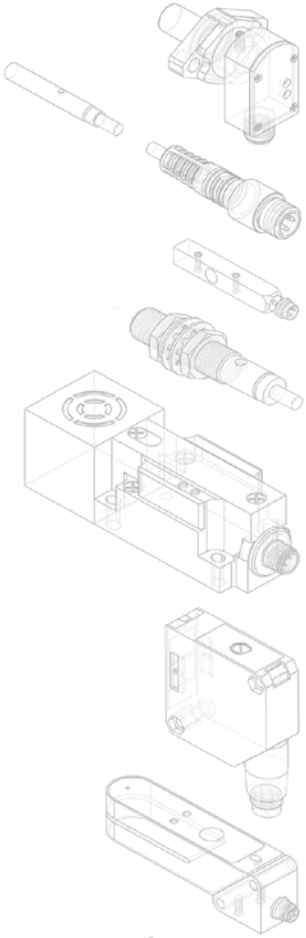
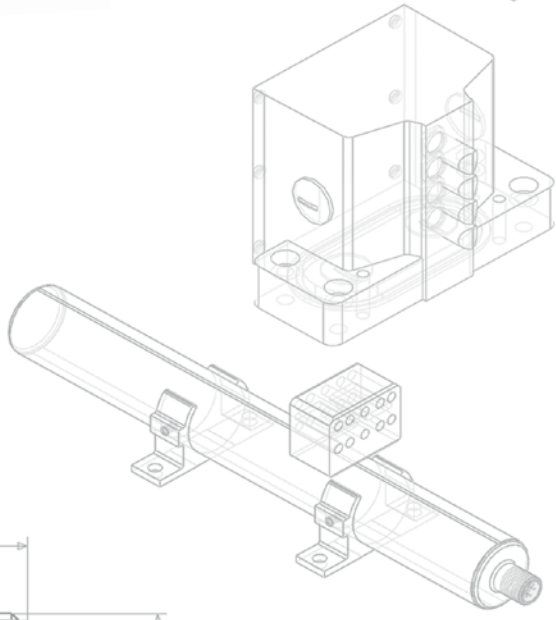
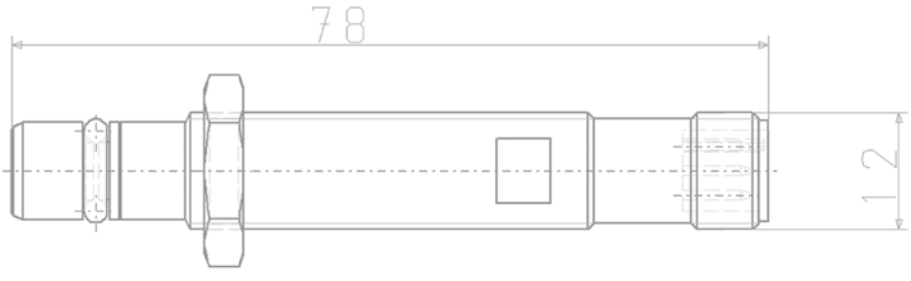
Balluff Products in 3D





- All catalog products are available: inductive sensors, photoelectric sensors, sensors for pneumatic cylinders, micropulse transducers, industrial RFID systems, vision sensors BVS, mechanical single and multiple position switches, industrial networking and connectivity, and so on.
- sizephics reduced to the essentials for optimized performance

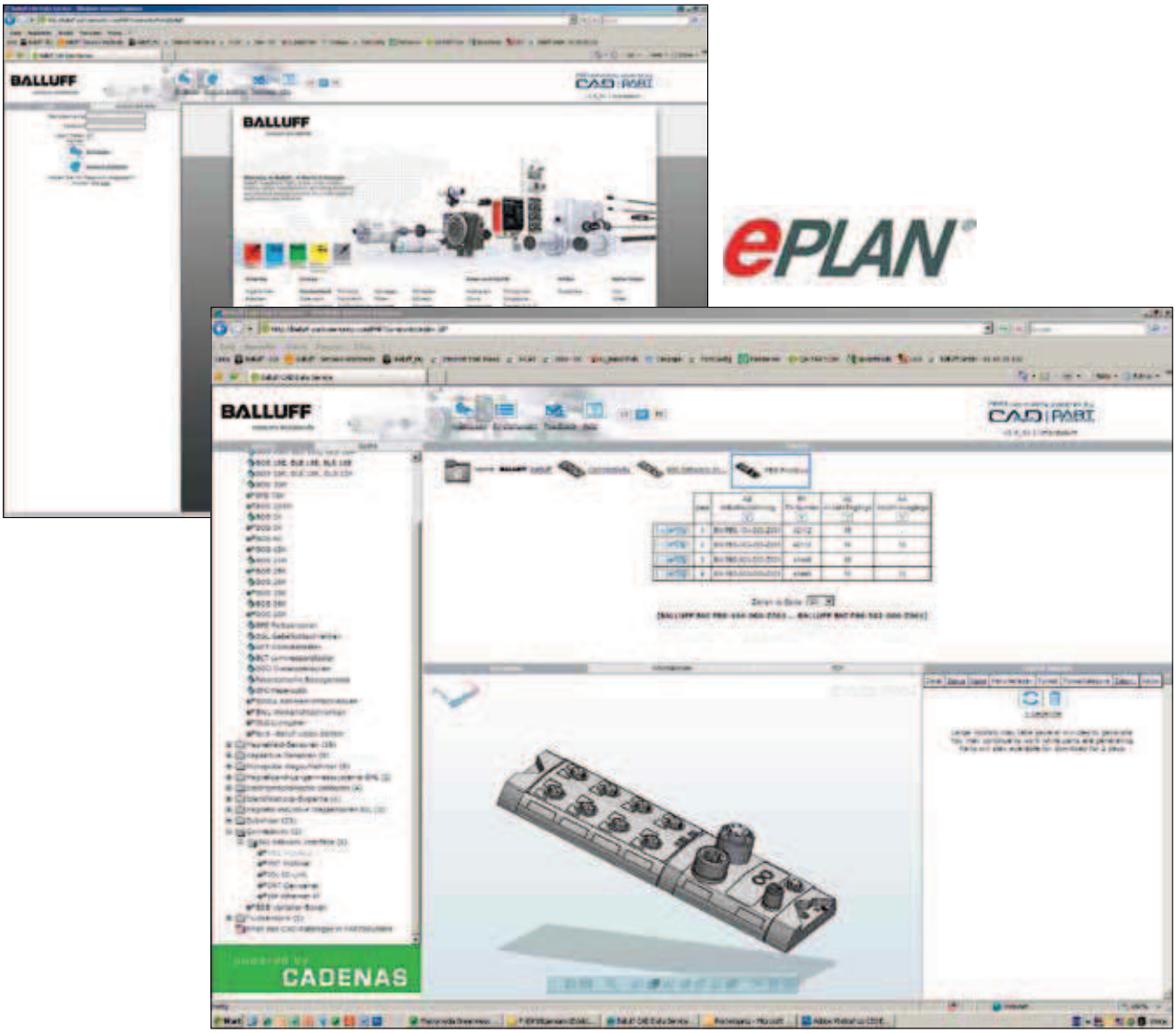




CAD formats on the Cadenas PARTserver

Retrieving Product Information Online

Various CAD and electronic diagram formats available



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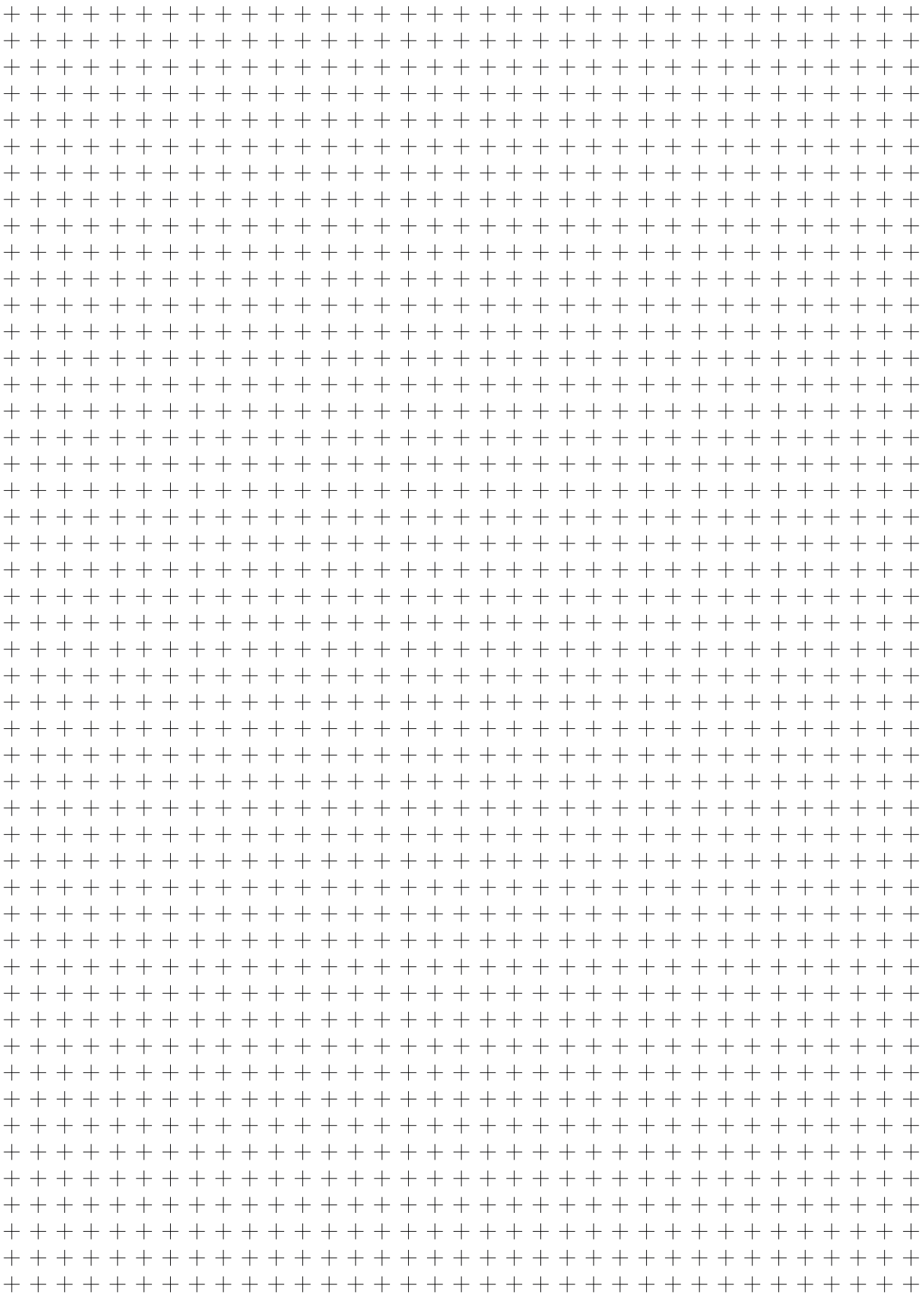

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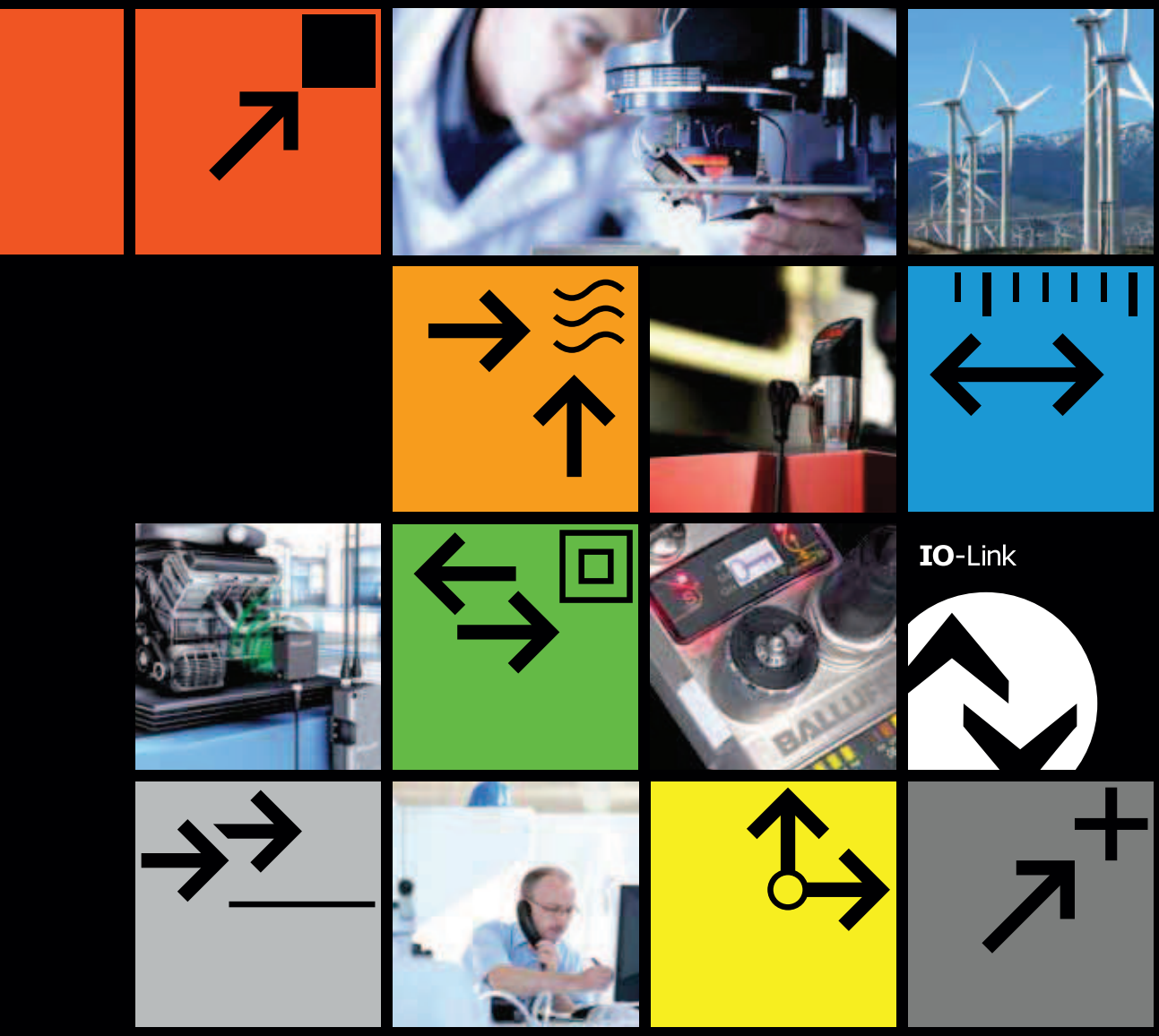

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- Linear Position Sensing and Measurement
- Condition Monitoring and Fluid Sensors
- Accessories

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