Capacitive sensors

Electrosensitive bloodhounds

KD/KL 06

from Page 666

- *Smallest design (ø 6.5 mm) with robust stainless steel housings*
- *Switching distance 0.1 … 1.5 mm (flush) or 0.1 … 3 mm (non-flush)*
- *Suitable for object detection and filling level measurement when mounting space limited*

KD/KL 08

from Page 668

- *Compact design in stainless steel housings*
- *Simple mounting thanks to universal M8 threads*
- *Switching distance 0.1 … 1.5 mm (flush) or 0.1 … 3 mm (non-flush)*

KD/KL 12

from Page 670

- *Robust stainless steel housings with universal M12 threads*
- *Switching distance 1 … 4 mm (flush) or 1 … 8 mm (non-flush)*
- *Sensitivity adjustment via potentiometer*

Capacitive sensors are suitable for the detection of metallic and non-metallic objects of all types. Even highly transparent glasses or liquids are easy to detect with a capacitive sensor. Only the dielectric conductivity of the target material is relevant: the greater the dielectric constant of a material, the higher the possible switching distances or the more reliable the detection.

The measurement of filling levels is among the classic applications of capacitive sensors because many liquids have comparatively high dielectric constants. Under certain circumstances it is also possible to measure from outside the container because capacitive sensors can, so to speak, see through walls. They are also used for detecting solids such as wood, paper and plastics. They are found in the most varied of industrial sectors due to their great immunity to interfering factors of all types. SensoPart offers a wide range of capacitive sensors in cylindrical housings for all areas of use.

TYPICAL SENSOPART

- Switching distances from 0.1 to 30 mm
- Robust cylindrical stainless steel housings (6.5 to 30 mm)
- Easy mounting thanks to conventional cylinder construction
- Simple sensitivity adjustment via potentiometer
- Various designs for flush and non-flush mounting
- Switching output: PNP or NPN
- Output function: N.O. or N.C.

KD/KL 18

from Page 672

- *Increased switching distance 1 … 8 mm (flush) or 2 … 15 mm (non-flush)*
- *Suitable for measurements through walls and measuring filling levels*
- *Sensitivity adjustment via potentiometer*

KD/KL 30

from Page 674

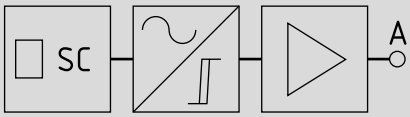
- *Long switching distance 1 … 20 mm (flush) or 1 … 30 mm (non-flush)*
- *Suitable for measurements through walls and for measuring at required distance from target object*

Capacitive Sensors – Product Overview					
	Installation	Adjustment	Switching distance	Special features	Page
KD / KL 06	Flush / non-flush	Potentiometer	0.1 … 1.5 / 0.1 … 3 mm		666
KD / KL 08	Flush / non-flush	Potentiometer	0.1 … 1.5 / 0.1 … 3 mm		668
KD / KL 12	Flush / non-flush	Potentiometer	1 … 4 / 1 … 8 mm		670
KD / KL 18	Flush / non-flush	Potentiometer	1 … 8 / 2 … 15 mm	Longer switching distance	672
KD / KL 30	Flush / non-flush	Potentiometer	1 … 20 / 1 … 30 mm	Longer switching distance	674

Capacitive sensors

System description

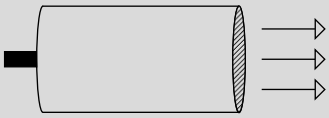
Method of function



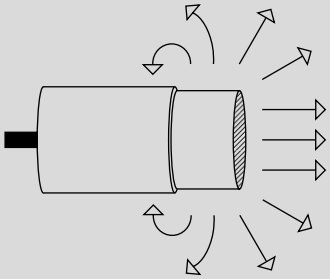
The non-contact capacitive sensor converts a value of interest for production purposes (distance or filling level) to a signal that can be further evaluated. Function is based on the change in the electrical field in the area of its active face. The basic structure of the device consists of an RC oscillator as a sensor, a demodulator and an output level.

The approach of metals or non-metals to the active face of the capacitive sensor results in a change in capacity, whereby the RC oscillator begins to oscillate. This causes the trigger level downstream from the oscillator to tip, and the switching amplifier changes its output state. The switching function at the output is N.O., N.C. or change-over contact depending on the device type.

Installation



Flush version
Sensors with a linear electrical field. These devices scan solid bodies (e.g. wafers, components, circuit boards, hybrids, cartons, stacks of paper, bottles, plastic blocks and sheets) for distance, or liquids through a partition made of glass or plastic (max. thickness 4 mm).



Non-flush version
Sensors with a spherical electrical field. The active face of these devices should be in contact with the target product to be actively scanned (e.g. granulate, sand, oil or water).

Size correction factor
With objects that are not flat and are smaller compared to the active face one obtains the following switching distances depending on the standardised surface F/F0 with F0 = sensor face surface (active face) and F = face surface of the target object. The data relate to flush sensors and objects in the form of long thin rods.

Standardised object area	Switching distance, S in %	ø – object in mm	F in mm²	S in mm
1.50	100	22	380	8
1.24	100	20	314	8
0.8	100	16	201	8
0.61	100	14	154	8
0.31	94	10	79	7.5
0.20	85	8	50	6.8
0.15	82.5	7	38	6.6
0.05	67.5	4	13	5.4
0.03	57.5	3	7	4.6

Table 1

Applications

Capacitive proximity switches are suitable for controlling and monitoring machine processes and for providing signals for counting tasks where metals and non-metals are available, as well as for signalling levels in containers and through container walls where liquid, pulverised or grainy materials require detection.

Types of interaction

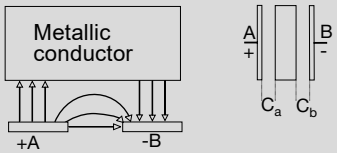


Fig. 1

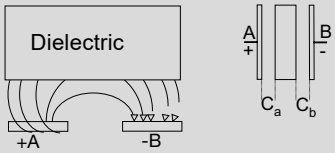


Fig. 2

Capacitive sensors are actuated by both conductive and non-conductive objects. Objects made of conductive materials form a counter-electrode to the sensor's active face. This forms two capacities, C_A and C_B connected in series, with the electrode surfaces A and B (Fig. 1). The capacity of this serial connection is always greater than the capacity of the uncovered electrodes A and B.

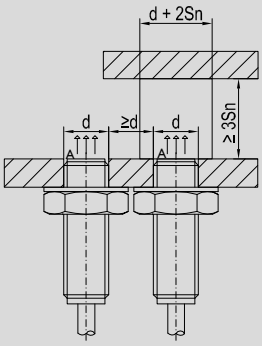
Metals achieve the highest switching distances due to their very high conductivity. Reduction factors for differing metals – like those of inductive sensors – must be taken into account.

Actuation by objects made of non-conductive materials (insulators): when one places an insulator between the electrodes of a condenser the capacity increases with the dielectric constant ε (Fig. 2) of the insulator.

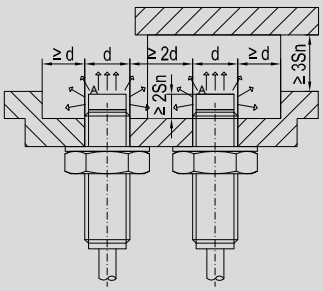
The dielectric constant of all solids and liquids is greater than air (ε_{air} = 1; see Table 2). Similarly, objects made of non-conductive materials have an effect on the active face of a capacitive sensor by increasing the coupling capacity. Materials with greater dielectric constants achieve longer switching distances. When scanning organic materials (wood, grain, etc.) it should be noted that the achievable switching distance is very strongly influenced by the water content (ε_{water} = 80!)

Installation / Mutual interference

Flush version



Non-flush version



A: Sensing face
d: Diameter
Sn: Operating distance

The IEC 60947-5-2 standard stipulates the mentionned above values as minimum distances. They refer to the mounting of frequently used cylindrical housings.
If several capacitive proximity switches of the same type are mounted close together, certain minimum distances between the units should also be observed.

The effect of differing materials

Switching distance and dielectric constants

The switching distance (S_r) is dependent on the dielectric constant (ε_r) of the target object. The maximum switching distance (100 %) is achieved with metallic objects while it is reduced with other materials in proportion to the dielectric constant of the target object.

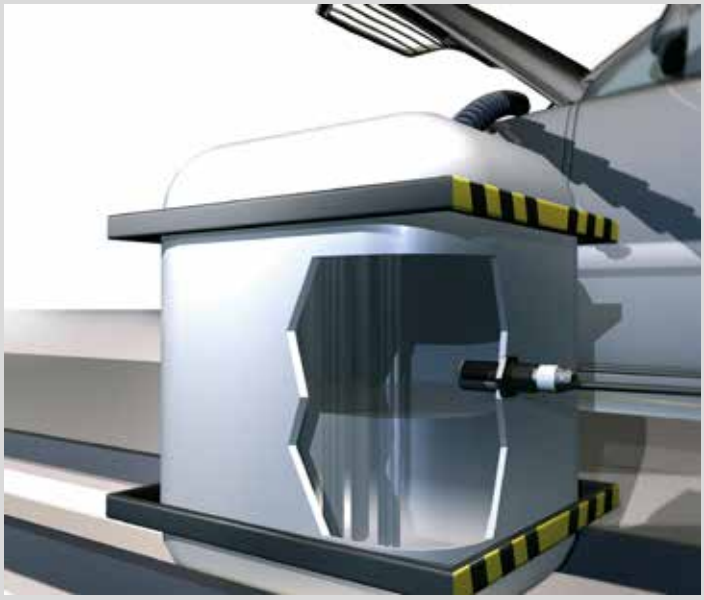
Table 2 (below) shows the dielectric constants of some important materials. As a result of the high dielectric constant value of water, wood exhibits relatively large fluctuations. Damp wood is therefore considerably better detected by capacitive sensors than dry wood.

Dielectric constants (ε_r) of various materials			
Air, vacuum	1	Perspex	3.2
Teflon	2	Araldite	3.6
Wood	2 … 7	Bakelite	3.6
Paraffin	2.2	Quartz glass	3.7
Petroleum	2.2	Hard rubber	4
Terpentine oil	2.2	Oiled paper	4
Transformer oil	2.2	Pressboard	4
Paper	2.3	Porcelain	4.4
Polyethylene	2.3	Laminated paper	4.5
Polypropylene	2.3	Quartz sand	4.5
Cable compound	2.5	Glass	5
Soft rubber	2.5	Polyamide	5
Silicone rubber	2.8	Mica	6
PVC	2.9	Marble	8
Polystyrene	3	Alcohol	25.8
Celluloid	3	Water	80

Table 2

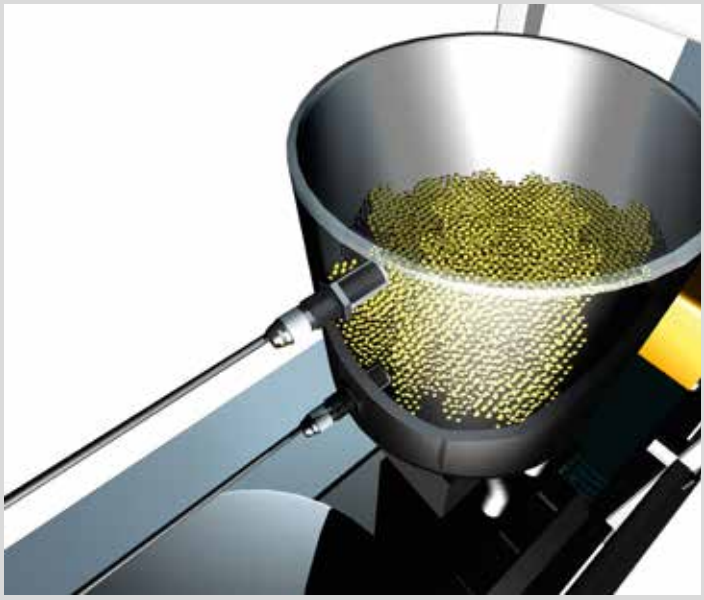
Object detection
Page 672

Capacitive sensors (e.g. KL 18) detect the quantity of the isolated bulk material through container walls with a thickness of up to 4 mm.



Level measuring
Page 668

The capacitive sensor (e.g. KL 08) detects the level of a reservoir for liquid refrigerant.



Level measuring
Page 670

For level control in a transparent container filled with pills, a capacitive sensor (e.g. KD 12) is used.

KD/KL 06

Capacitive sensor

CE

PRODUCT HIGHLIGHTS

- Robust stainless steel housings
- Small housings
- Optional N.O. or N.C. variants
- Flush or non-flush design options

Sensor data	
Switching distance (flush)	0.1 … 1.5 mm
Switching distance (non-flush)	0.1 … 3 mm
Hysteresis	15 %[1]
Repeatability	2 %[1]
Temperature drift	15 % / °C[1] [-5 … +55 °C]

Functions	
Indicator LED, yellow	Switching output indication
Sensitivity adjustment	Via potentiometer
Default settings	Max. switching distance

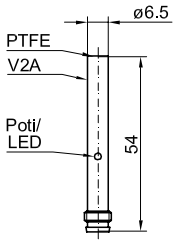
Electrical data	
Operating voltage, $+U_B$	11 … 30 V DC
No-load current, I_0	≤ 10 mA
Output current, Ie	≤ 50 mA
Protective circuits	Reverse polarity protection. U_B / short-circuit protection (Q) / overload protection
Power On Delay	< 300 ms
Switching output, Q	PNP / NPN (see Selection Table)
Output function	N.O. / N.C. (see Selection Table)
Switching frequency f (ti/tp 1:1)	100 Hz

Mechanical data	
Dimensions	Ø 6.5 x 54 mm
Enclosure rating	IP 65
Material, housing	Stainless steel V2A
Material, front surface	PTFE
Type of connection	See Selection Table
Ambient temperature: operation	-10 … +70 °C
Vibration and impact resistance	EN 60947-5-2

[1] Relating to switching distance

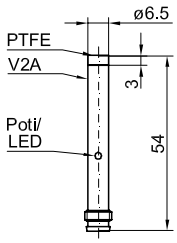
Switching distance	Installation	Switching output	Type of connection	Part number	Article number
0.1 … 1.5 mm	Flush	PNP (N.O.)	Plug, M8x1, 3-pin	KD 06 B-PSM3	681-50878
0.1 … 1.5 mm	Flush	PNP (N.C.)	Plug, M8x1, 3-pin	KD 06 B-POM3	681-50879
0.1 … 1.5 mm	Flush	NPN (N.O.)	Plug, M8x1, 3-pin	KD 06 B-NSM3	681-50880
0.1 … 1.5 mm	Flush	NPN (N.C.)	Plug, M8x1, 3-pin	KD 06 B-NOM3	681-50881
0.1 … 3 mm	Non-flush	PNP (N.O.)	Plug, M8x1, 3-pin	KL 06 NB-PSM3	681-50886
0.1 … 3 mm	Non-flush	PNP (N.C.)	Plug, M8x1, 3-pin	KL 06 NB-POM3	681-50887
0.1 … 3 mm	Non-flush	NPN (N.O.)	Plug, M8x1, 3-pin	KL 06 NB-NSM3	681-50888
0.1 … 3 mm	Non-flush	NPN (N.C.)	Plug, M8x1, 3-pin	KL 06 NB-NOM3	681-50889

Plug connection (flush)



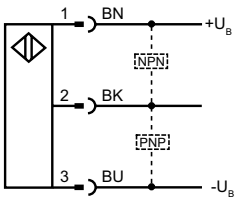
153-00516

Plug connection (non-flush)



153-00517

Connection, 3-pin



154-00459

Accessories

Connection cables	From Page A-38
Brackets	From Page A-4

13

KD/KL 08

Capacitive sensor

CE

PRODUCT HIGHLIGHTS

- Ideal for filling level measurements
- Robust stainless steel housings
- Optional N.O. or N.C. variants
- Flush or non-flush design options

Sensor data	
Switching distance (flush)	0.1 … 1.5 mm
Switching distance (non-flush)	0.1 … 3 mm
Hysteresis	15 %[1]
Repeatability	2 %[1]
Temperature drift	15 % / °C[1] [-5 … +55 °C]

Functions	
Indicator LED, yellow	Switching output indication
Sensitivity adjustment	Via potentiometer
Default settings	Max. switching distance

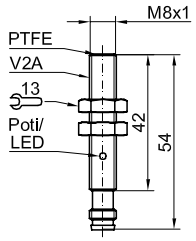
Electrical data	
Operating voltage, $+U_B$	11 … 30 V DC
No-load current, I_0	≤ 10 mA
Output current, Ie	≤ 50 mA
Protective circuits	Reverse polarity protection. U_B / short-circuit protection (Q) / overload protection
Power On Delay	< 300 ms
Switching output, Q	PNP / NPN (see Selection Table)
Output function	N.O. / N.C. (see Selection Table)
Switching frequency f (ti/tp 1:1)	100 Hz

Mechanical data	
Dimensions	M8 x 54 mm
Enclosure rating	IP 65
Material, housing	Stainless steel V2A
Material, front surface	PTFE
Type of connection	See Selection Table
Ambient temperature: operation	-10 … +70 °C
Vibration and impact resistance	EN 60947-5-2

[1] Relating to switching distance

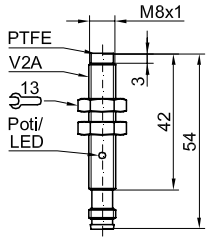
Switching distance	Installation	Switching output	Type of connection	Part number	Article number
0.1 … 1.5 mm	Flush	PNP (N.O.)	Plug, M8x1, 3-pin	KD 08 B-PSM3	681-50894
0.1 … 1.5 mm	Flush	PNP (N.C.)	Plug, M8x1, 3-pin	KD 08 B-POM3	681-50895
0.1 … 1.5 mm	Flush	NPN (N.O.)	Plug, M8x1, 3-pin	KD 08 B-NSM3	681-50896
0.1 … 3 mm	Non-flush	PNP (N.O.)	Plug, M8x1, 3-pin	KL 08 NB-PSM3	681-50902
0.1 … 3 mm	Non-flush	PNP (N.C.)	Plug, M8x1, 3-pin	KL 08 NB-POM3	681-50903
0.1 … 3 mm	Non-flush	NPN (N.O.)	Plug, M8x1, 3-pin	KL 08 NB-NSM3	681-50904
0.1 … 3 mm	Non-flush	NPN (N.C.)	Plug, M8x1, 3-pin	KL 08 NB-NOM3	681-50905

Plug connection (flush)



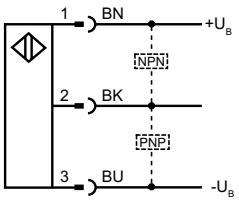
153-00518

Plug connection (non-flush)



153-00519

Connection, 3-pin



154-00459

Accessories

Connection cables	From Page A-38
Brackets	From Page A-4

13

KD/KL 12

Capacitive sensor

CE

PRODUCT HIGHLIGHTS

- Ideal for filling level measurements
- Robust stainless steel housings
- Optional N.O. or N.C. variants
- Flush or non-flush design options

Sensor data	
Switching distance (flush)	1 … 4 mm
Switching distance (non-flush)	1 … 8 mm
Hysteresis	15 %[1]
Repeatability	2 %[1]
Temperature drift (flush)	20 % / °C[1] [-5 … +55°C]
Temperature drift (non-flush)	15 % / °C[1] [-5 … +55°C]

Functions	
Indicator LED, yellow	Switching output indication
Sensitivity adjustment	Via potentiometer
Default settings	Max. switching distance

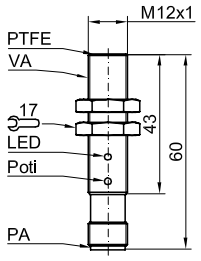
Electrical data	
Operating voltage, $+U_B$	12 … 35 V DC
No-load current, I_0	≤ 10 mA
Output current, Ie	≤ 200 mA
Protective circuits	Reverse polarity protection. U_B / short-circuit protection (Q) / overload protection
Power On Delay	< 300 ms
Switching output, Q	PNP / NPN (see Selection Table)
Output function	N.O. / N.C. (see Selection Table)
Switching frequency f (ti/tp 1:1)	100 Hz

Mechanical data	
Dimensions	M12 x 60 mm
Enclosure rating	IP 65
Material, housing	Stainless steel VA
Material, front surface	PTFE
Type of connection	See Selection Table
Ambient temperature: operation	-30 … +70 °C
Vibration and impact resistance	EN 60947-5-2

[1] Relating to switching distance

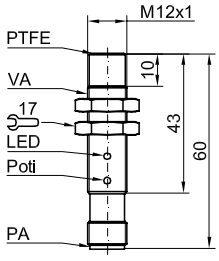
Switching distance	Installation	Switching output	Type of connection	Part number	Article number
1 … 4 mm	Flush	PNP (N.O.)	Plug, M12x1, 4-pin	KD 12 B-PSL4	681-50914
1 … 4 mm	Flush	PNP (N.C.)	Plug, M12x1, 4-pin	KD 12 B-POL4	681-50915
1 … 4 mm	Flush	NPN (N.O.)	Plug, M12x1, 4-pin	KD 12 B-NSL4	681-50916
1 … 4 mm	Flush	NPN (N.C.)	Plug, M12x1, 4-pin	KD 12 B-NOL4	681-50917
1 … 8 mm	Non-flush	PNP (N.O.)	Plug, M12x1, 4-pin	KL 12 NB-PSL4	682-50994
1 … 8 mm	Non-flush	PNP (N.C.)	Plug, M12x1, 4-pin	KL 12 NB-POL4	682-50995
1 … 8 mm	Non-flush	NPN (N.O.)	Plug, M12x1, 4-pin	KL 12 NB-NSL4	682-50996
1 … 8 mm	Non-flush	NPN (N.C.)	Plug, M12x1, 4-pin	KL 12 NB-NOL4	682-50997

Plug connection (flush)



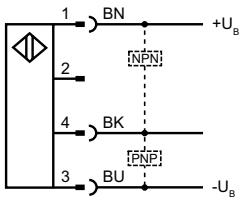
153-00520

Plug connection (non-flush)



153-00521

Connection, 4-pin



154-00460

Accessories

Connection cables	From Page A-38
Brackets	From Page A-4

13

KD/KL 18

Capacitive sensor

CE

PRODUCT HIGHLIGHTS

- Ideal for filling level measurements
- Robust stainless steel housings
- Optional N.O. or N.C. variants
- Flush or non-flush design options

Sensor data	
Switching distance (flush)	1 … 8 mm
Switching distance (non-flush)	2 … 15 mm
Hysteresis	15 %[1]
Repeatability	2 %[1]
Temperature drift	20 % / °C[1] [-5 … +55 °C]
Temperature drift	15 % / °C[1] [-5 … +55 °C]

Functions	
Indicator LED, yellow	Switching output indication
Sensitivity adjustment	Via potentiometer
Default settings	Max. switching distance

Electrical data	
Operating voltage, $+U_B$ (flush)	10 … 30 V DC
Operating voltage, $+U_B$ (non-flush)	10 … 35 V DC
No-load current, I_0 (flush)	≤ 18 mA
No-load current, I_0 (non-flush)	≤ 10 mA
Output current, Ie (flush)	≤ 100 mA
Output current, Ie (non-flush)	≤ 300 mA
Protective circuits	Reverse polarity protection. U_B / short-circuit protection (Q) / overload protection
Power On Delay	< 300 ms
Switching output, Q	PNP / NPN (see Selection Table)
Output function	N.O. / N.C. (see Selection Table)
Switching frequency f (ti/tp 1:1)	100 Hz

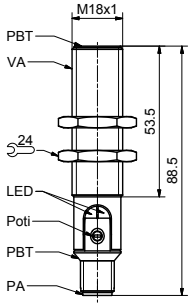
Mechanical data	
Dimensions	M18 x 75 mm
Enclosure rating	IP 67
Material, housing	Stainless steel VA
Material, front surface (flush)	PBT
Material, front surface (non-flush)	PTFE
Type of connection	See Selection Table
Ambient temperature: operation (flush)	-25 … +85 °C
Ambient temperature: operation (non-flush)	-30 … +70 °C
Vibration and impact resistance	EN 60947-5-2

[1] Relating to switching distance

Switching distance	Installation	Switching output	Type of connection	Part number	Article number
1 … 8 mm	Flush	PNP (N.O.)	Plug, M12x1, 4-pin	KD 18 B-PSL4	681-50990
1 … 8 mm	Flush	PNP (N.C.)	Plug, M12x1, 4-pin	KD 18 B-POL4	681-50991
1 … 8 mm	Flush	NPN (N.O.)	Plug, M12x1, 4-pin	KD 18 B-NSL4	681-50992
1 … 8 mm	Flush	NPN (N.C.)	Plug, M12x1, 4-pin	KD 18 B-NOL4	681-50993
2 … 15 mm	Non-flush	PNP (N.O.)	Plug, M12x1, 4-pin	KL 18 NB-PSL4	682-51014
2 … 15 mm	Non-flush	PNP (N.C.)	Plug, M12x1, 4-pin	KL 18 NB-POL4	682-51015
2 … 15 mm	Non-flush	NPN (N.O.)	Plug, M12x1, 4-pin	KL 18 NB-NSL4	682-51016
2 … 15 mm	Non-flush	NPN (N.C.)	Plug, M12x1, 4-pin	KL 18 NB-NOL4	682-51017

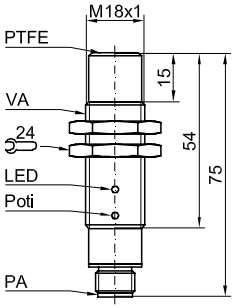
Version: 07/2016. Subject to changes; diagrams similar

Plug connection (flush)



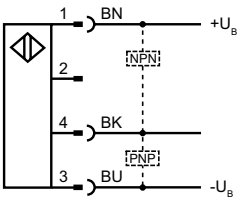
153-00522

Plug connection (non-flush)



153-00523

Connection, 4-pin



154-00460

Accessories

Connection cables	From Page A-38
Brackets	From Page A-4

13

KD/KL 30

Capacitive sensor

CE

PRODUCT HIGHLIGHTS

- Robust stainless steel housings
- N.O. / N.C. switchable
- Switching distance adjustment via potentiometer
- Long switching distance

Sensor data	
Switching distance (flush)	1 … 20 mm
Switching distance (non-flush)	1 … 30 mm
Hysteresis	15 %[1]
Repeatability	5 %[1]
Temperature drift (flush)	10 % / °C[1] [-5 … +55 °C]
Temperature drift (non-flush)	15 % / °C[1] [-5 … +55 °C]

Functions	
Display LED, green	Operating voltage indicator
Indicator LED, yellow	Switching output indication
Sensitivity adjustment	Via potentiometer
Adjustment possibilities	N.O. / N.C. via potentiometer
Default settings	Max. switching distance and N.O.

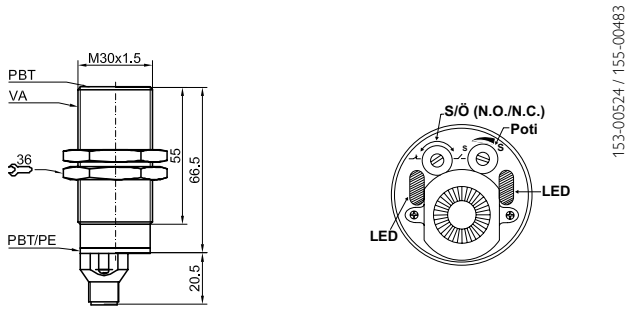
Electrical data	
Operating voltage, $+U_B$	10 … 35 V DC
No-load current, I_0	≤ 15 mA
Output current, Ie	≤ 300 mA
Protective circuits	Reverse polarity protection. U_B / short-circuit protection (Q) / overload protection
Power On Delay	< 300 ms
Switching output, Q	PNP / NPN (see Selection Table)
Output function	N.O. / N.C.
Switching frequency f (ti/tp 1:1)	100 Hz

Mechanical data	
Dimensions	M30 x 87 mm
Enclosure rating	IP 64
Material, housing	Stainless steel VA
Material, front surface (flush)	PBT
Material, front surface (non-flush)	PTFE
Type of connection	See Selection Table
Ambient temperature: operation	-30 … +70 °C
Vibration and impact resistance	EN 60947-5-2

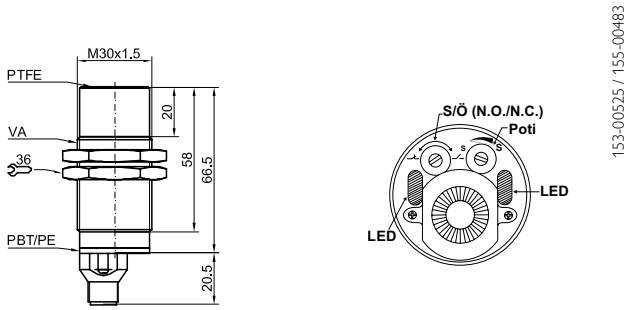
[1] Relating to switching distance

Switching distance	Installation	Switching output	Type of connection	Part number	Article number
1 … 20 mm	Flush	PNP	Plug, M12x1, 4-pin	KD 30 B-PSOL4	681-50942
1 … 20 mm	Flush	NPN	Plug, M12x1, 4-pin	KD 30 B-NSOL4	681-50944
1 … 30 mm	Non-flush	PNP	Plug, M12x1, 4-pin	KL 30 NB-PSOL4	682-51034
1 … 30 mm	Non-flush	NPN	Plug, M12x1, 4-pin	KL 30 NB-NSOL4	682-51036

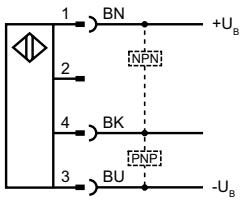
Plug connection (flush)



Plug connection (non-flush)



Connection, 4-pin



Accessories

Connection cables	From Page A-38
Brackets	From Page A-4

13