

# Capacitive sensors

## Electrosensitive bloodhounds

### KD/KL 06

from Page 654

- Smallest design ( $\varnothing$  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 656

- 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 658

- 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 SENSO PART

- 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 660

- Increased switching distance  
2 ... 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 662

- 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



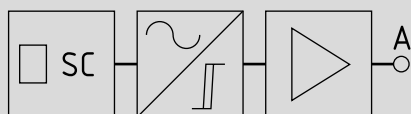
#### Capacitive Sensors – Product Overview

	Installation	Adjustment	Switching distance	Special features	Page
KD / KL 06	Flush / non-flush	Potentiometer 	0.1 ... 1.5 / 0.1 ... 3 mm		654
KD / KL 08	Flush / non-flush	Potentiometer 	0.1 ... 1.5 / 0.1 ... 3 mm		656
KD / KL 12	Flush / non-flush	Potentiometer 	1 ... 4 / 1 ... 8 mm		658
KD / KL 18	Flush / non-flush	Potentiometer 	2 ... 8 / 2 ... 15 mm	Longer switching distance	660
KD / KL 30	Flush / non-flush	Potentiometer 	1 ... 20 / 1 ... 30 mm	Longer switching distance	662

# Capacitive sensors

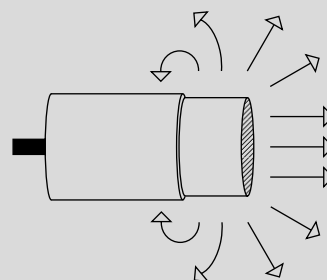
## System description

### 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.

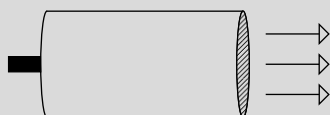
The approach of metals or non-metals to the active face of the capacitive sensor results in a change in capacity, whereby the RC oscillator begins to oscillate. This causes the trigger level downstream from the oscillator to tip, and the switching amplifier changes its output state. The switching function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



### 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).

### 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).

### 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  $F/F_0$  with  $F_0$  = 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 %	$\phi$ – object in mm	F in mm <sup>2</sup>	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.

The dielectric constant of all solids and liquids is greater than air ( $\epsilon_{\text{air}} = 1$ ; 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 ( $\epsilon_{\text{water}} = 80!$ )

## Types of interaction

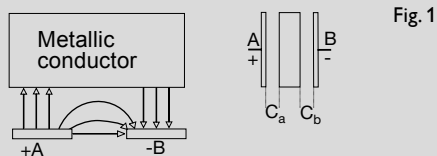


Fig. 1

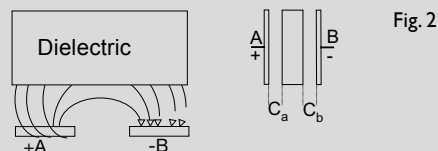


Fig. 2

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  $\epsilon$  (Fig. 2) of the insulator.

# Capacitive sensors

## System description

### The effect of differing materials

#### Switching distance and dielectric constants

The switching distance ( $S_p$ ) is dependent on the dielectric constant ( $\epsilon_r$ ) 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 ( $\epsilon_r$ ) 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

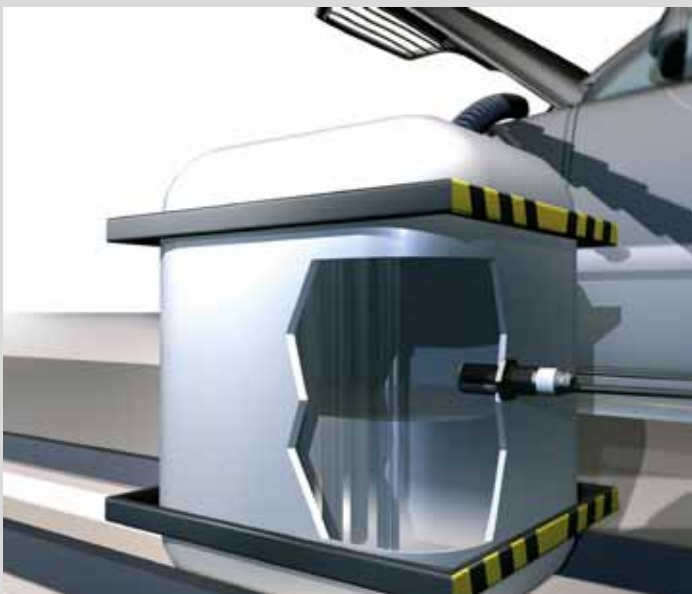
Table 2



**Object detection**

**Page 660**

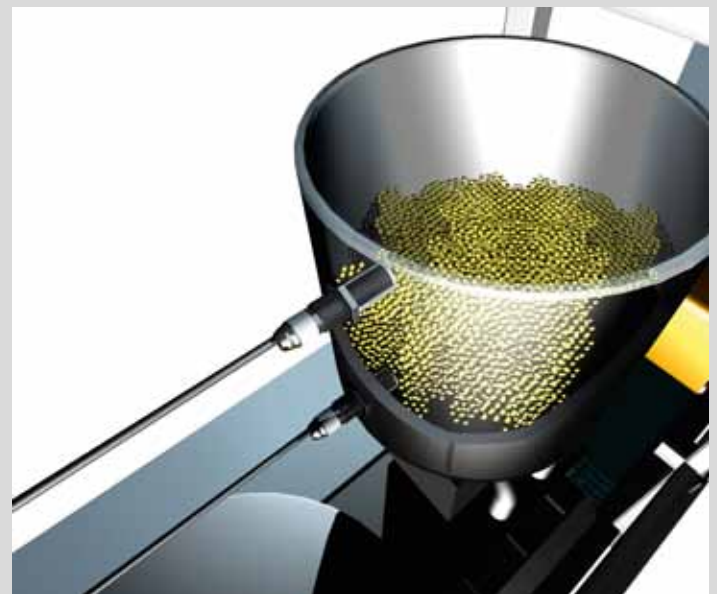
Capacitive sensors (e.g. KL 18) detect the quantity of the isolated bulk material through container walls with a thickness of up to 4 mm.



**Level measuring**

**Page 656**

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



**Level measuring**

**Page 658**

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

# KD/KL 06

## Capacitive sensor



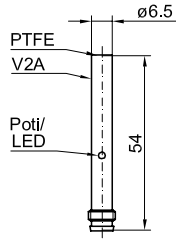
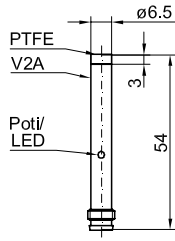
### PRODUCT HIGHLIGHTS

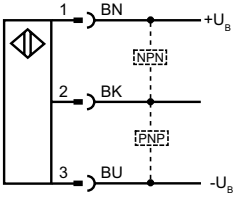
- Robust stainless steel housings
- Small housings
- Optional N.O. or N.C. variants
- Flush or non-flush design options

Sensor data		Functions	
Switching distance (flush)	0.1 ... 1.5 mm	Indicator LED, yellow	Switching output indication
Switching distance (non-flush)	0.1 ... 3 mm	Sensitivity adjustment	Via potentiometer
Hysteresis	15 % <sup>1</sup>	Default settings	Max. switching distance
Repeatability	2 % <sup>1</sup>		
Temperature drift	15 % / °C <sup>1</sup> [-5 ... 55 °C]		
Electrical data		Mechanical data	
Operating voltage, +U <sub>B</sub>	11 ... 30V DC	Dimensions	Ø 6.5 x 54 mm
No-load current, I <sub>0</sub>	≤ 10 mA	Enclosure rating	IP 65
Output current, I <sub>e</sub>	≤ 50 mA	Material, housing	Stainless steel V2A
Protective circuits	Reverse polarity protection, U <sub>B</sub> / short-circuit protection (Q) / overload protection	Material, front surface	PTFE
Power On Delay	< 300 ms	Type of connection	See Selection Table
Switching output, Q	PNP / NPN (see Selection Table)	Ambient temperature: operation	-10 ... +70 °C
Output function	N.O. / N.C. (see Selection Table)	Vibration and impact resistance	EN 60947-5-2
Switching frequency f (ti/tp 1:1)	100 Hz		

<sup>1</sup> 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)	Plug connection (non-flush)
 <p style="text-align: right;">153-00516</p>	 <p style="text-align: right;">153-00517</p>

Connection, 3-pin
 <p style="text-align: right;">154-00459</p>

Accessories	
Connection cables	From Page A-32
Brackets	From Page A-4



# KD/KL 08

## Capacitive sensor



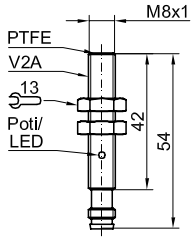
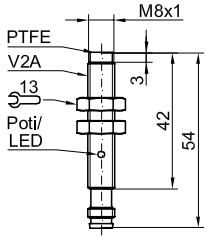
### PRODUCT HIGHLIGHTS

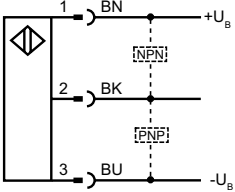
- Ideal for filling level measurements
- Robust stainless steel housings
- Optional N.O. or N.C. variants
- Flush or non-flush design options

Sensor data		Functions	
Switching distance (flush)	0.1 ... 1.5 mm	Indicator LED, yellow	Switching output indication
Switching distance (non-flush)	0.1 ... 3 mm	Sensitivity adjustment	Via potentiometer
Hysteresis	15 % <sup>1</sup>	Default settings	Max. switching distance
Repeatability	2 % <sup>1</sup>		
Temperature drift	15 % / °C <sup>1</sup> [-5 ... 55 °C]		
Electrical data		Mechanical data	
Operating voltage, +U <sub>B</sub>	11 ... 30V DC	Dimensions	M8 x 54 mm
No-load current, I <sub>0</sub>	≤ 10 mA	Enclosure rating	IP 65
Output current, I <sub>e</sub>	≤ 50 mA	Material, housing	Stainless steel V2A
Protective circuits	Reverse polarity protection, U <sub>B</sub> / short-circuit protection (Q) / overload protection	Material, front surface	PTFE
Power On Delay	< 300 ms	Type of connection	See Selection Table
Switching output, Q	PNP / NPN (see Selection Table)	Ambient temperature: operation	-10 ... +70 °C
Output function	N.O. / N.C. (see Selection Table)	Vibration and impact resistance	EN 60947-5-2
Switching frequency f (ti/tp 1:1)	100 Hz		

<sup>1</sup> 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)	Plug connection (non-flush)
 <p style="text-align: right;">153-00518</p>	 <p style="text-align: right;">153-00519</p>

Connection, 3-pin
 <p style="text-align: right;">154-00459</p>

Accessories	
Connection cables	From Page A-32
Brackets	From Page A-4

# KD/KL 12

## Capacitive sensor



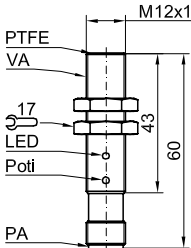
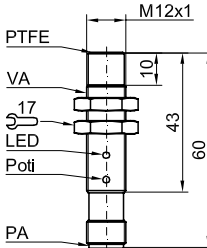
### PRODUCT HIGHLIGHTS

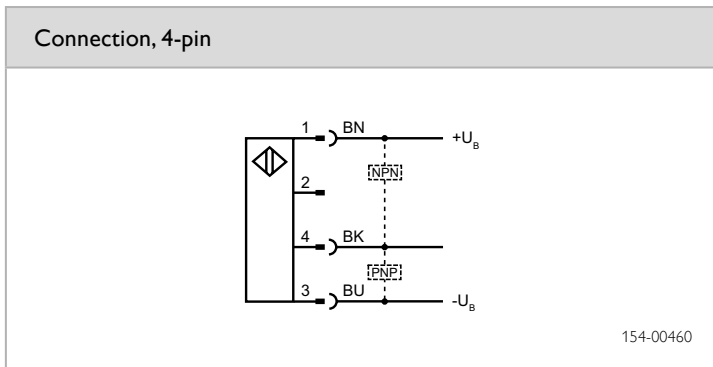
- Ideal for filling level measurements
- Robust stainless steel housings
- Optional N.O. or N.C. variants
- Flush or non-flush design options

Sensor data		Functions	
Switching distance (flush)	1 ... 4 mm	Indicator LED, yellow	Switching output indication
Switching distance (non-flush)	1 ... 8 mm	Sensitivity adjustment	Via potentiometer
Hysteresis	15 % <sup>1</sup>	Default settings	Max. switching distance
Repeatability	2 % <sup>1</sup>		
Temperature drift (flush)	20 % / °C <sup>1</sup> [-5 ... 55°C]		
Temperature drift (non-flush)	15 % / °C <sup>1</sup> [-5 ... 55°C]		
Electrical data		Mechanical data	
Operating voltage, +U <sub>B</sub>	12 ... 35 V DC	Dimensions	M12 × 60 mm
No-load current, I <sub>0</sub>	≤ 10 mA	Enclosure rating	IP 65
Output current, I <sub>e</sub>	≤ 200 mA	Material, housing	Stainless steel VA
Protective circuits	Reverse polarity protection. U <sub>B</sub> / short-circuit protection (Q) / overload protection	Material, front surface	PTFE
Power On Delay	< 300 ms	Type of connection	See Selection Table
Switching output, Q	PNP / NPN (see Selection Table)	Ambient temperature: operation	-30 ... +70 °C
Output function	N.O. / N.C. (see Selection Table)	Vibration and impact resistance	EN 60947-5-2
Switching frequency f (ti/tp 1:1)	100 Hz		

<sup>1</sup> 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)	Plug connection (non-flush)
 <p style="text-align: right;">153-00520</p>	 <p style="text-align: right;">153-00521</p>



Accessories	
Connection cables	From Page A-32
Brackets	From Page A-4

# KD/KL 18

## Capacitive sensor



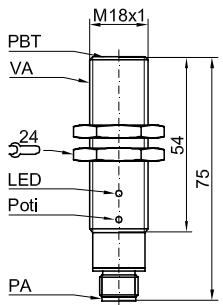
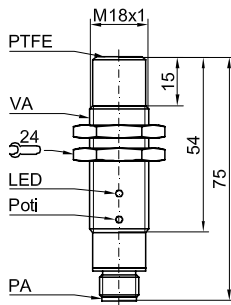
### PRODUCT HIGHLIGHTS

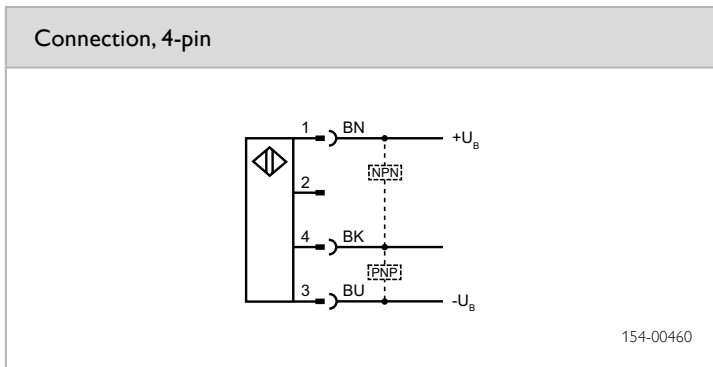
- Ideal for filling level measurements
- Robust stainless steel housings
- Optional N.O. or N.C. variants
- Flush or non-flush design options

Sensor data		Functions	
Switching distance (flush)	2 ... 8 mm	Indicator LED, yellow	Switching output indication
Switching distance (non-flush)	2 ... 15 mm	Sensitivity adjustment	Via potentiometer
Hysteresis	15 % <sup>1</sup>	Default settings	Max. switching distance
Repeatability	2 % <sup>1</sup>		
Temperature drift	15 % / °C <sup>1</sup> [-5 ... 55 °C]		
Electrical data		Mechanical data	
Operating voltage, +U <sub>B</sub>	10 ... 35 V DC	Dimensions	M18 x 75 mm
No-load current, I <sub>0</sub>	≤ 10 mA	Enclosure rating	IP 67
Output current, I <sub>e</sub>	≤ 300 mA	Material, housing	Stainless steel VA
Protective circuits	Reverse polarity protection, U <sub>B</sub> / short-circuit protection (Q) / overload protection	Material, front surface (flush)	PBT
Power On Delay	< 300 ms	Material, front surface (non-flush)	PTFE
Switching output, Q	PNP / NPN (see Selection Table)	Type of connection	See Selection Table
Output function	N.O. / N.C. (see Selection Table)	Ambient temperature: operation	-30 ... +70 °C
Switching frequency f (ti/tp 1:1)	100 Hz	Vibration and impact resistance	EN 60947-5-2

<sup>1</sup> Relating to switching distance

Switching distance	Installation	Switching output	Type of connection	Part number	Article number
2 ... 8 mm	Flush	PNP (N.O.)	Plug, M12x1, 4-pin	KD 18 B-PSL4	681-50926
2 ... 8 mm	Flush	PNP (N.C.)	Plug, M12x1, 4-pin	KD 18 B-POL4	681-50927
2 ... 8 mm	Flush	NPN (N.O.)	Plug, M12x1, 4-pin	KD 18 B-NSL4	681-50928
2 ... 8 mm	Flush	NPN (N.C.)	Plug, M12x1, 4-pin	KD 18 B-NOL4	681-50929
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

Plug connection (flush)	Plug connection (non-flush)
 <p style="text-align: right;">153-00522</p>	 <p style="text-align: right;">153-00523</p>



Accessories	
Connection cables	From Page A-32
Brackets	From Page A-4

# KD/KL 30

## Capacitive sensor



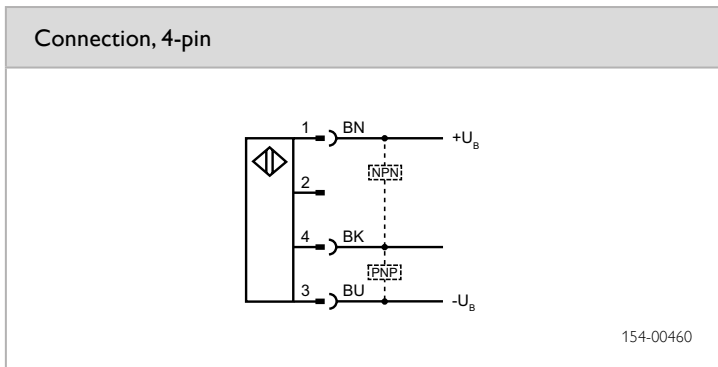
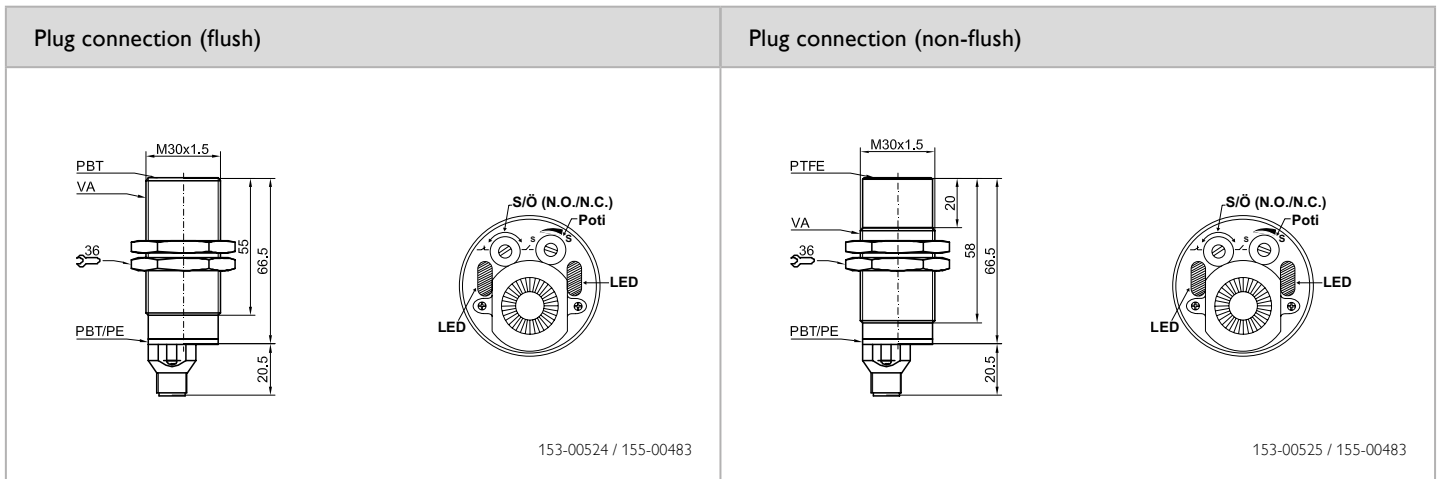
### PRODUCT HIGHLIGHTS

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

Sensor data		Functions	
Switching distance (flush)	1 ... 20 mm	Display LED, green	Operating voltage indicator
Switching distance (non-flush)	1 ... 30 mm	Indicator LED, yellow	Switching output indication
Hysteresis	15 % <sup>1</sup>	Sensitivity adjustment	Via potentiometer
Repeatability	5 % <sup>1</sup>	Adjustment possibilities	N.O. / N.C. via potentiometer
Temperature drift (flush)	10 % / °C <sup>1</sup> [-5 ... 55 °C]	Default settings	Max. switching distance and N.O.
Temperature drift (non-flush)	15 % / °C <sup>1</sup> [-5 ... 55 °C]		
Electrical data		Mechanical data	
Operating voltage, +U <sub>B</sub>	10 ... 35 V DC	Dimensions	M30 × 87 mm
No-load current, I <sub>0</sub>	≤ 15 mA	Enclosure rating	IP 64
Output current, I <sub>e</sub>	≤ 300 mA	Material, housing	Stainless steel VA
Protective circuits	Reverse polarity protection. U <sub>B</sub> / short-circuit protection (Q) / overload protection	Material, front surface (flush)	PBT
Power On Delay	< 300 ms	Material, front surface (non-flush)	PTFE
Switching output, Q	PNP / NPN (see Selection Table)	Type of connection	See Selection Table
Output function	N.O. / N.C.	Ambient temperature: operation	-30 ... +70 °C
Switching frequency f (ti/tp 1:1)	100 Hz	Vibration and impact resistance	EN 60947-5-2

<sup>1</sup> 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



Accessories	
Connection cables	From Page A-32
Brackets	From Page A-4