APPLICATIONS

Proximity switches can be used in many control functions and in particular they can operate even in the most arduous conditions exceeding the performance of any type of mechanical switch. The most frequent applications are:

- Limit switch without contact
- Detection of working pieces
- Sequence detection
- Detection of rotating or linear speed
- Incremental encoder function (2 sensors with 90° out of phase signals)
- Measurements of thickness and smoothness of metallic sheets (linear sensors)
- Detection of materials and alloys composition (linear sensors)

BENEFITS

The use of proximity sensors solves all the difficult problems of automation and detection in industrial and automotive places.

Compared to traditional mechanical micro-switches, they offer more advantages:

- No physical contact is required for operation
- Elimination of contact oxidation, due to solid state switching components
- No sparking of contacts; types ATEX Ex can operate in environments with explosive gas or inflammable liquids and solvents vapours
- Impermeableness against liquids, oils, powders, thanks to the resin clad
- High resistance against vibrations and impacts
- Very long life time thanks to non-electromechanical circuits
- No bounces on the switching edges
- Possibility of direct connecting to logical circuits and counters
- Almost unlimited life time non depending by the number of cycles

STANDARDS

Conformities CE

In accordance with the European Directives 2004/108/EC and 2006/95/EC, all products are in accordance with the rules for electromagnetic compatibility and safety standards for low voltage machinery.
These standards are met in accordance with EN60947-5-2.

Namur Sensors non-amplified

The non-amplified d.c. sensors are built according to EN60947-5-6 standards.

Amplified sensors

The amplified d.c. types (DCA and AC types) are manufactured according to EN60947-5-2.

ATEX sensors

For potentially explosive atmosphere applications a wide range of sensors is available certified according to the ATEX directive 94/9/EC. Please refere to the specific catalogue.

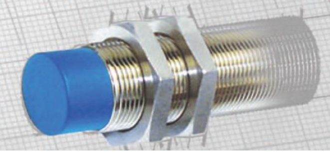
CABLE CHARACTERISTICS

All the standard sensor cables are manufactured from flexible PVC type with flammability resistance according to CEI 20-22 II - IEC 332.3A, with these characteristics:

- conductor formation according to VDE 0295 class 6
- insulation: PVC flammability resistance
- sheath: YM2 flammability resistance to VDE 0209/3.69

The standard cable length is 2 metres, however it is possible on request to have different cable lengths. It is also possible to have BDC sensors with PUR (polyurethane) sheath, particularly impervious against oils, acids or continuous stress. The cables can also be supplied with insulation and thermoplastic elastomer sheath (TPE-O) for temperatures from - 40° up to +140° C (sensors for high-low temperatures).

BDC Electronic - Viale Lidice, 37/39 - 10095 Grugliasco (To) - Italy -Tel. (+39)011.31.49.021/022 Fax (+39) 011.31.49.023 - www.bdcelectronic.com - E-mail:bdc@bdcelectronic.com



RESISTANCE TO MECHANICAL SHOCK AND VIBRATION

Shock by EN 60068-2-27

- Max acceleration: 50 g
- Impulse time: 11 ms

Vibrations to EN 60068-2-6

- Frequency range: 10 ÷ 55 Hz
- Amplitude: ± 2 mm.

DEGREE OF PROTECTION

According to EN60529
IP 6X: against ingress of dust-tight.
IP 65: water jets from all directions.
IP 67: immersion for 30 min. under 1 m. depth of water.
IP 68: extended immersion in water at conditions agreed between user and manufacturer.
Please contact our technical office for further details.

According to DIN40050
IP 69K: high pressure/steam water jet cleaning.

DESCRIPTION OF THE TECHNICAL TERMS IN THE CATALOGUE

RATED OPERATING DISTANCE (S_n)

The rated operating distance is a nominal value used to designate the operating distance. Manufacturing tolerances and external factors are not taken into account. Fig. 1 shows the relation between the operating distance (S_n,S_r,S_a) and the hysteresis (H).

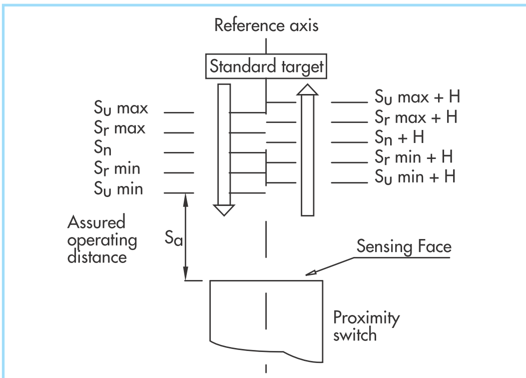


Fig. 1

STANDARD TARGET

The target used for the sensing distance is referenced to FE360 square steel sheet 1mm thick and with side the diameter of the circle on the active surface of the sensing face, or three times the rated operating distance Sn if this is more than the diameter. If the object to sense is of a different material, the rated operating distance is determined by multiplying the effective operating distance (Sr) by one of the following reduction factors:

Inductive Sensors

- stainless steel	0,3 ÷ 0,4
- brass	0,35 ÷ 0,50
- aluminum	0,35 ÷ 0,50
- copper	0,25 ÷ 0,45

Capacitive Sensors

- metal	1
- water	1
- PVC	0,5
- wood	0,25
- clothes	0,15
- paper	0,1

These reductions are not valid for the slot types, on which the switching point is almost indipendent of the metal used.

REAL OPERATING DISTANCE (S_r)

The real operating distance is measured with rated voltage and with a temperature of 23 ± 5°C. It must be between the 90% and 110% of the rated operating distance (S_n):

$$0{,}9\ S_n \leq S_r \leq 1{,}1\ S_n$$

GUARANTEED OPERATING DISTANCE (S_a)

This represents the safe sensing distance considering the manufacturing tolerances and the voltage and temperature changes. For the inductive proximity switches the guaranteed operating distance is between 0 and 81% of the rated operating distance (S_n):

$$0 \leq S_a \leq 0{,}81\ S_n$$

For the capacitive proximity switches the assured operating distance is between 0 and 72% of the rated operating distance (S_n):

$$0 \leq S_a \leq 0{,}72\ S_n$$

DIFFERENTIAL TRAVEL OR HYSTERESIS (H)

The differential travel is the difference between the switch-on point and the switch-off point with an axial motion of the target.

This is given as a percentage of the real operating distance (S_r) with a temperature of 23 ± 5°C and is shown in the tables. That value is never greater than the 15% of the real operating distance (S_r).

REPEAT ACCURACY (R)

The repeat accuracy (R) is the maximum variation, in percentage, of the effective operating distance (S_r) performing several switching cycles in 8 hours with a temperature of 23 ± 5°C and power supply changes of ± 5%.
The differences between measurments will never be greater than the 10% of the real operating distance:

$$R \leq 0{,}1 \cdot S_r$$

MAX SWITCHING FREQUENCY (f)

The max switching frequency specified in the tables of the products, is measured according to fig. 2.

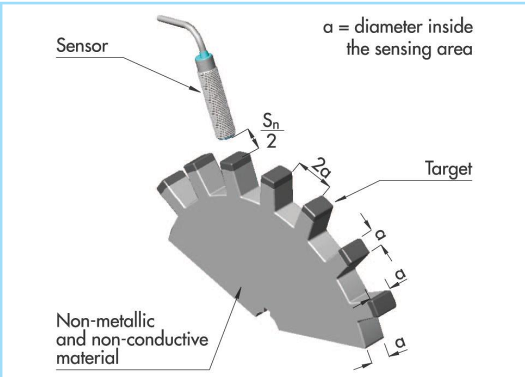


Fig. 2

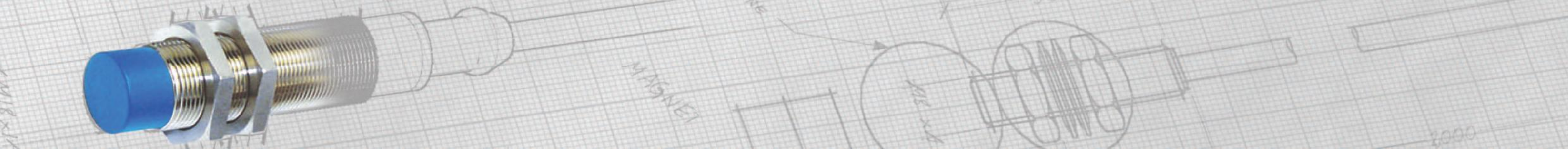
OPERATIONAL VOLTAGE (U_B)

This is the voltage range where the device will work correctly. It includes ripples and oscillations.

VOLTAGE DROP (U_d)

This is the voltage measured at the end of the active output of the sensor when it is passing the rated operational current (I_e).

BDC Electronic - Viale Lidice, 37/39 - 10095 Grugliasco (To) - Italy -Tel. (+39)011.31.49.021/022 Fax (+39) 011.31.49.023 - www.bdcelectronic.com - E-mail:bdc@bdcelectronic.com



RATED OPERATIONAL CURRENT (I_e)

This is the maximum load current which the sensor can continuously pass at the specified temperature and operational voltage range.

OFF-STATE CURRENT (I_r)

This is the current which flows through the 2-wire amplified sensors in the off condition. It is recommended to check that this current doesn't exceed the minimum activation current of the load.

MINIMUM OPERATIONAL CURRENT (I_m)

This is the minimum current needed for a proper functioning of the 2-wire amplified sensors in on condition.

IMPULSE WITHSTAND VOLTAGE

All sensors are protected against the overvoltages coming from the supply line or from the load. The minimum value is 1KV and is tested according to EN60947-5-2 standards.

CHARACTERISTIC OF THE OUTPUT STAGES

NON AMPLIFIED IN d.c. NAMUR SERIES

The sensors of this series contain only the oscillator stage and an output filter. This allows the reduction of space and costs. Thanks to a small number of components and being used with low currents, these sensors ensure a very high reliability. The driving of a load is possible using them with a proper amplifier (AM… series. See section G) or connected to equipment with specific input stage for NAMUR devices.
ATEX sensors category 1G - 1D must be used with associated apparatus with ATEX certification.

Working:
With references to fig. 3, apply Un between 5 and 30 Volts: the **I** current flows through the sensor crossing the **Rx** resistance giving the **Vo** voltage. The current value will decrease in proportion to how a metal approaches its sensible surface, following the characteristic curve shown.
With Vo voltage we can control a trigger stage having then an exact switching point and giving an ON/OFF output. For the scaling of Rx look the table below:

Un (V)	Rx (Ω)
5	390
8,2	1000
12	1800
24	3900

It's important to consider that the NAMUR rules recommend the applications of these sensors in a supply range between 7,7 and 9 Vdc with an Rx of 1000 Ω.

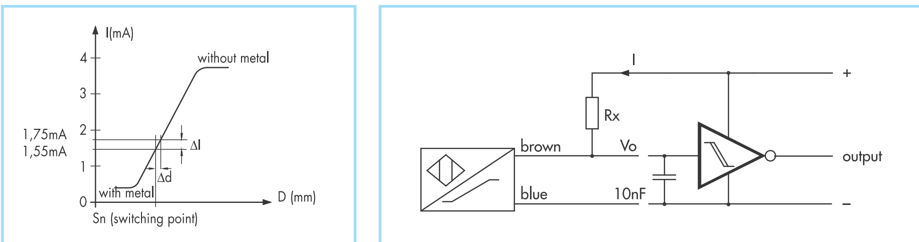


Fig. 3

NAMUR WITH LED SERIES

This series has a LED for the output condition and thanks to the integrated trigger, it has an exact switching point which permits the possibility to control PLC inputs and direct loads up to 10 mA without any interface module.

AMPLIFIED SERIES IN d.c. with 3 or 4-wire

The sensors in this series employ a power output stage with output protection (only K versions). They are suitable for direct driving of typical devices such as relays, PLC, contactors.

OUTPUT LOGIC

The choice for the output logic (NPN or PNP) depends on the connection type of load.

The typical output stages are shown in fig. 4. Open collector versions are available upon request.

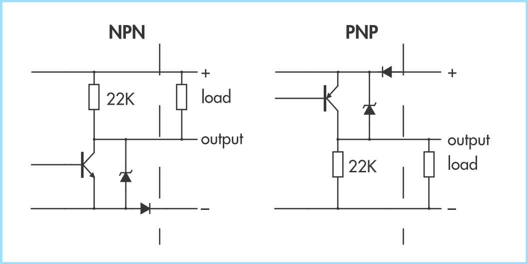


Fig. 4

PROTECTION AGAINST SHORT CIRCUIT

For the “K” version sensors, there is a protection against short circuits and overload in output stage. The protection is activated when the rated operational current is exceeded, blocking the current until there is a significant reduction. On d.c. sensors the sensor restarts to work as soon as the fault condition is removed. On a.c. sensors the power supply must be disconnected in order to reset the protection stage. In some cases the protection can be triggered because of high capacitive loads, like filter capacitors higher than 100 nF or lamps. In this case we recommend to use our specific proximity switches.

SERIES CONNECTION: AND LOGIC

With this connection the load is powered only when all switches are closed. The number of switches which can be connected in this way is limited by three factors:

1) from the residual voltage drop typical of selected switch, which is 2,2V (max for some types) at maximum load current;

2) from the maximum load current of switches employed, because it’s important to consider that the self consumption of each sensor must be added to the final load.

3) from the delay time of availability. For each sensor there can be a maximum delay of 30 ms. which has to be multiplied for the number of sensors used.

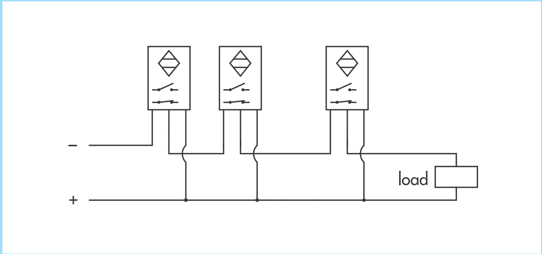


Fig. 5
Example of series connection with NPN sensors.

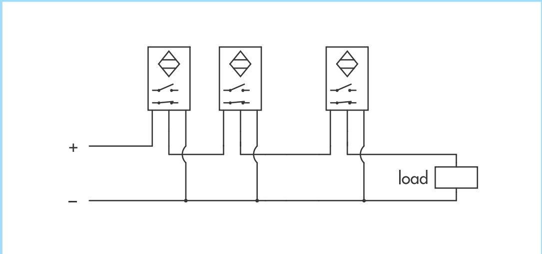
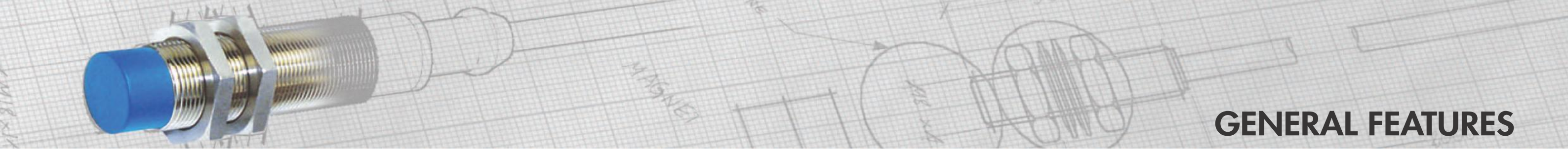


Fig. 6
Example of series connection with PNP sensors.

BDC Electronic - Viale Lidice, 37/39 - 10095 Grugliasco (To) - Italy -Tel. (+39)011.31.49.021/022 Fax (+39) 011.31.49.023 - www.bdcelectronic.com - E-mail:bdc@bdcelectronic.com



PARALLEL CONNECTION: OR LOGIC

With this type of connection, the load is powered whenever any of the switches are closed (or its output is conducting). In switches which are parallel connected, it must be considered that every connected sensor is loaded by other sensors internal resistor (collector resistor RC). It is possible to avoid this, using open collector types, or by introducing decoupling diodes as shown in fig 7-8.

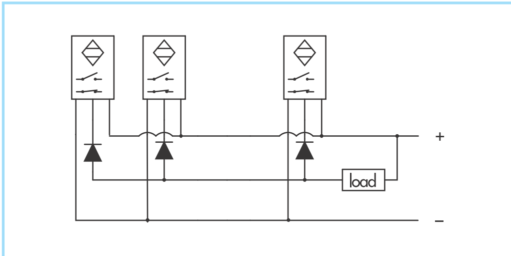


Fig. 7
Example of parallel connection with NPN sensors.

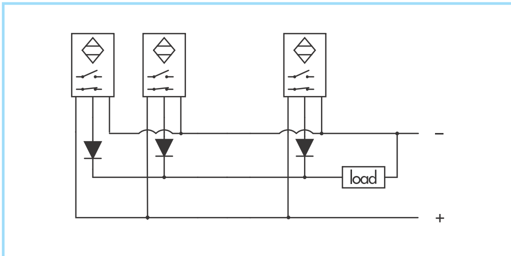


Fig. 8
Example of parallel connection with PNP sensors.

AMPLIFIED SERIES IN d.c. or a.c.

They are connected in series to the load like electro-mechanical micro-switches. It's important to verify that, after subtracting the voltage drop (U_d) from the supply voltage (U_B), there is sufficient voltage to drive the load correctly. Another important factor in this sensor is the minimum operational current (Im), below which the sensor doesn't work properly. In open conditions, there will always be a Off-state current (I_r) which will go through the load: it is important to make sure that this current will not activate the load.
If this happens it will be necessary to connect a resistor in parallel to the load itself.

SERIES CONNECTION: AND LOGIC

If several sensors must be connected in series, it is necessary to verify that summing all the sensors voltage drops the load continues to have sufficient voltage for the correct functioning. One must also consider that in the open condition the supply voltage is divided by the number of sensors: make sure that on each sensor there is a voltage greater than the minimum value of UB.

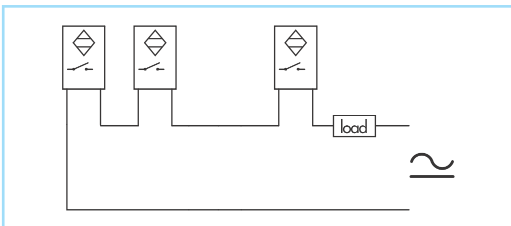


Fig. 9
Example of series connection with
2-wire amplified sensors.

AMPLIFIED SERIES IN a.c. 3-wire + earth

This series of sensors (ACB, ACBF) is suitable to solve minimum load, residual current and voltage drop problems typical on 2-wire series. They have two wires for supply, one for the output and one for the earth connection.

Their connection is similar to the amplified models in d.c. (fig. 10).

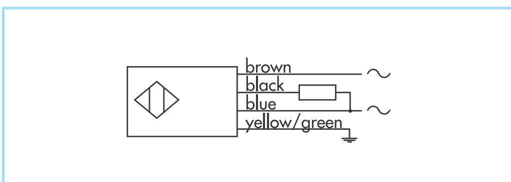


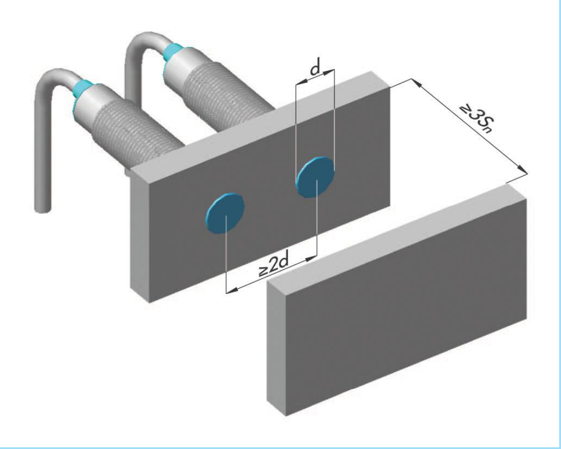
Fig. 10

MOUNTING PRECAUTIONS

Although sensors are made to resist to the most difficult conditions of use, it is recommended:

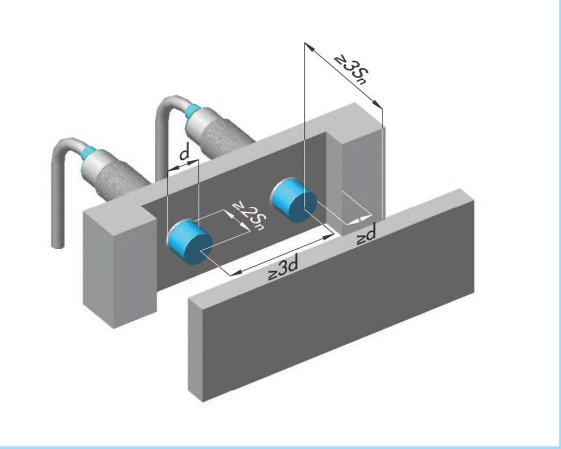
- not to wire sensors connections along with power conductors. Use of separated cable routing is recommended.
- never exceed the maximum of the fixing torque recommended for the fasteners. Bear in mind in addition that the threaded zone next to the sensing head on cylindrical products is less resistant than the rest of the body.
- make sure the product doesn't contact corrosive agents, oils, aggressive solvents, etc. Call our technical office to have further guidance on the resistance of materials to the various substances.
- avoid shocks and abrasive actions on the sensible face of the products: this area represents the most fragile zone of the device.
- the power supply circuit for sensors must be provided with suitable insulation and current limitation means.
- never use devices for the safety of machineries or people if they are not specifically recommended for that purpose. Contact our technical offices for more details.

CYLINDRICAL SENSORS



Totally shielded: flush mounting

Sensors are not influenced by surrounding metals.
However it's recommended to keep a distance between adjacent sensors to avoid interferences.
If this isn't possible, it's recommended the use of sensors with different frequencies for mounting alongside each other.



Unshielded: non flush mounting

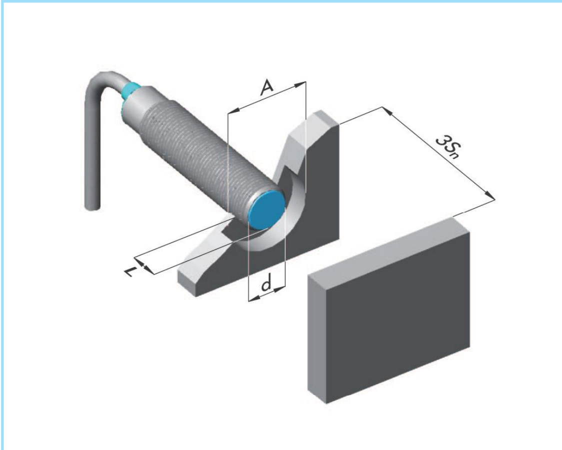
Sensors can be influenced by surrounding metals. A distance ≥ 3 d between adjacent sensors is needed. For extended sensing distance versions a distance at least ≥ 4d is recommended.

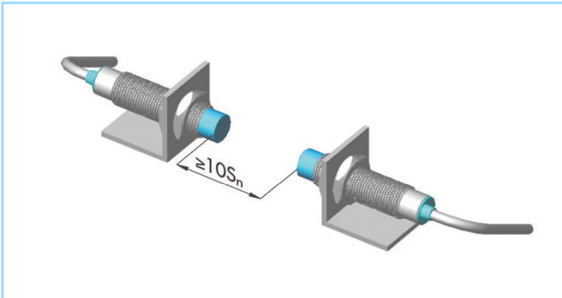
BDC Electronic - Viale Lidice, 37/39 - 10095 Grugliasco (To) - Italy -Tel. (+39)011.31.49.021/022 Fax (+39) 011.31.49.023 - www.bdcelectronic.com - E-mail:bdc@bdcelectronic.com

Extended sensing distance and stainless steel sensing face versions: quasi flush mounting

These sensors, because of their high sensitivity, are slightly sensitive to surrounding ferromagnetic metals which can reduce their sensing distance. To avoid this effect it's recommended to mount the sensor as indicated by the diagrams and charts shown.

Sensor diameter d (mm)	L min. (mm)	A min. (mm)
6,5 - 8	1,5	12
12	2,4	18
18	3,6	28
30	8	45

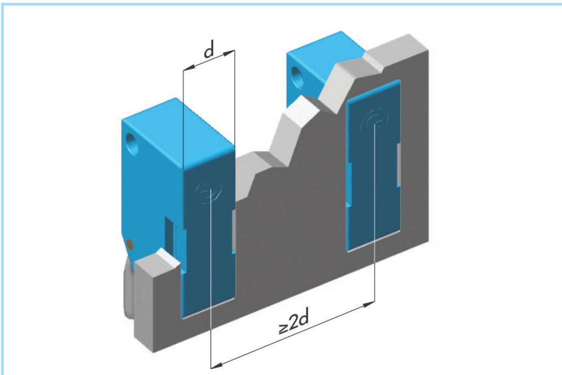




Opposed mounting of two sensors

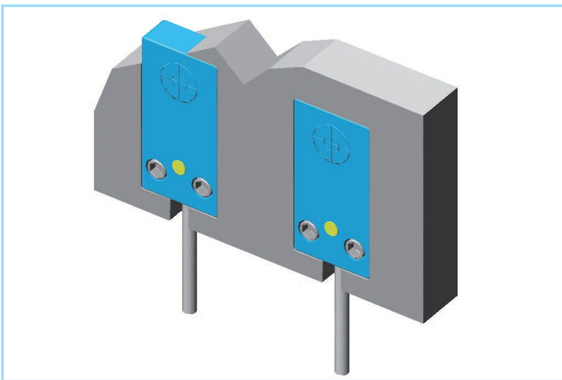
A minimum distance of 10 S_n ensures non interference between electromagnetic fields.

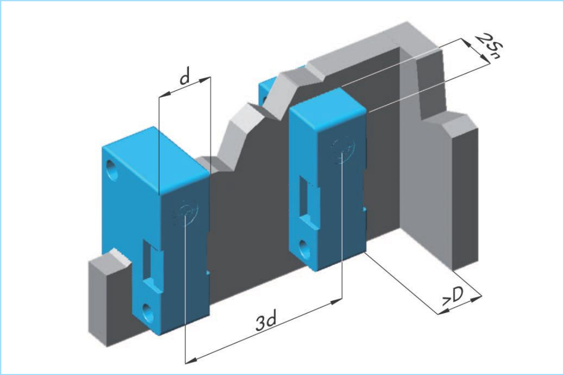
RECTANGULAR SENSORS



Totally shielded: flush mounting

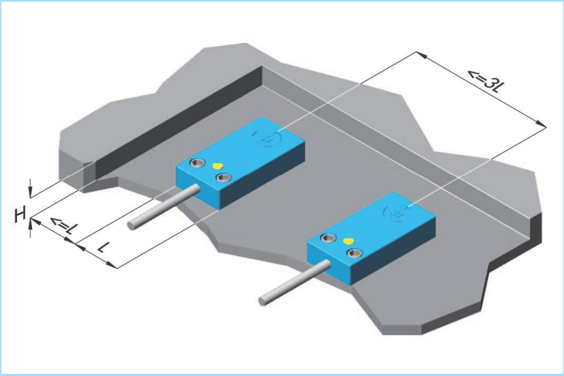
Sensors are not influenced by surrounding metals. However it's recommended to keep a distance between adjacent sensors to avoid interferences. If this isn't possible, it's recommended to use sensors with different frequencies when mounting side by side.

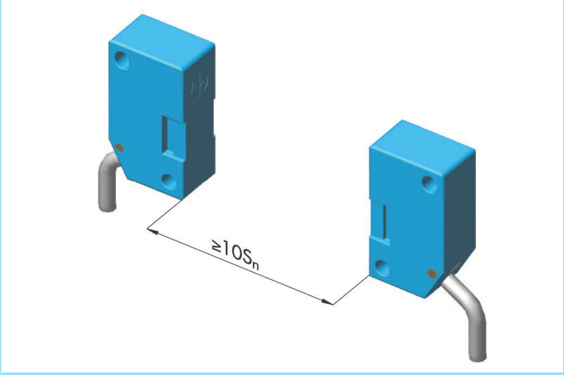




Unshielded: non flush mounting

Sensors can be influenced by surrounding metals.
It's necessary to have more space between adjacent sensors.

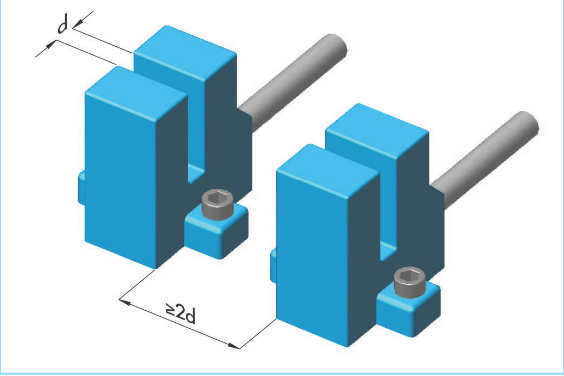




Opposed mounting of two sensors

A minimum distance of 10 S_n ensures non interference between electromagnetic fields.

SLOT SENSORS

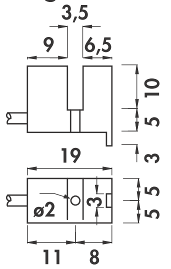


It's recommended to keep a distance of twice the slot width (d) between adjacent sensors.

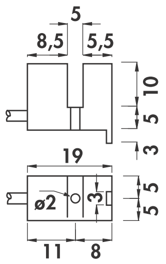
BDC Electronic - Viale Lidice, 37/39 - 10095 Grugliasco (To) - Italy -Tel. (+39)011.31.49.021/022 Fax (+39) 011.31.49.023 - www.bdcelectronic.com - E-mail:bdc@bdcelectronic.com

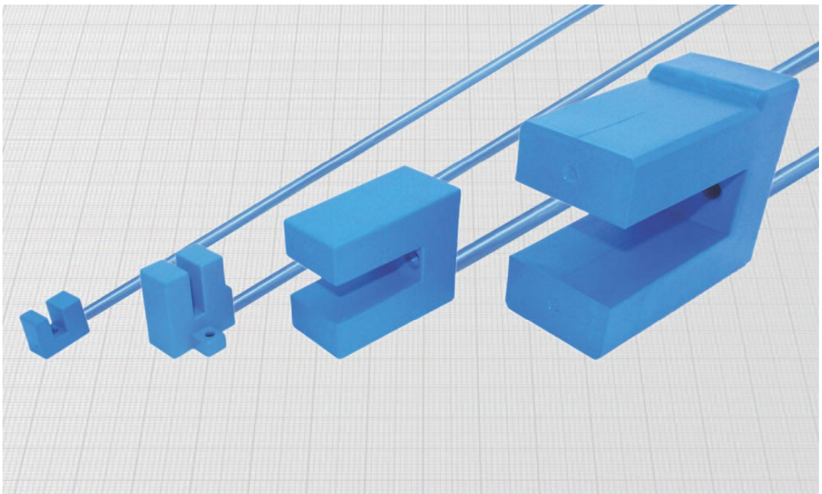
• NAMUR SERIES
• Non-amplified in d.c. 2-wire
• Cable output

Housing U

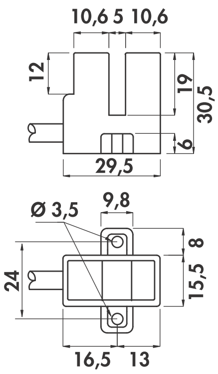


Housing Q

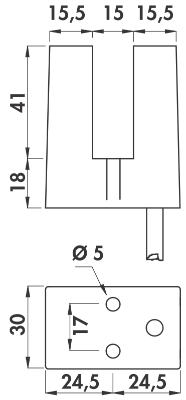




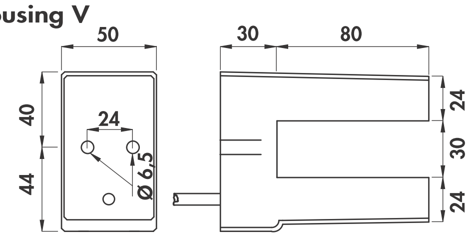
Housing S



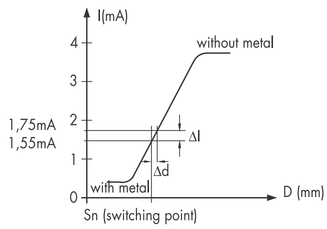
Housing T



Housing V



Typical curve

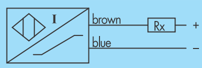


Materials:

- Cable: 2 m PVC CEI 20 - 22 II; 90°C; 300 V; O.R.
- Housing: plastic
- Screw and nut (included on DF3,5… and DF5…) brass

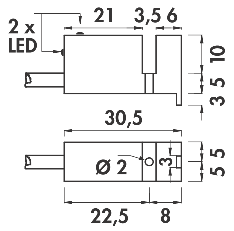
Technical data:

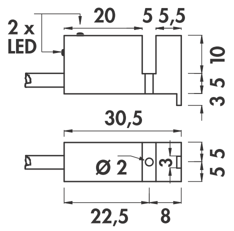
- Working voltage: 5 ÷ 30 Vdc
- Supply voltage according to NAMUR: 7,7 ÷ 9 Vdc
- Max ripple: 10%
- Consumption at 8,2 V con Rx = 1000 Ω
  - with metal: ≤ 1 mA
  - without metal: ≥ 3 mA
- Temperature range: - 25° ÷ + 70°C
- Max thermal drift of sensing distance S_r: ± 10%
- Repeat accuracy (R): 2%
- Degree of protection: IP67
- Cable conductor cross section: 0,15 mm^2 on DF3,5/… and DF5/… 0,75 mm^2 on DF6/…, DF15/… and DF30/…
- According to EN60947-5-6
- Electromagnetic compatibility (EMC) according to EN60947-5-2 CE
- Shock and vibration resistance according to EN60068-2-27 EN60068-2-6
- For certified ATEX version see ATEX Catalogue

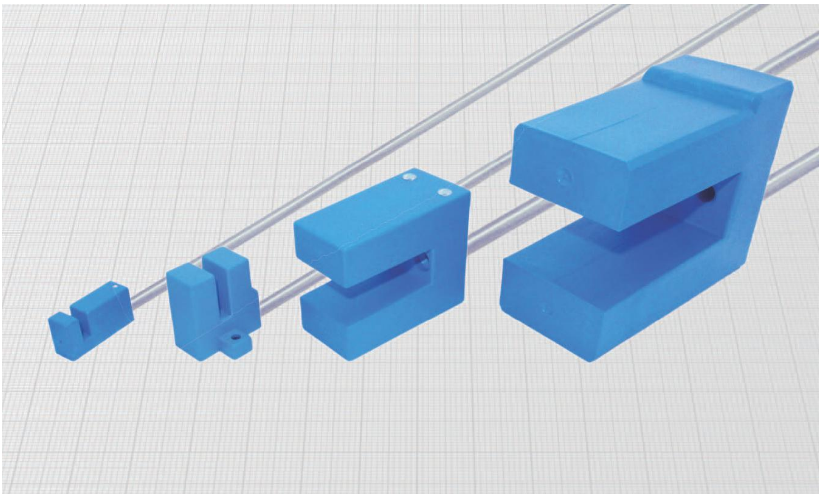
Housing	Cable diameter	Slot width	Max switching frequency (f)	Minimum penetration	ORDERING REFERENCES
	mm	mm	KHz	mm	
U	3	3,5	3	5	**DF3,5/4600**
Q	3	5	3	5	**DF5/4600**
S	5	5	1	9	**DF6/4600**
T	5	15	0,8	16	**DF15/4600**
V	5	30	0,3	30	**DF30/4600**

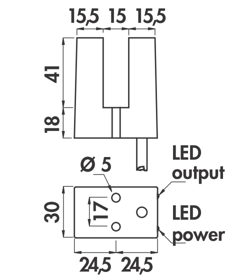
BDC Electronic - Viale Lidice, 37/39 - 10095 Grugliasco (To) - Italy -Tel. (+39)011.31.49.021/022 Fax (+39) 011.31.49.023 - www.bdcelectronic.com - E-mail:bdc@bdcelectronic.com

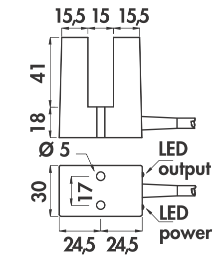
Slot width 3,5 - 30 mm •
Amplified in d.c. 3 and 4-wire •
Cable output •

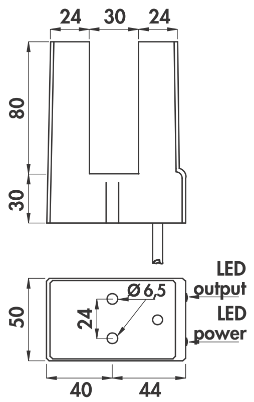
Housing Z


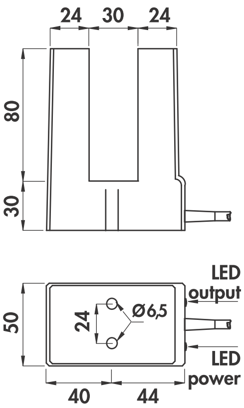
Housing R




Housing T


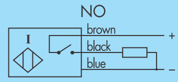
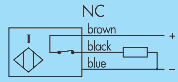
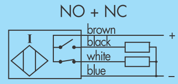
Housing T -1


Housing V


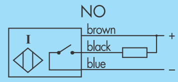
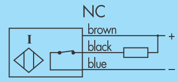
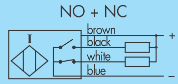
Housing V -1


Materials:
- Cable: 2 m PVC CEI 20 - 22 II; 90°C; 300 V; O.R.
- Housing: plastic
- Screw and nut (included on mod. DF3,5… and DF5…) brass

Technical data:
- Supply voltage(U_B) tipi DCF3,5/… and DCF5/… 10 ÷ 30 Vdc
- Supply voltage (U_B) tipi DCF15/… and DCF30/… 10 ÷ 60 Vdc
- Max ripple: 10%
- No-load supply current (I_o): ≤ 10 mA
- Voltage drop (U_d): ≤ 2,2 V
- Temperature range: - 25° ÷ + 70°C
- Max thermal drift of sensing distance S_r: ± 10%
- Repeat accuracy (R): 2%
- Switching hysteresis (H): 10%
- Degree of protection: IP67
- Switch status indicator: yellow LED
- Cable conductor cross section
  0,22 mm^2 on DCF3,5/… and DCF5/…
  0,50 mm^2 on DCF15/… and DCF30/…
- Protected against short-circuit and overload (versions with letter K)
- Protected against any wrong connection
- Suppression of initial false impulse
- Electromagnetic compatibility (EMC) according to EN60947-5-2 CE
- Shock and vibration resistance according to EN60068-2-27 EN60068-2-6

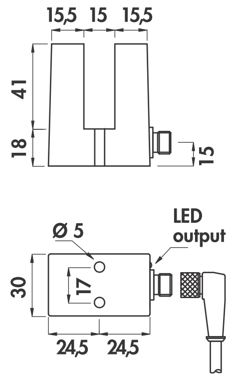
Housing	Cable diameter	Slot width	Rated operational current (I_e)	Max switching frequency (f)	Minimum penetration	ORDERING REFERENCES – PNP (positive switching) NO	NC	NO + NC
	mm	mm	mA	KHz	mm			
Z	3,5	3,5	200	1	5	**DCF3,5/4609KS**	**DCF3,5/4619KS**	**DCF3,5/4629KS**
R	3,5	5	200	1	5	**DCF5/4609KS**	**DCF5/4619KS**	**DCF5/4629KS**
T	6	15	400	0,5	16	**DCF15/4609KS**	**DCF15/4619KS**	**DCF15/4629KS**
T - 1	6	15	400	0,5	16	**DCF15/4L09KS**	**DCF15/4L19KS**	**DCF15/4L29KS**
V	6	30	400	0,2	30	**DCF30/4609KS**	**DCF30/4619KS**	**DCF30/4629KS**
V - 1	6	30	400	0,2	30	**DCF30/4L09KS**	**DCF30/4L19KS**	**DCF30/4L29KS**

NPN (negative switching)
Use the above mentioned part number changing the last number 9 with 8 (ie. DCF3,5/4608KS)

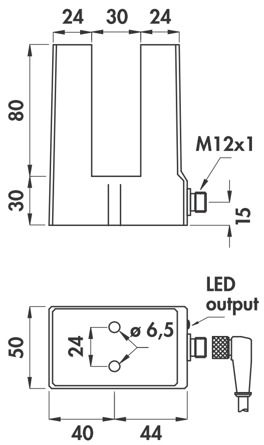
NO	NC	NO + NC
		

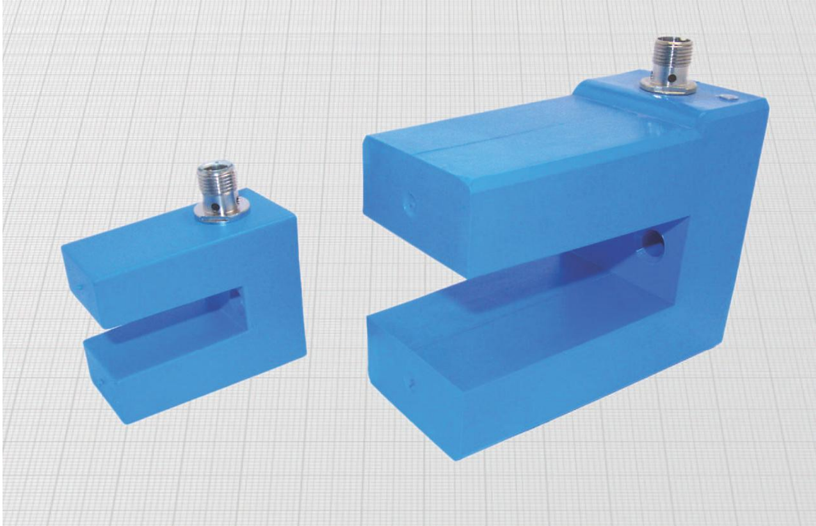
- **Slot width 15 - 30 mm**
- **Amplified in d.c.**
- Connector output M12 x 1

Housing X



Housing Y



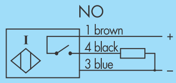
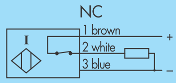
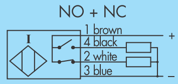


Materials:

- Housing: plastic
- Connector: nickel plated brass

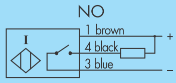
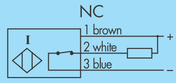
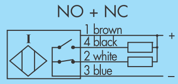
Technical data:

- Supply voltage (U_B): 10 ÷ 60 Vdc
- Max ripple: 10%
- No-load supply current (I_o): ≤ 10 mA
- Voltage drop (U_d): ≤ 2,2 V
- Temperature range: - 25° ÷ + 70°C
- Max thermal drift of sensing distance S_r: ± 10%
- Repeat accuracy (R): 2%
- Switching hysteresis (H): 10%
- Degree of protection con connettori costampati: IP67
- Switch status indicator: yellow LED
- Protected against short-circuit and overload
- Protected against any wrong connection
- Suppression of initial false impulse
- Electromagnetic compatibility (EMC) according to EN60947-5-2 CE
- Shock and vibration resistance according to EN60068-2-27 EN60068-2-6

Housing	Female connector	Slot width	Rated operational current (I_e)	Max switching frequency (f)	Minimum penetration	ORDERING REFERENCES PNP (positive switching) NO	 NC	 NO + NC
	n°	mm	mA	KHz	mm			
X	6 - 8B - 10	15	400	0,5	16	**DCF15/4309KS**	**DCF15/43C9KS**	**DCF15/4329KS**
Y	6 - 8B - 10	30	400	0,2	30	**DCF30/4309KS**	**DCF30/43C9KS**	**DCF30/4329KS**

NPN (negative switching)

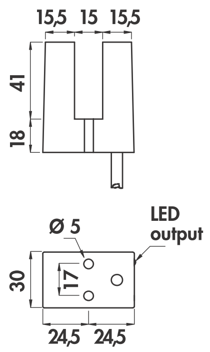
Use the above mentioned part number changing the last number 9 with 8 (ie. DCF15/4308KS)

NO	NC	NO + NC
		

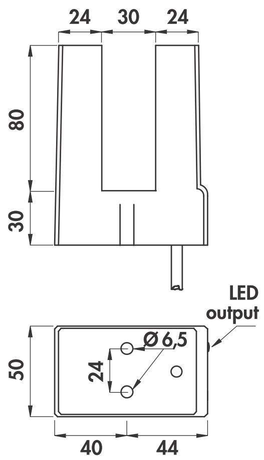
BDC Electronic - Viale Lidice, 37/39 - 10095 Grugliasco (To) - Italy -Tel. (+39)011.31.49.021/022 Fax (+39) 011.31.49.023 - www.bdcelectronic.com - E-mail:bdc@bdcelectronic.com

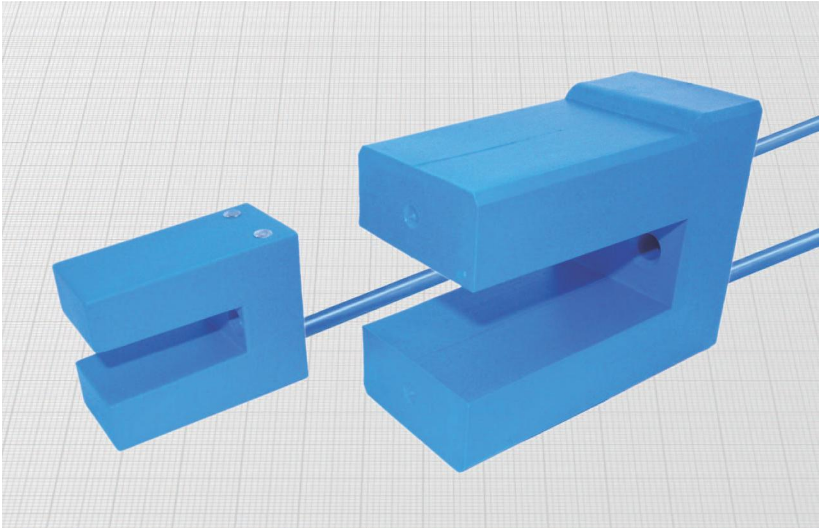
Slot width 15 - 30 mm •
Amplified in a.c. 2-wire •
Cable output •

Housing T



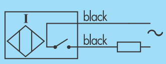
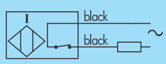
Housing V





Materials:
- Cable: 2 m PVC CEI 20 - 22 II; 90°C; 300 V; O.R.
- Housing: plastic

Technical data:
- Supply voltage (U_B): 20 ÷ 240 Vac
- Electrical system frequency: 40 ÷ 60 Hz
- Off-state current (I_r): ≤1,5 mA at 110 Vac
- Minimum operational current (I_m): 5 mA
- Voltage drop (U_d): ≤ 5 V
- Temperature range: - 25° ÷ + 70°C
- Max thermal drift of sensing distance S_r: ± 10%
- Repeat accuracy (R): 2%
- Switching hysteresis (H): 10%
- Degree of protection: IP67
- Switch status indicator: yellow LED
- Cable conductor cross section: 0,75 mm²
- Suppression of initial false impulse
- Class 2 equipment according to EN61140 ⧈
- Shock and vibration according to EN60068-2-27 EN60068-2-6
- Electromagnetic compatibility (EMC) according to EN60947-5-2 CE

Housing	Cable diameter	Slot width	Rated operational current (I_e)	Max switching frequency (f)	Minimum penetration	ORDERING REFERENCES	
						NO	NC
	mm	mm	mA	Hz	mm		
T	6	15	500	15	16	**ACF15/4609S**	**ACF15/4619S**
V	6	30	500	15	30	**ACF30/4609S**	**ACF30/4619S**