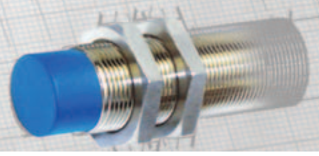


UTILIZATION OF SENSORS

More detailed explanations on the catalogue, at the beginning of each section.

INDUCTIVE SENSORS

Detection of metal objects

Advantages:

- Low cost
- Complete insensitivity to dust, grease, water, non-metal materials

CAPACITIVE PROXIMITY SENSORS

Detection of metal and non-metal objects

Advantages:

- Possibility to adjust the switching point
- Insensitivity to dust on the sensing area (in limited quantity)

MAGNETIC SENSORS

Detection of external magnets

Advantages:

- Very low cost
- High sensing distances with very small sensors
- High resistance under pressure

Detection of ferromagnetic objects

Advantages:

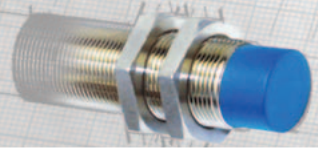
- Insensitivity to non ferromagnetic metals (aluminium, brass, copper, gold, silver…)

SPEED SENSORS

Detection of toothed wheels or holes

Advantages:

- Small teeth detection
- High switching frequency
- Very rugged construction
- High resistance to high temperatures and pressure
- Possibility of speed and direction detection with the same sensor
- Versions with integrated control and self-teaching thresholds



GENERAL FEATURES

APPLICATIONS

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

- Limit switch without contact
- Detection of working pieces
- Sequence detection
- Detection of rotating or sliding speed
- Incremental encoder function (2 sensors with 90° out of phase signals)
- Measurements of thickness and waviness 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, being only electronic components
- No sparking of contacts; types in execution Ex can work in places with explosive gas or inflammable liquids and solvents evaporations
- 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
- 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 the 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 produced of 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 (polyurethan cable) sheath, particularly safe 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).

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RESISTANCE TO MECHANICAL SHOCKS AND VIBRATIONS

Shock by EN 60068-2-27

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

Vibrations by EN 60068-2-6

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

DEGREE OF PROTECTION by EN60529

IP 65: spouting water from all directions.
IP 67: immersion for 30 min. in 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.

DESCRIPTION OF THE TECHNICAL TERMS IN THE CATALOGUE

RATED OPERATING DISTANCE (S_n)

The rated operating distance is a conventional quantity used to designate the operating distance. Manufacturing tolerances and external factors are not taken in account. In fig. 1 we can see the relation between the operating distance (S_n,S_r,S_a) and the hysteresis (H).

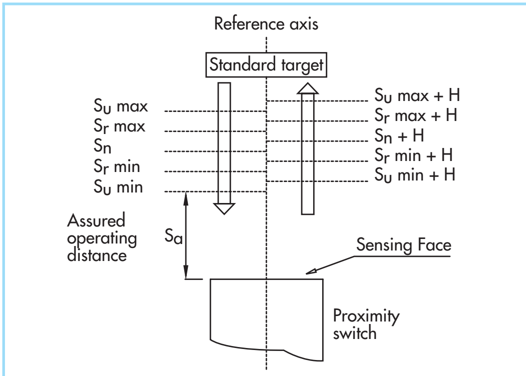

Fig. 1

STANDARD TARGET

The target used for the distance survey is built with an FE360 square steel sheet 1mm thick and on the side it is like the diameter of the circle on the active surface of the sensing face, or either three times the rated operating distance Sn if this is more than the diameter. If the object to survey is of a different material, you can have the rated operating distance by multiplying the effective operating distance (Sr) by one of these 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 by 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):

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

ASSURED OPERATING DISTANCE (S_a)

It represents the safe sensibility distance considering the constructive tolerances and the voltage and temperature changes. For the inductive proximity switches the assured 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. It's given as a percentage of the effective operating distance (S_r) with a temperature of 23 ± 5°C and is shown in the tables. That value is never over the 15% of the effective 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 any measures is never higher 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.

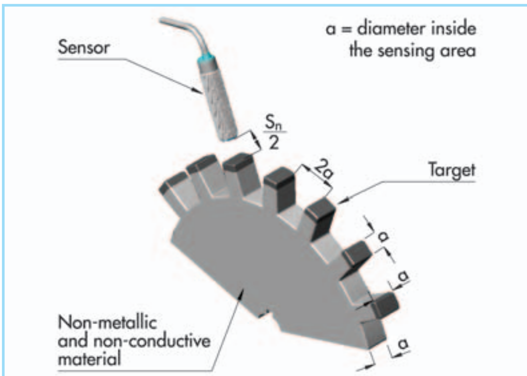

Fig. 2

OPERATIONAL VOLTAGE (U_B)

It's the voltage range where is ensured the proper working of the device. It includes ripples and oscillations.

VOLTAGE DROP (U_d)

It's the voltage measured at the end of the active output of the sensor when it is in on condition at the rated operational current (I_e).

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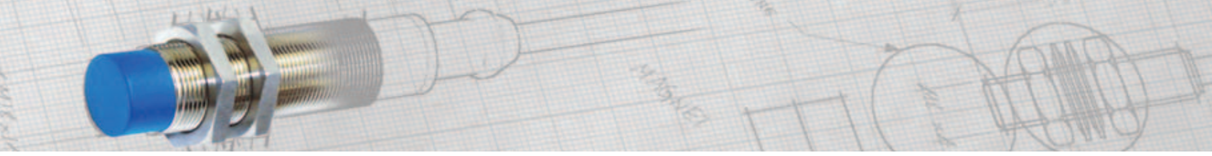

RATED OPERATIONAL CURRENT (I_e)

It's the load current which the sensor can withstand in all temperature and operational voltage range.

OFF-STATE CURRENT (I_r)

It's the current which flows through the 2 wire amplified sensors in 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)

It's the minimum current needed for a proper working 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.

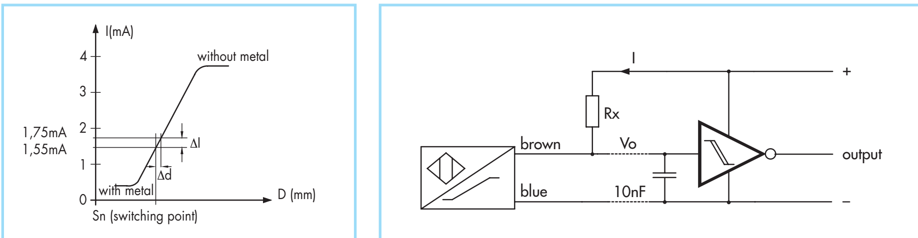

Fig. 3

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 to control PLC inputs and direct loads up to 10 mA without any interface module.

AMPLIFIED SERIES IN d.c. with 3 or 4 wires

The sensor of this series implements a power output stage and the outputs protection (only K versions). They are suitable for direct driving of typical devices such as relais, 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.

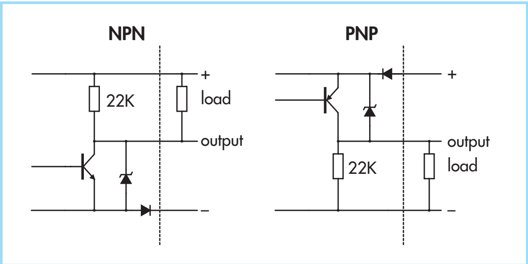

Fig. 4

PROTECTION AGAINST SHORT CIRCUIT

For the "K" version sensors, there is a protection against short circuits and overload in output. This protection starts to work at a value just a bit higher than the rated operational current, stopping the current until there is an excessive absorption. 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 taken off in order to reset the protection stage. In some cases the protection can start because of the high capacitive loads, like filter capacitors higher than 100 nF or either 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.

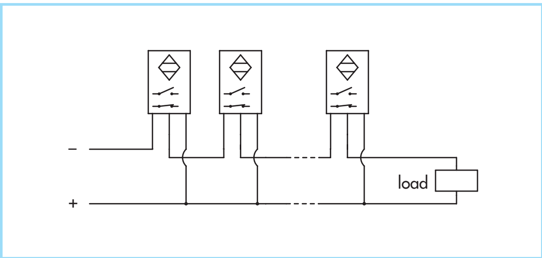

Fig. 5
Example of series connection with NPN sensors.

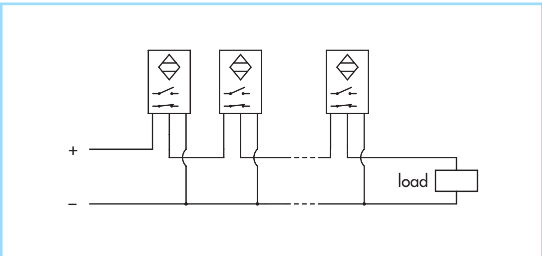

Fig. 6
Example of series connection with PNP sensors.

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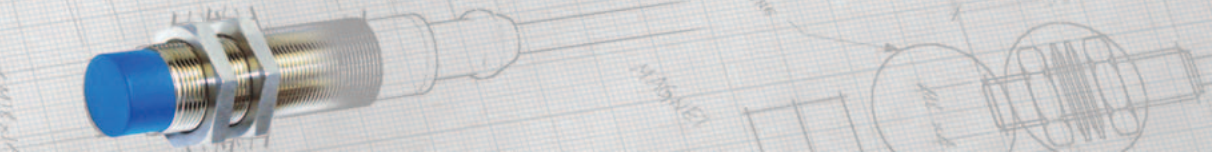


PARALLEL CONNECTION: OR LOGIC

With this type of connection, the load is powered whenever any of the switches is 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 putting some de-coupling diodes as shown in fig 7-8.

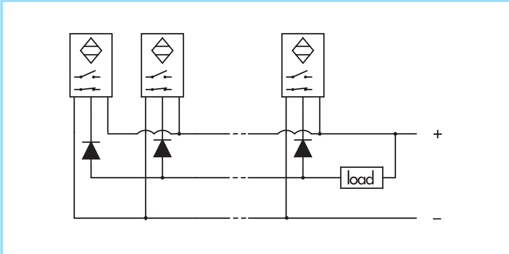


Fig. 7
Example of parallel connection with NPN sensors.

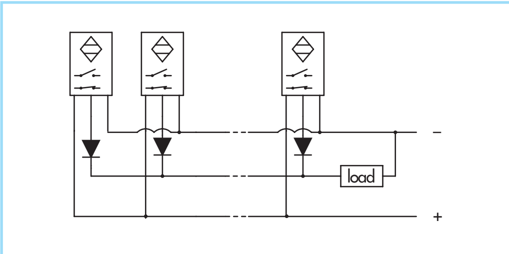


Fig. 8
Example of parallel connection with PNP sensors.

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, subtrahend the voltage drop (U_d) by the supply voltage (U_B), there is enough voltage on the load for a correct working.
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 across the load: make sure that the current isn't enough to keep the load active.
If this would happen it will be necessary to connect a resistance 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 sensor voltages drop the load continues to have sufficient voltage for the correct working. We 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 not lower than minimum value of UB.

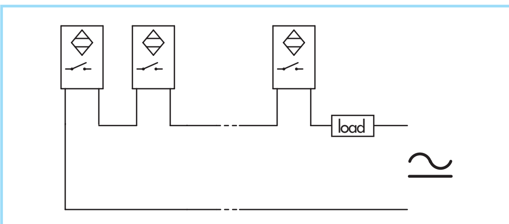


Fig. 9
Example of series connection with
2 wires amplified sensors.

AMPLIFIED SERIES IN a.c. 3 wires + earth

This series of sensors (ACB, ACBF) is suitable to solve minimum load, residual current and voltage drop problems typical on 2 wires series. They've got two wires for supply, one for the output and one for the earthing.

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

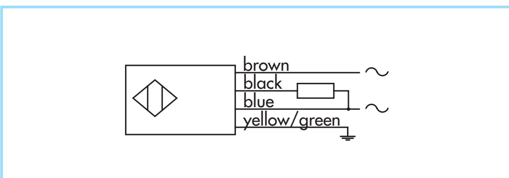


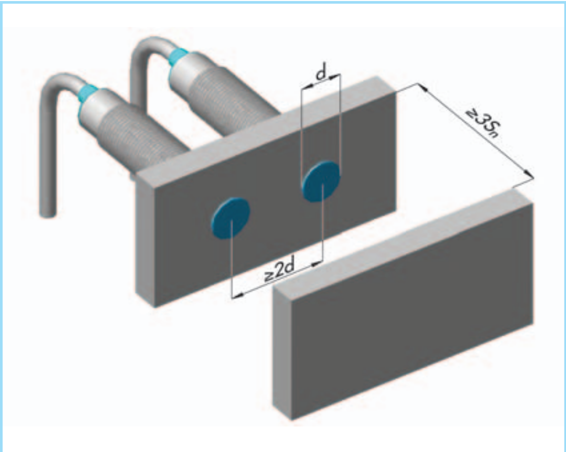
Fig. 10

MOUNTING PRECAUTIONS

Although sensors are made to resist to the most difficult use conditions, anyway we recommend you:

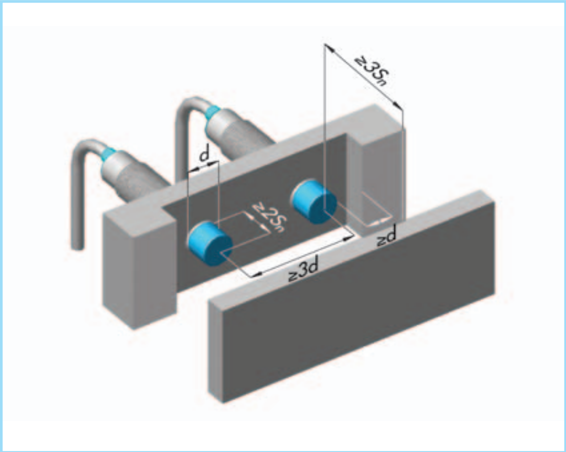
- not to wire sensors connections along with power conductors. Use of separated raceways is recommended.
- never exceed the maximum of the fixing torque recommended for the nuts fixing. Bear in mind in addition that the threaded zone next to the sensible head is less resistant than the rest of the body.
- make sure the product doesn't touch corrosive agents, oils, aggressive solvents, etc. Call our technical office to have further informations about the resistance of materials to the various substances.
- avoid shocks and abrasive actions on the sensible part of the sensors: this one represents the most fragile zone of the device.
- connect a high-speed fuse with appropriate value in series with the circuit if you use sensors without protection against short circuit.

CYLINDRICAL SENSORS



Totally shielded: flush mounting

Sensors are not influenced by surrounding metals.
However it's recommended to keep a distance between sensors placed side by side to avoid interferences.
If this isn't possible, it's recommended the use of sensors with differentiated frequencies for mounting in line.



Unshielded: non flush mounting

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

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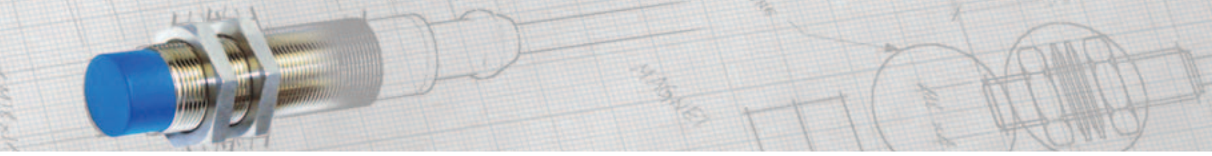
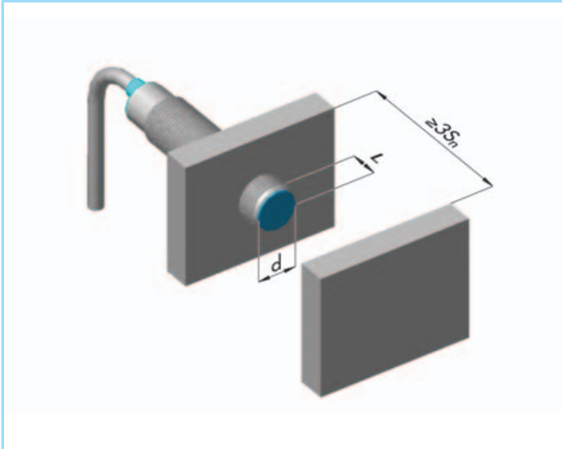
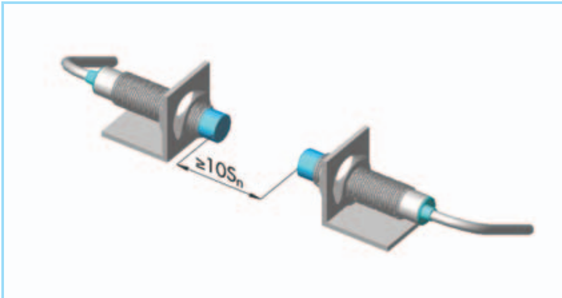


Extended sensing distance and stainless steel sensing face versions: quasi flush mounting

These sensors, because of their high sensitivity, are slightly sensible to surrounding ferromagnetic metals which can bring down their sensing distance. To avoid this effect it's advised to keep the sensor a little out from the plain for a lenght (L) indicated in the chart.

Sensor diameter (mm)	L
6,5 - 8	1,5
12	2,4
18	3,6
30	8

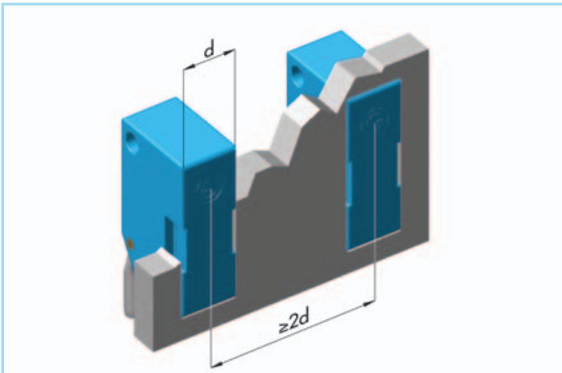




Opposed mounting of two sensors

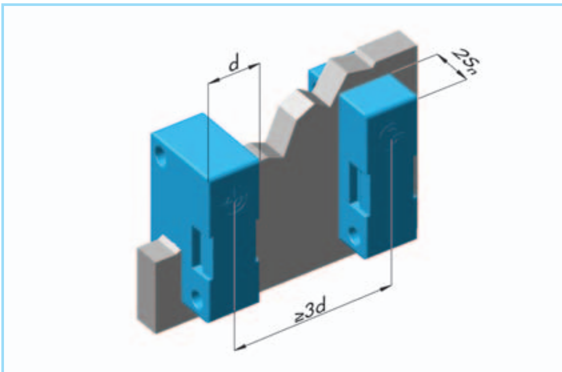
A security distance of 10 S_n avoids interferences between electromagnetic fields.

RECTANGULAR SENSORS



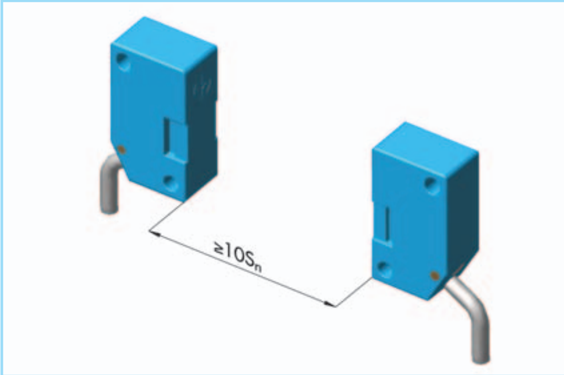
Totally shielded: flush mounting

Sensors are not influenced by surrounding metals. However it's recommended to keep a distance between sensors placed side by side to avoid interferences. If this isn't possible, it's recommended the use of sensors with differentiated frequencies for mounting in line.



Unshielded: non flush mounting

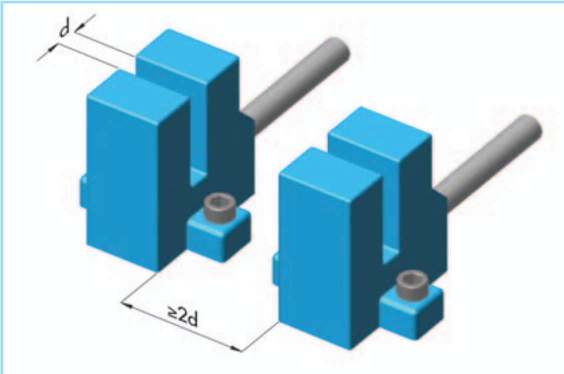
Sensors can be influenced by surrounding metals.
It's necessary to have more space between a sensor and the other.



Opposed mounting of two sensors

A safety distance of 10 S_n avoids interferences between electro-magnetic fields.

SLOT SENSORS



It's recommended to keep a distance of twice the gap (d).

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