Inductive proximity sensors

Presentation

Inductive proximity detection

Inductive proximity sensors enable the detection, without contact, of metal objects at distances of up to 60 mm.

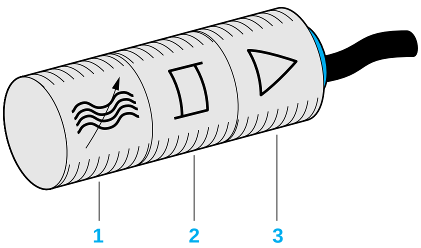
Their range of applications is very extensive and includes : the monitoring of machine parts (cams, mechanical stops, etc.), monitoring the flow of metal parts, counting, etc.

Advantages of inductive detection

- No physical contact with the object to be detected, thus avoiding wear and enabling fragile or freshly painted objects to be detected.
- High operating rates.
- Fast response.
- Excellent resistance to industrial environments (robust products, fully encapsulated in resin).
- Solid state technology : no moving parts, therefore service life of sensor independent of the number of operating cycles.

Principle of operation

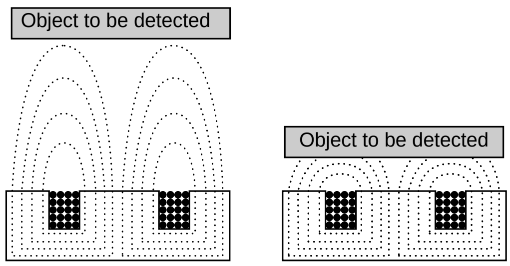
Inductive proximity sensors are solely for the detection of metal objects.
They basically comprise an oscillator whose windings constitute the sensing face.
An alternating magnetic field is generated in front of these windings.



Composition of an inductive proximity sensor
1 Oscillator
2 Output driver
3 Output stage

When a metal object is placed within the magnetic field generated by the sensor, the resulting currents induced form an additional load and the oscillation ceases.

This causes the output driver to operate and, depending on the sensor type, a NO, NC or NO + NC (complementary) output signal is produced.



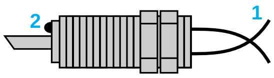
Detection of a metal object.

Inductive proximity sensors

Terminology

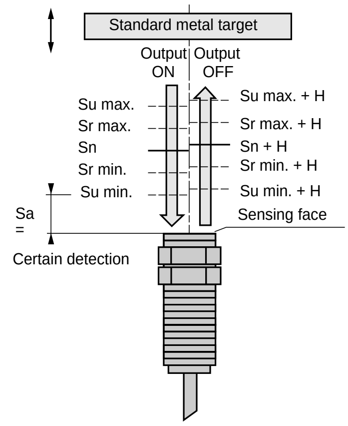
Operating zone

The operating zone relates to the area in front of the sensing face in which the detection of a metal object is certain. The values stated in the characteristics relating to the various types of sensor are for steel objects of a size equal to the sensing face of the sensor. For objects of a different nature (smaller than the sensing face of the sensor, other metals, etc.), it is necessary to apply a correction coefficient (see page 31100/14).



1 Detection threshold curves
2 “Object detected” LED

Sensing distances



H = course différentielle

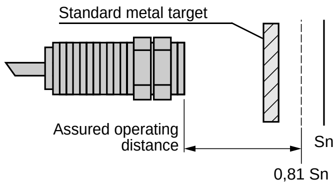
Nominal sensing distance (Sn).
The rated operating distance for which the sensor is designed. It does not take into account any variations (manufacturing tolerances, temperature, voltage, etc.).

Real sensing distance (Sr).
The real sensing distance is measured at the rated voltage (Un) and at rated ambient temperature (Tn).
It must be between 90% and 110% of the nominal sensing distance (Sn) :
0.9 Sn ≤ Sr ≤ 1.1 Sn.

Usable sensing distance (Su).
The usable sensing distance is measured at the limits of the permissible variations of the ambient temperature (Ta) and the supply voltage (Ub). It must be between 90% and 110% of the real sensing distance (Sr) :
0.9 Sr ≤ Su ≤ 1.1 Sr.

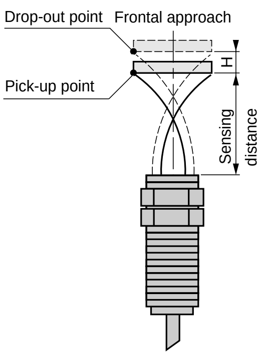
Assured operating distance (Sa).
This is the operating zone of the sensor.
The assured operating distance is between 0 and 81% of the nominal sensing distance (Sn) :
0 ≤ Sa ≤ 0.9 x 0.9 x Sn.

Standard metal target



Square mild steel (Fe 360) plate, 1 mm thick.
The side dimension of the plate is either equal to the diameter of the circle engraved on the active surface of the sensing face or 3 times the nominal sensing distance (Sn).

Differential travel



The differential travel (H), or hysteresis, is the distance between the pick-up point as the standard metal target moves towards the sensor and the drop-out point as it moves away.

Repeat accuracy
(Repeatability)

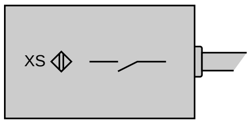
The repeat accuracy (R) is the repeatability of the usable sensing distance between successive operations. Readings are taken over a period of time whilst the sensor is subjected to voltage and temperature variations : 8 hours, 10 to 30 °C, Un ± 5 %. It is expressed as a percentage of Sr.

Inductive proximity sensors

Outputs and wiring

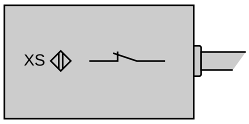
Output signal (contact logic)

NO



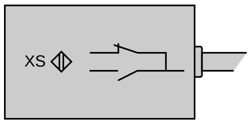
Corresponds to a proximity sensor whose output (transistor or thyristor) changes to the closed state when an object is present in the operating zone.

NC



Corresponds to a proximity sensor whose output (transistor or thyristor) changes to the open state when an object is present in the operating zone.

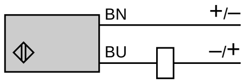
NO + NC complementary outputs



Corresponds to a proximity sensor with 2 complementary outputs, one of which opens and one of which closes when an object is present in the operating zone.

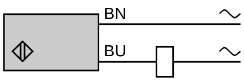
2-wire type

2-wire ⎓ non polarised NO or NC output



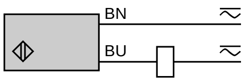
- Not polarity conscious, connections to + and – immaterial.
- Protected against overload and short-circuit.

2-wire ∼ NO or NC output



- Not protected against overload or short-circuit.

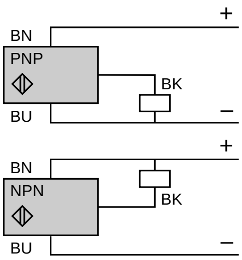
2-wire ≂ NO or NC output



- 20…264 V supply, either ∼ or ⎓.
- Certain models protected against overload and short-circuit.

3-wire type

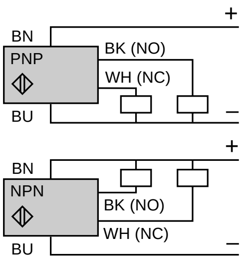
3-wire ⎓ NO or NC output PNP or NPN



- Protected against reverse supply polarity.
- Protected against overload and short-circuit.

4-wire type, complementary outputs

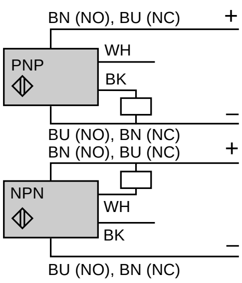
4-wire ⎓ NO and NC PNP or NPN



- Protected against reverse supply polarity.
- Protected against overload and short-circuit.

4-wire type, multifunction, programmable

4-wire ⎓ NO or NC, PNP or NPN



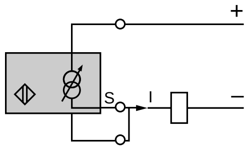
- Protected against reverse supply polarity.
- Protected against overload and short-circuit.

Inductive proximity sensors

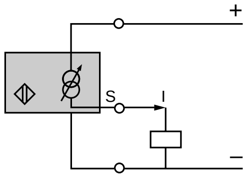
Outputs and wiring

Specific output signals

Analogue type



2-wire connection

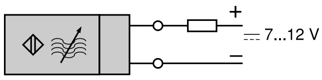


3-wire connection

These proximity sensors convert the approach of a metal object towards the sensing face into a current variation which is proportional to the distance between the object and the sensing face.
2 models available :

- Dual voltage : ⎓ 24…48 V
  Output 0-10 mA for 3-wire connection, and 4-14 mA for 2-wire connection.
- Single voltage : ⎓ 24 V
  Output 0-16 mA for 3-wire connection and 4-20 mA for 2-wire connection

NAMUR type



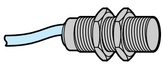
The proximity sensors conforming to NAMUR (DIN 19234) recommendations are electronic devices whose current consumption is altered by the presence of a metallic object within the sensing zone.
Their small size makes them suitable for various applications in many sectors, notably :

- Intrinsically safe
  (hazardous areas).
  Sensors used with an NY2 intrinsically safe relay/amplifier or a compatible solid state input which is suitably approved for intrinsically safe applications.
- Non intrinsically safe
  (normal safe areas).
  Sensors used with an XZD power supply/amplifier unit or a compatible (DIN 19234) solid state input amplifier.

Connection methods

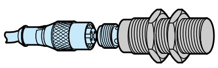
Pre-cabled

Factory fitted moulded cable, good protection against splashing liquids.
Example : machine tool applications.



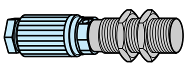
Connector

Ease of installation and maintenance.



Screw terminals

Flexibility, cable runs to required length.



Additional information regarding outputs

For characteristics of the various types of output, wiring precautions and terminology, see pages 31100/15 to 31100/18.

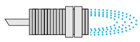
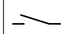
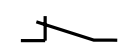
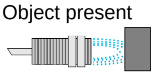
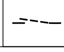
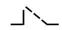
Inductive proximity sensors

Specific functions

LED indicators

Output LED

All Telemecanique brand inductive proximity sensors incorporate an output state LED indicator.

		NO output	NC output
No object present 	LED	⊗	☼
	Output state		
Object present 	LED	☼	⊗
	Output state		

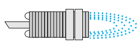
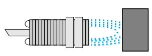
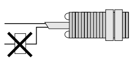
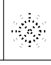
Output LED function table

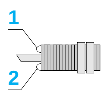
Supply LED

Certain block type XS7, XS8, XSD inductive proximity sensors incorporate a supply LED, in addition to the output LED.
This provides instant verification of the supply state of the sensor .

Short-circuit LED

This LED, complementary to the output LED, flashes in the event of a short-circuit occurring on the load side of the sensor.
It remains in the flashing state until the supply to the sensor is removed and the short-circuit rectified.
This feature is particularly useful when switching inductive loads, which are prone to short-circuits.
The short-circuit LED is incorporated in the following 2-wire type ∼ and ⎓ short-circuit protected sensors : Ø 18 mm cylindrical type, Ø 30 mm cylindrical type and XSD block type.

		NO output	NC output
No object present 	1	⊗	☼
	2	☼	⊗
Object present 	1	☼	⊗
	2	⊗	☼
Short-circuit 	1	⊗	⊗
	2		



1 Output LED
2 Short-circuit LED

Short-circuit LED function table

Inductive proximity sensors

Specific functions

Output signal time delay

Principle

Block type XSC and XSD sensors incorporate a potentiometer adjusted 1 to 20 second output time delay.

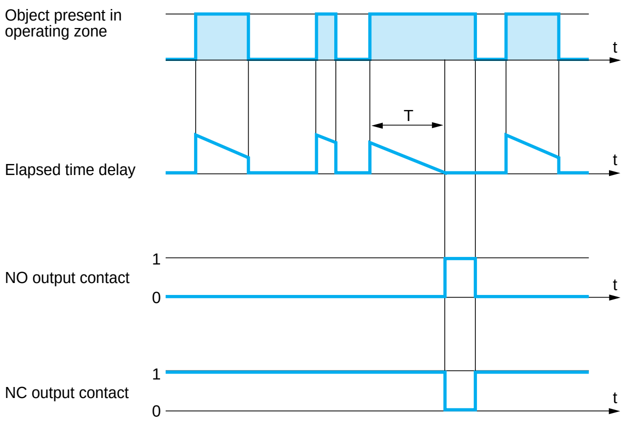
The outputs of these sensors are programmable (by links) and any of the following configurations are possible :

- NO output contact - time delay when an object enters the operating zone,
- NC output contact - time delay when an object enters the operating zone,
- NO output contact - time delay when an object leaves the operating zone,
- NC output contact - time delay when an object leaves the operating zone.

Time delay when object enters operating zone

The time delay is triggered as the object enters the operating zone and the output contact changes state only if the object is still present after the preset time (T) has elapsed.

Application example : monitoring the flow of metal parts on a conveyor belt.

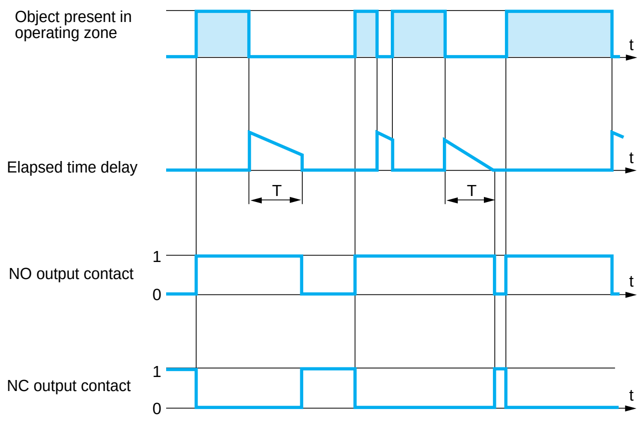


Time that object is present in the operating zone

Time delay when object leaves operating zone

The time delay is triggered as the object leaves the operating zone and the output contact changes state only if the preset time delay (T) elapses before another object enters the operating zone.

Application example : monitoring for missing metal parts on a conveyor belt.



Time that object is present in the operating zone

Inductive proximity sensors

Specific functions

Rotation monitoring

Principle

Sensors of the type generally known as “rotation monitoring” compare the passing speed of metal targets to an internal preset value.

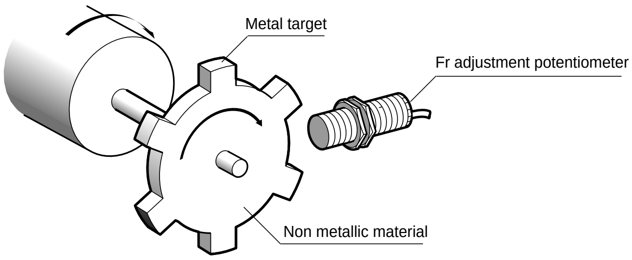
The trajectory of the target objects can either be rotary or linear.

The moving part to be monitored is fitted with metal targets, aligned for detection by the sensor.

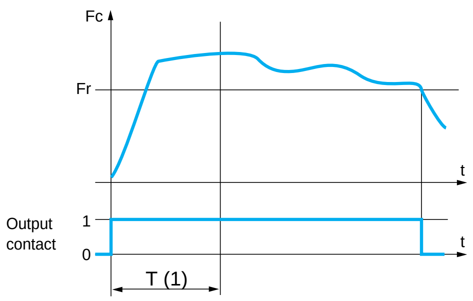
Operation

The impulse frequency Fc generated by the moving part to be monitored is compared with the frequency Fr preset on the sensor.
The output of the sensor is in the closed state for Fc > Fr and in the open state for Fc < Fr.

Note : Following “power-up” of the sensor, the “rotation monitoring” function is subject to a start-up delay of 9 seconds in order for the moving part to run up to speed.
(Sensors without this feature or with a delay reduced to 3 seconds are also available on request).



Adjustment of Fr

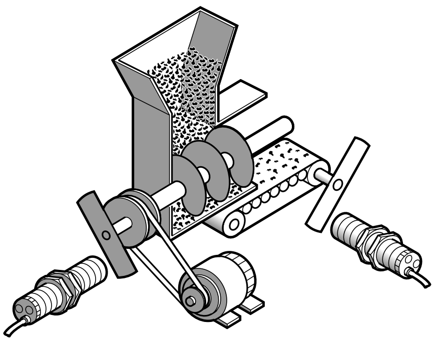


(1) Start-up time delay (contact closed during start-up period)

Operating curve

Applications

Detecting :
- underspeed,
- slip,
- coupling breakage,
- overload.



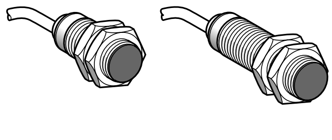
Example : coupling breakage detection.

Inductive proximity sensors

Mounting and installation precautions

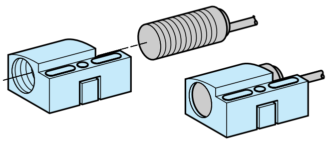
Features of the various models

Types of case



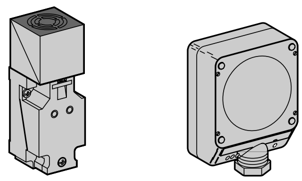
Short case   Form A case

Cylindrical type
- fast installation and setting-up,
- pre-cabled or connector output,
- small size facilitates mounting in locations with restricted access.



Indexed fixing bracket

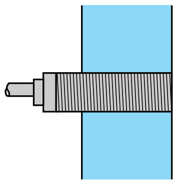
Interchangeability, provided by indexed **fixing bracket**. When assembled, becomes similar to a block type sensor.



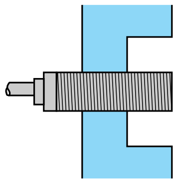
Form C   Form D

Block type
- direct interchangeability, without the need for readjustment,
- output terminals, providing connection flexibility,
- robustness.

Suitability for flush mounting in metal



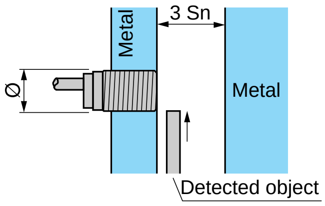
Sensors suitable for flush mounting
- no lateral effect, but
- reduced sensing distance.



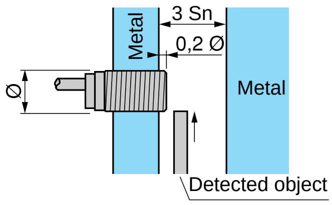
Sensors not suitable for flush mounting
- sensing distance greater than that for flush mountable models, but
- space required around the sensor to eliminate the effects of surrounding metal.

Mounting cylindrical type sensors on metal supports

Sensors suitable for flush mounting

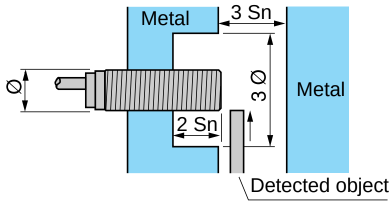


Standard model

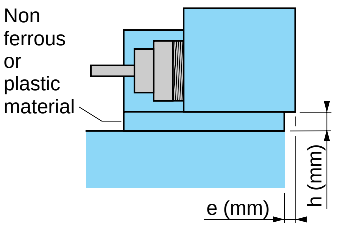


Increased sensing range model

Sensors not suitable for flush mounting



Mounting in conjunction with fixing bracket



- Standard flush mountable types:
  e = 0, h = 0
- Standard non flush mountable types and increased range types:
  - Ø 6.5, 8 & 12 mm e = 0, h = 0
  - Ø 18 mm if : h = 0, e ≥ 5
    e = 0, h ≥ 3
  - Ø 30 mm if : h = 0, e ≥ 8
    e = 0, h ≥ 4

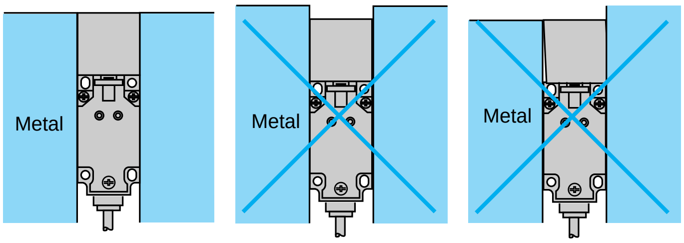
Inductive proximity sensors

Mounting and installation precautions

Mounting block type sensors on metal supports

Sensors suitable for flush mounting

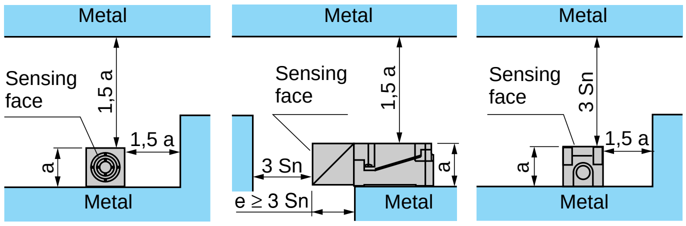
Mounting in the vicinity of metal masses, on one or more sides simultaneously.



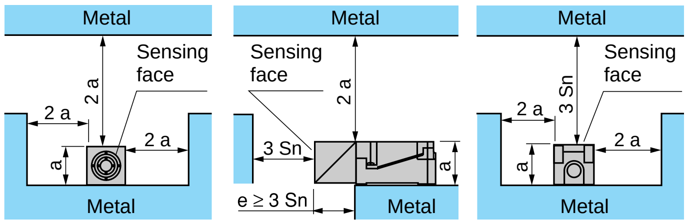
Correct mounting | Not to be recessed mounted | Not to be mounted adjacent to an angle

Sensors not suitable for flush mounting

Mounting in an angle section

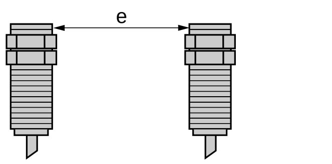


Mounting in a U section

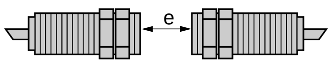


Mounting distance between sensors

Standard sensors



Mounting side by side, e ≥ 2 Sn



Mounted face to face, e ≥ 10 Sn

Two sensors mounted too close to each other are likely to lock in the “detection” state, due to interference between their respective oscillating frequencies.
To avoid this condition, minimum mounting distances given for the sensors should be adhered to.

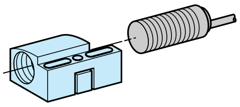
Staggered frequency sensors

For applications where the minimum recommended mounting distances for standard sensors cannot be achieved, it is possible to overcome this restraint by mounting a staggered frequency sensor adjacent or opposite to each standard sensor.
For information on staggered frequency sensors, please consult your Regional Sales Office.

Inductive proximity sensors

Mounting and installation precautions

Mounting cylindrical type sensors using fixing bracket



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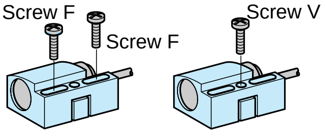
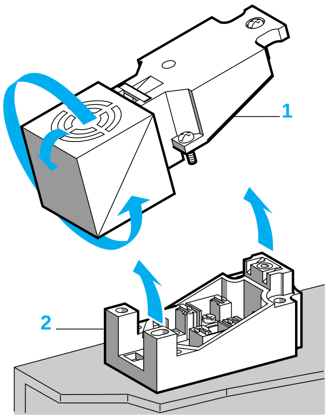


2 3

1 Insert the sensor into the bracket.
2 Secure sensor in fixing bracket using screw V.
3 The sensor is now rigidly clamped in the fixing bracket.
Adjust the bracket/sensor assembly to ensure correct detection and positively secure the assembly using fixing screws F.

The proximity sensor is positively indexed in position. If, for any reason, it is necessary to change the sensor :
- loosen screw V and remove sensor,
- insert the new sensor until it is against the stop. On tightening screw V, the new sensor will be indexed into the same position as the previous sensor.

Plug-in body Turret head



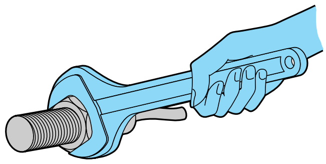
1 Part containing sensor electronics
2 Base comprising electrical connections and fixing points

Plug-in body sensors enable mechanical separation of the part containing all the necessary electronics and the base part comprising the electrical connections and fixing points.
This feature considerably reduces maintenance time in the event of a sensor being replaced, since only the electronic part need be replaced. The base part remains fixed in position, without the need of remaking the electrical connections or adjusting the settings.

Sensors type XSB, XS7, XS8 and XSD feature a plug-in body.

In addition, sensors type XS7 and XS8 incorporate a 5 position turret head. The head of the sensor can be rotated laterally throughout the 4 side detection quadrants or turned vertically for end detection.

Tightening torque for cylindrical type sensors

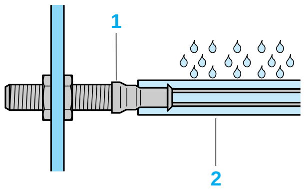


Maximum tightening torque for the various sensor case materials

	Brass	**Brass**	**Stainless steel**	**Plastic**
Diameter of sensor	Short case model	Form A model	Form A model	All models
Ø 5 mm	1.6	1.6	2	–
Ø 8 mm	5	5	9	1
Ø 12 mm	6	15	30	2
Ø 18 mm	15	35	50	5
Ø 30 mm	40	50	100	20

Torque indicated in N.m

Protection of connecting cable



1 CNOMO adaptor
2 Protective sleeve

Consider the use of a protective sleeve and CNOMO adaptor.

Inductive proximity sensors

Standards and certifications
Parameters related to the environment

Conformity to standards

All Telemecanique brand proximity sensors conform to the standard IEC 60947-5-2.

Resistance to temperature

- Operating temperature range of sensors : - 25…+ 70 °C.
  Exceptions :
  - Increased range sensors : - 25…+ 50 °C,
  - Plastic case cylindrical type sensors (XS3-P and XS4-P) : - 25…+ 80 °C,
  - Metal case cylindrical type form A sensors (XS1-M and XS2-M) : - 25…+ 80 °C.
- Storage temperature range of sensors : - 40…+ 85 °C.

Resistance to chemicals in the environment

Owing to the very wide range of chemicals encountered in modern industry, it is very difficult to give general guidelines common to all sensors.
To ensure lasting efficient operation, it is essential that the chemicals coming into contact with the sensors will not affect their casings and, in doing so, prevent their reliable operation.

Cylindrical type metal case sensors XS1-N, XS2-N and XS1-M, XS2-M offer very good resistance to oils in general, salts, essences and hydrocarbons. Also, sensor models XS1-M and XS2-M are particularly well adapted to severe environments such as machine-tool applications.
Note : The cable used conforms to the standard NF C 32-206 and the recommendations of CNOMO E 03-40-150 N.

Cylindrical type plastic case sensors XS3 and XS4 offer an excellent overall resistance to :
- chemical products such as salts, haliphactic and aromatic oils, essences, acids and diluted bases. For alcohols, ketones and phenols, preliminary tests should be made relating to the nature and concentration of the liquid.
- agricultural and food industry products such as animal or vegetable based food products (vegetable oils, animal fat, fruit juice, dairy proteins, etc.).

Resistance to shock

The sensors are tested in accordance with the standard IEC 60068-2-27, 50 gn, duration 11 ms.

Resistance to vibration

The sensors are tested in accordance with the standard IEC 60068-2-6, amplitude ± 2 mm, f = 10…55 Hz, 25 gn at 55 Hz.

Degree of protection

Please refer to the reference/characteristic pages for the various sensors.

IP 67 : Protection against the effects of immersion, tested in accordance with the standard IEC 529. Sensor immersed for 30 minutes in 1 m of water.
No deterioration in either operating or insulation characteristics is permitted.
IP 68 : Protection against the effects of prolonged immersion. The test conditions are subject to agreement between the manufacturer and the user.
Example : Machine-tool applications or other machines frequently drenched in cutting fluids.

Protective treatment

Inductive proximity sensors have “TC” protective treatment as standard.

Inductive proximity sensors

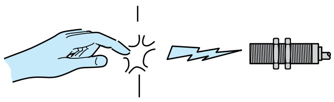
Standards and certifications
Parameters related to the environment

Resistance to electromagnetic interference

Proximity sensors type XS1, XS2, XS3, XS4, XSE, XS7 and XS8 are tested in accordance with the recommendations of the standard IEC 60947-5-2.

Electrostatic discharges

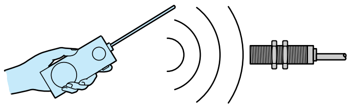
- ⎓ sensors : level 3 immunity except Ø 4 mm and Ø 5 mm (level 2).
- ∿ and ≂ sensors : level 4 immunity.



IEC 61000-4-2
Level 3 : 8 kV
Level 4 : 15 kV

Radiating electromagnetic fields (electromagnetic waves)

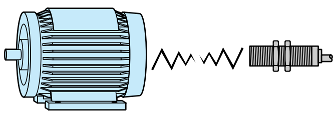
- ⎓, ∿ and ≂ sensors : level 2 or level 3 immunity.



IEC 61000-4-3
Level 2 : 3 V/metre
Level 3 : 10 V/metre

Fast transients (motor start/stop interference)

- ⎓ sensors : level 3 immunity.
- ∿ and ≂ sensors : level 4 immunity except Ø 8 mm (level 2).
- Models with increased sensing range : level 2 immunity (at I = 50 mA).

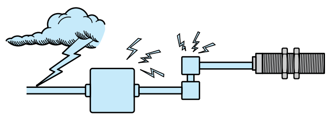


IEC 61000-4-4
Level 3 : 1 kV
Level 4 : 2 kV

Dielectric strength

Impulse voltages

- ⎓, ∿ and ≂ sensors : level 3 immunity except Ø 8 mm and smaller models : level 1 kV.



IEC 60947-5-2
Level 3 : 2.5 kV

Insulation

Class 2 devices

⧈

Electrical insulation conforming to the standards IEC 61140 and NF C 20-030 concerning means of protection against electrical shocks.

Product certifications

- Cylindrical type sensors
  Standard version : UL, CSA except sensors with integral connector type XS●-●●●●●●●●LD, XS●-●●●●●●●●LA, XS●-●●●●●●●●C and XS●-●●●●●●●●T.

- Block type sensors
  The certifications pertaining to the various block type models are listed on their respective characteristic pages.

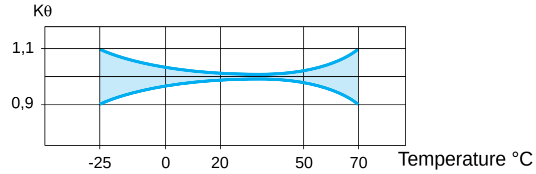
Inductive proximity sensors

Sensing distance correction coefficients

Correction coefficients to apply to the assured sensing distance

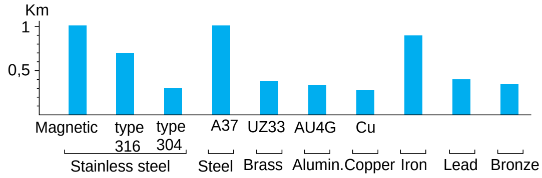
In practice, most target objects are generally made of steel and are of a size equal to, or greater, than the sensing face of the proximity sensor.
To calculate the sensing distance for other application conditions the following parameters, which affect the sensing distance, must be taken into account :
Note : The curves indicated below are purely representative of typical curves. They are given as a guide to the approximate usable sensing distance of a proximity sensor for a given application.

Variations in ambient temperature



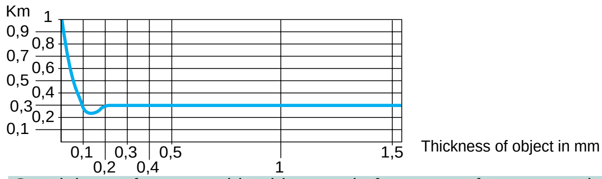
Apply a correction coefficient Kθ, determined from the curve shown above.

Different types of object material



Apply a correction coefficient Km, determined from the diagram shown above.

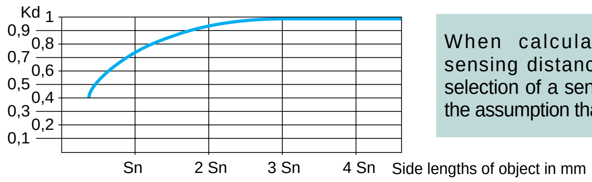
Typical curve for a copper object used with a Ø 18 mm cylindrical sensor.



Special case for a very thin object made from a non ferrous metal.

Size of the object to be detected

Typical curve for a steel object used with a Ø 18 mm cylindrical sensor.



When calculating the sensing distance for the selection of a sensor, make the assumption that Kd = 1.

Apply a correction coefficient Kd, determined from the curve shown above.

Variation of supply voltage

In all cases, apply the correction coefficient Kt = 0.9.

Calculation examples

Example 1 : correction of the sensing distance of a sensor
Proximity sensor **XS7-C40FP260** with nominal sensing distance Sn = 15 mm.
Ambient temperature variation 0 to + 20 °C.
Object material and size : steel, 30 x 30 x 1 mm thick.
The assured sensing distance **Sa** can be determined using the formula :
Sa = Sn x Kθ x Km x Kd x Kt = 15 x 0.98 x 1 x 0.95 x 0.9, i.e. Sa = 12.5 mm.

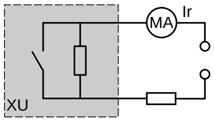
Example 2 : selecting a sensor for a given application
Application characteristics :
- object material and size : iron (Km = 0.9), 30 x 30 mm,
- temperature : 0 to 20 °C (Kθ = 0.98),
- object detection distance : 3 mm ± 1.5 mm, i.e. Sa max. = 4.5 mm,
- assume Kd = 1.

A sensor must be selected for which $Sn \geq \frac{Sa}{K\theta \times Km \times Kd \times Kt} = \frac{4.5}{0.98 \times 0.9 \times 1 \times 0.9}$, i.e. Sn ≥ 5.7 mm.
One possible choice is a Ø 18 mm cylindrical non flush mountable sensor, type **XS2-M18PA370** (Sn = 8 mm).

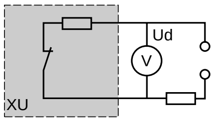
Inductive proximity sensors

Specific aspects of electronic sensors

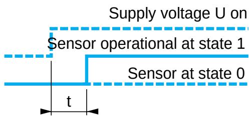
Terminology



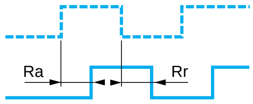
Residual current (Ir)
The residual current (Ir) corresponds to the current flowing through the sensor when in the “open” state.
Characteristic of 2-wire type proximity sensors.



Voltage drop (Ud)
The voltage drop (Ud) corresponds to the voltage at the sensor's terminals when in the “closed” state.
(Value measured at nominal current rating of sensor).
Characteristic of 2-wire type proximity sensors.



First-up delay
The time (t) between the connection of the power supply to the proximity sensor and its fully operational state.



Delays

- Response time (Ra) :
  The time delay between entry of an object (standard metal target) into the operating zone of the proximity sensor and the subsequent change of output state.
  This parameter limits the speed and size of the object.
- Recovery time (Rr) :
  The time delay between an object (standard metal target) leaving the operating zone, in which it is being detected, and the subsequent change of output state.
  This parameter limits the interval between successive objects.

Power supplies

Proximity sensors for a.c. circuits

(∼ and ≂ models)

Check that the voltage limits of the proximity sensor are compatible with the rated voltage of the a.c. supply used.

Proximity sensors for d.c. circuits

d.c. source : Check that the voltage limits of the proximity sensor and the acceptable level of ripple, are compatible with the supply used.

a.c. source (comprising transformer, rectifier, smoothing capacitor) :
The supply voltage must be within the operating limits specified for the proximity sensor.

Where the voltage is derived from a single-phase a.c. supply, the voltage must be rectified and smoothed to ensure that :
- The peak voltage of the d.c. supply is lower than the maximum voltage rating of the proximity sensor.
Peak voltage = nominal voltage x $\sqrt{2}$
- The minimum voltage of the d.c. supply is greater than the minimum voltage rating of the proximity sensor, given that :
$\Delta V = (I \times t) / C$
ΔV = maximum ripple : 10 % (V),
I = anticipated load current (mA),
t = period of 1 cycle (10 ms full wave rectified for a 50 Hz supply frequency),
C = capacitance (µF).
As a general rule, use a transformer with a lower secondary voltage (Ue) than the required d.c. voltage (U).
Example :
∼ 18 V to obtain ⎓ 24 V,
∼ 36 V to obtain ⎓ 48 V.
Fit a smoothing capacitor of 400 µF minimum per proximity sensor, or 2000 µF minimum per Ampere required.

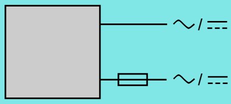
Note : Certain models have increased operating limits.
- short case models XS1-N, XS2-N, XS3-P, XS4-P (10…38 V) :
can be supplied from full wave rectified and smoothed ∼ 24 V,
- form A case 3-wire type models XS1-M, XS2-M, XS3-P, XS4-P (10…58 V):
can be supplied from full wave rectified ∼ 24 V.

Inductive proximity sensors

Specific aspects of electronic sensors
Electrical installation of electronic sensors

Types of output

2-wire type



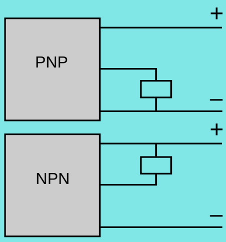
These proximity sensors are wired in series with the load to be switched. Because of this they are subject to :
- a residual current (in the open state),
- a voltage drop (in the closed state).

For polarised (polarity conscious) ⎓ proximity sensors, the supply polarities must be observed.
For non polarised (not polarity conscious) ⎓ proximity sensors, the supply polarity and load connections to the + or - sides are immaterial.

Advantages :
- The proximity sensors can be wired in the same way as mechanical limit switches.
- For ∼ and ≂ models, they can be connected to either positive (PNP) or negative (NPN) logic inputs. No risk of incorrect connections.

But :
Check the possible effects of residual current and voltage drop on the input device being controlled (pick-up and drop-out thresholds).

3-wire type



These proximity sensors comprise 2 wires for the d.c. supply and a third wire for transmission of the output signal.
- PNP type : switching the positive side to the load,
- NPN type : switching the negative side to the load.

The programmable, universal sensors provide a choice of function, either : PNP/NO, PNP/NC, NPN/NO or NPN/NC.

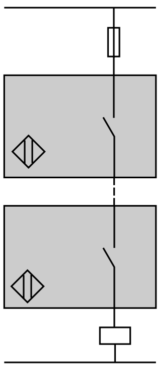
Note : Connection can only be made to a single load. Also, it is imperative that a discharge diode be incorporated when using an inductive load.
The output LED indicator is wired for NPN operation (output ON : LED illuminated, output OFF : LED off). Therefore, for PNP operation the LED signalling is reversed.

Advantages :
- Programmable output signal, no residual current, low voltage drop.
- NO + NC versions, for solid state input coincidence control (4-wire type).
- Programmable models, reduced stock levels.

But :
Certain models must only be used with their designated PNP or NPN type of logic input.

Connection in series

2-wire type proximity sensors



The following points should be taken into account :
- Series wiring is only possible using sensors with wide voltage limits.
- When in the open state, each sensor will share the supply voltage, i.e. :

  $$U\ sensor = \frac{U\ supply}{n\ sensors}$$

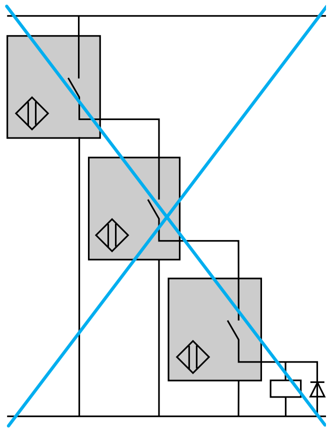
  (based on the assumption that each sensor has the same residual current value).
  U sensor and U supply must remain within the sensor's voltage limits.
- If only one sensor in the circuit is in the open state, it will be supplied at a voltage almost equal to the supply voltage.
- When in the closed state, a small voltage drop is present across each sensor. The resultant loss of voltage at the load will be the sum of the individual voltage drops and therefore, the load voltage should be selected accordingly.

Inductive proximity sensors

Electrical installation of electronic sensors

Connection in series (continued)

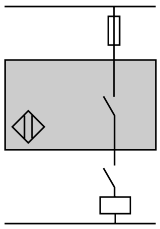
3-wire type proximity sensors



This connection method is not recommended.
Correct operation of the sensors cannot be assured and, if this method is used, tests must be made before installation. The following points should be taken into account :

- Sensor 1 carries the load current in addition to the no-load current consumption values of the other sensors connected in series. For certain models, this connection method is not possible unless a current limiting resistor is used.
- When in the closed state, each sensor will produce a voltage drop and, therefore, the load voltage should be selected accordingly.
- As sensor 1 closes, sensor 2 will not operate until a certain time "T" has elapsed (corresponding to the first-up delay) and likewise for the following sensors in the sequence.
- "Flywheel" diodes should be used when the load being switched is inductive.

Wiring sensor with mechanical contact

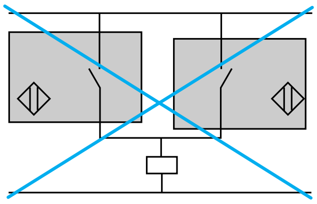


The following points should be taken into account (2 and 3-wire types) :

- When the mechanical contact is open, the sensor is not supplied.
- When the contact closes, the sensor will not operate until a certain time "T" has elapsed (corresponding to the first-up delay)

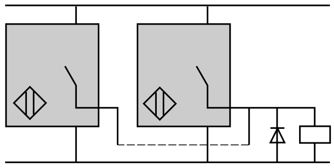
Connection in parallel

2-wire type proximity sensors



The use of proximity sensors wired in parallel, either between themselves or together with mechanical contacts, is not recommended.
Should one of the sensors be in the closed state, the sensor in parallel will be "shorted-out" and no longer supplied. As the first sensor passes into the open state, the second sensor will become energised and will be subject to its first-up delay.
The configuration is only permissible where the sensors will be working alternately.
This method of connection can lead to irreversible damage of the units.

3-wire type proximity sensors



No specific restrictions.
The use of a "flywheel" diodes is recommended when an inductive load (relay) is being switched.

Inductive proximity sensors

Electrical installation of electronic sensors

Wiring advice

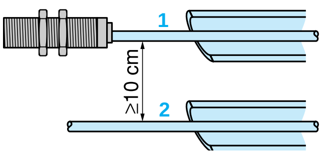
Length of cable

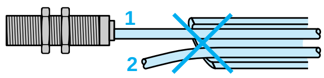
No limitation up to 200 m or up to a line capacitance of ≤ 0.1 µF (characteristics of sensor remain unaffected). It is, however, advisable to take into account voltage drop on the line.

Separation of control and power circuit wiring

The proximity sensors are immune to electrical interference encountered in normal industrial conditions.
Where extreme conditions of electrical “noise” could occur (large motors, spot welders, etc.), it is advisable to protect against transients in the normal way:
- suppress interference at source,
- limit the length of the cable,
- separate power and control wiring from each other,
- smooth the supply,
- use twisted and screened cable pairs for output signals.

In the event of machine or installation repairs (using an arc welder, for example), disconnect the proximity sensor.





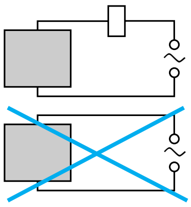
1 Control cable
2 Power cable

Dust and damp protection of cable glands

The level of dust and damp protection depends on how carefully the screws, seals, cable glands, blanking plugs, etc. have been tightened.
To ensure efficient dust and damp protection, use the correct diameter cable for the cable gland used.

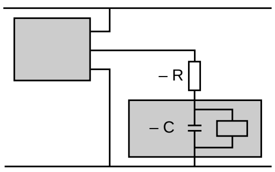
Cable gland	Diameter of cable Ø min.	Ø max.
7 mm plastic	3.5	6
9 mm plastic	6	8
11 mm plastic	8	10
13 mm plastic	10	12

a.c. supply



2-wire type ∿ proximity sensors cannot be connected directly to an a.c. supply.
This would result in immediate destruction of the proximity sensor and considerable danger to the user.
An appropriate load (refer to the instruction sheet supplied with the sensor) must always be connected in series with the proximity sensor.

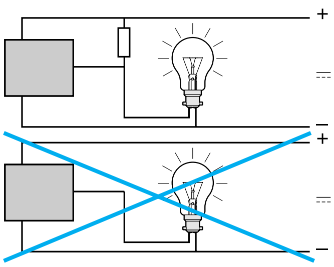
Capacitive load (C > 0.1 µF)



At switch-on, it is necessary to limit (by resistor) the charging current of the capacitive load C.
The voltage drop in the sensor can also be taken into account by subtracting it from the supply voltage for calculation of R.

$$R = \frac{U\ (supply)}{I\ max.\ (sensor)}$$

Load comprising an incandescent lamp



If the load comprises an incandescent lamp, the cold state resistance can be 10 times lower than the hot state resistance. This can cause very high current levels on switching.
Fit a pre-heat resistance in parallel with the proximity sensor.

$$R = \frac{U^2}{P} \times 10$$

U = supply voltage
P = lamp power

Inductive proximity sensors

Fast trouble shooting guide

Problem	Possible causes	Remedy
The sensor's output will not change state when an object enters the operating zone	Output stage faulty or the short-circuit protection has tripped	Check that the proximity sensor is compatible with the supply being used. Check the load current characteristics : - if load current I ≥ nominal current, a relay should be interposed between the sensor and the load, - if I ≤ nominal current, check for wiring faults (short-circuit). In all cases, a "quick-blow" fuse should be fitted in series with the proximity sensor.
	Wiring error	Verify that the wiring conforms to the wiring shown on the proximity sensor label or instruction sheet
	Supply fault	Check that the proximity sensor is compatible with the supply (⎓ or ∿). Check that the supply voltage is within the voltage limits of the sensor. Remember that with rectified, smoothed supply : U peak = U rms x $\sqrt{2}$.
False or erratic operation, with or without the presence of an object in the operating zone	Eletromagnet interference	Observe the wiring advice shown on page 31100/18.
	Influence of surrounding metal	Refer to the instruction sheet supplied with the proximity sensor. For sensors with adjustable sensitivity, reduce the sensing distance.
	Effect of interference on the supply lines	Check that the supply voltage is within the voltage limits of the sensor. Ensure that any d.c. supplies, when derived from rectified a.c., are correctly smoothed (C ≥ 400 µF). Separate a.c. power cables and d.c. low level cables. Where very long distances are involved, use suitable cable : screened and twisted pairs of the correct cross-sectional area. Position the sensors as far away as possible from any sources of interference.
	Response time of the sensor too slow for the particular object being detected	Check the suitability of the proximity sensor for the object to be detected. If necessary, select a proximity sensor with a higher switching frequency.
	Influence of high temperature	Eliminate sources of radiated heat, or protect the proximity sensor casing with a heat shield.