I B T 12 – S 02 P A – D 3 Y 2 / C38

1.Proximity sensor type
A: Analog Output Proximity Sensor
I: Inductive Proximity Sensor
M: Metal Probe Proximity Sensor
N: Namur Inductive Proximity Sensor
C: Capacitive Proximity Sensor
G: High-speed Gear Proximity Sensor
H: Hall Effect Proximity Sensor
P: Reed Proximity Sensor
U: Ultrasonic Proximity Sensor

2.Housing Material
B:Nickel-plated Brass
D:Die-casting
P:Plastic
S:Stainless steel

3.Housing Shape
D: Smooth Cylindrical type
L: L-shaped
R: Ring type
S: Rectangular type
T: Threaded Cylindrical type
U: U-shaped type

4.Specifications
Cylindrical type only(diameter):
4: 4mm 5: 5mm 6.5: 6.5mm 8: 8mm
12: 12mm 18: 18mm 20: 20mm 30: 30mm
34: 34mm 40: 40mm
Other type:
BH:17x17x28 LA: 17x17x34 DH:30x30x52
FT: 6x10x27 XL: 6x15x32 FS: 10x18x30
DB: 80x80x40 .....

5.Mounting
S: Shield N: Non-Shield
LS: Shield(Long sensing Range)
L N: Non-Shield(Long sensing Range)

6.Rated Sensing Distance
0.8: 0.8mm 01: 1mm
02: 2mm 04: 4mm
05: 5mm 08: 8mm
15: 15mm

7.Output
A: AC 2wires B: AC 3wires P: PNP
N: NPN L: DC 2wires T: AC/DC 2wires

8.Output state
A: N.O. B: N.C. C: N.O.+N.C.
I: Current Output 4-20mA V: Voltage Output 0-10V
R: Relay output N.O.+N.C.
H: Current output / voltage output changeover

9.Operating Voltage
A: AC20-250V C: DC15-30V D: DC10-30V
E: DC10-60V H: DC5V N: DC8.2V

10.Wires / Pins
Cable type:
2: 2 wires 3: 3 wires
4: 4 wires 5: 5 wires
Connector type:
2: 2 pins 3: 3pins
4: 4pins 5: 5pins

11.Protection
Y: Output short circuit , overload protection and reversed polarity protection
N: No protection

12.Connection
Cable type:
2: 2M 3: 3M 5: 5M 10: 10M .....
Connector type:
V1: M12 4-pin connector
V2: M8 3-pin connector
V7: M8 pigtail connector
V8: M12 pigtail connector
T: Terminal connection
.....

13.Others
C: Length of the body(C40 = 40mm)
W: L-shape(90°)....

* Please check related page for detailed model NO and specifications .

Definition

Proximity sensor is a general term of sensors that adopts non-contact way to detect the approaching information or presentation information of the object . It is an advanced replacement to limit switch , travel switch . The movement information and presence information of objects can be converted into electric signal by a proximity sensor .

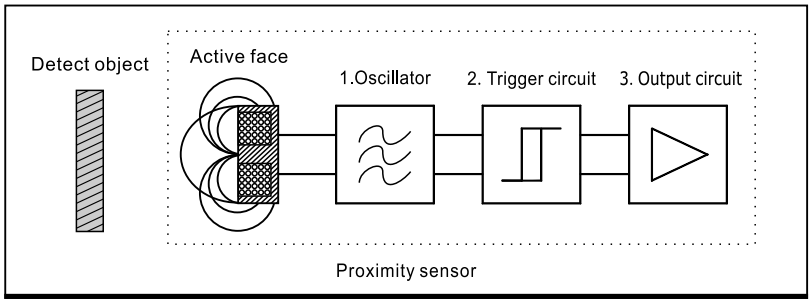
Proximity sensors can be divided into several types , including Inductive type , Capacitive type , Photoelectric type , Ultrasonic type , Magnetic type , Displacement type , NAMUR type.

Operating Principle

Inductive proximity sensor

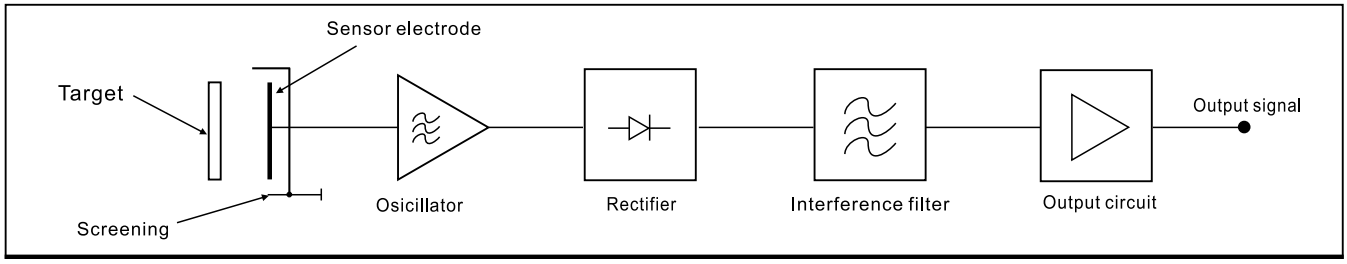
When the conductor is approaching a proximity sensor that can generate electromagnetic field , there will be formation of eddy current inside the conductor . Usually , a proximity sensor is made up of 3 parts as below :
1: an oscillator
2: a trigger circuit
3: an output circuit

The coil of the oscillator will generate alternating magnetic field on the surface of the sensor after power on . When a metal object is approaching the sensing surface , it will generate eddy current inside the object . Then energy emitted from the oscillator will be weakened . Finally it will stop vibrating . When the metal object is getting away from the active face , the oscillator start vibrating again . The actions of starting vibration and stopping vibration will be converted into switching signals (ON/ OFF) by trigger circuit.



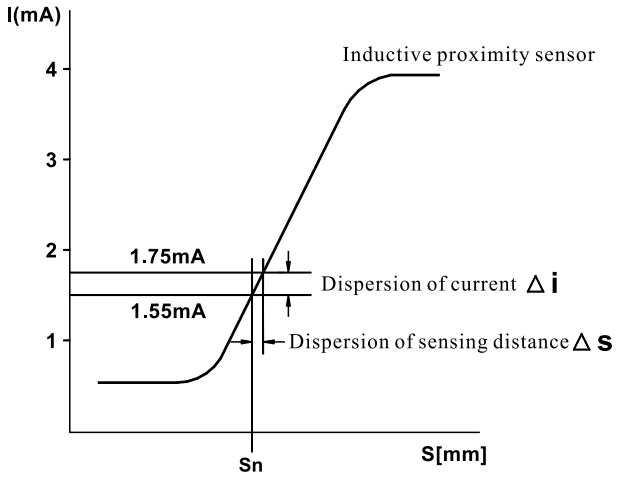
Capacitive proximity sensor

The active component of capacitive sensor is a disk shaped sensor electrode inside a screening can. These two electrodes from a capacitor with a basic capacitance Cg. When a target approaches upon the sensor area, the capacitance alters by the value △C. The capacitor is a member component of an RC oscillator . The output voltage U is dependent upon the effective capacitance Ca = Cg + △C between the sensor electrode and the screen potential. The oscillator output voltage is rectified, filtered and the interference pulses suppressed. This forms a switching signal which is converted to an output signal in the output stage.



Namur Inductive Proximity Sensor

Compared with common inductive proximity sensor , Namur inductive sensor simply contains the coils and oscillator. The trigger circuit and switch output device is in an amplifier. Namur inductive sensor has to be connected to an external amplifier when operating . It can not be used alone . The working principle of Namur inductive sensor is similar to a 1kΩ...8Kω variable resister. The oscillating circuit works while the metal object leaves (proximity sensor is equal to 1kΩ resistor), the internal current loss is over 2.2mA. When the metal object is approaching (proximity sensor is equal to 8kΩ resistor) ,the oscillating circuit stops, the internal current loss will reduce to less than 1mA.



Remark : rated operating value is defined as :
U0 = 8.2VDC $I_{attenuation}$ < 1mA Ri = 1KΩ $I_{non\text{-}attenuation}$ > 2.2mA
Make sure Δi is in available range 1.55mA-1.75mA.

Inductive analogue output sensor

Inductive sensors with analogue output work in the same way as standard inductive sensors. When a metal target approaches the active face of the sensor, energy is drawn from the oscillator. The ratio of the energy loss is proportional to the distance between the target and the sensor. The energy loss is converted to an analogue signal which is made linear and amplified. A standard analogue signal is available at the output (0～10V and/or4～20mA).

Magnetic proximity sensor

Hall element and Reed pipe are two types of magnetic component. Proximity sensor which is made of these elements is called magnetic proximity sensor . When the magnetic objects gets close to the proximity sensor , the internal circuit state changes due to magnetic effect caused by the magnetic components will be applied to identify the magnetic objects nearby and then switch on or off. The detecting objects for this type of sensor must be a magnetic object.
Magnetic sensors are designed to identify the presence of magnets and electromagnetic objets.
Magnetic proximity sensor can detect magnetci field generated by a permanent magnet or electromagnet. Two main types of magnetic sensors are used in automation technology:

1. Hall effect sensor
   Hall effect sensor may be actuated by any permanent magnet or electromagnet with sufficient flux density.
2. Reed sensor
   Reed sensor may be actuated by the permanent magnet.

Characteristics

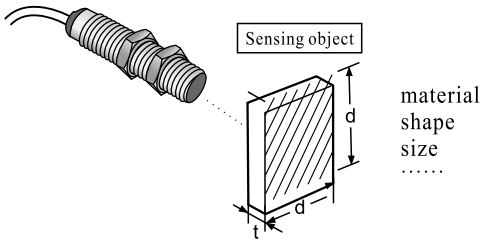
1. Non-contact detection , no abrasion / damage to detecting objects .
   Limit switch and other switches need to contact with detecting objects . But proximity sensors converts presentation information into electric signals , no need direct contact with objects .
2. No-contact output , long life-span (except for magnetic sensors) .
   Adopt semi-conductor technology , no effect to contact life-span .
3. Suitable for applications in water and oil environment .
   Housing of special proximity sensors can resist welding spark , chemical corrosion affection .
4. Higher response frequence .
   Proximity sensor is consist of electrical components, while contact type switch is made up of mechanical materials .
5. No affection from color of detected objects .
   Proximity sensors detect physical properties change of detecting objects , no influence from the color of objects and so on .
6. Affection from ambient temperature, surrounding objects , and similar sensors .
   Similar sensors include : inductive proximity sensors , capactive proximity sensors .When mounting inductive proximity sensors , please take interface of similar sensors into consideration . For magnetic type , try to avoid affection from surrounding metals ; for capactive type , try to avoid affection from surrounding objects .

Output Function

N.O. :
Normally open . When there is no object approaching, no signal output ; When there is an object approaching output a signal .
N.C. :
Normally closed . When there is no objects approaching , there are continuous output signals ; When there is an object approaching , no output signal.
N.O.+N.C. :
Normally open + Normally closed . When there is an object approaching , the circuit that doesn't have output signals before will have output signals .

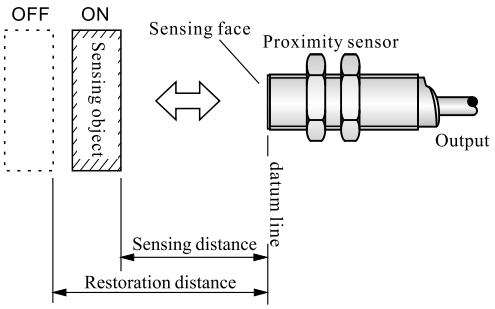
Standard target:

Standard object to calibrate the basic property of sensors . The material , shape , size have certain requirements .



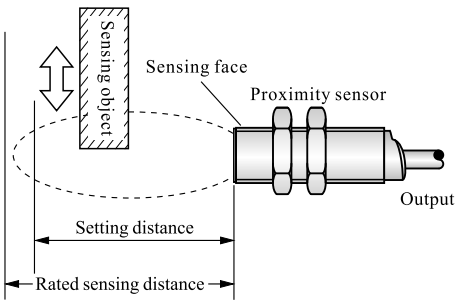
Rated sensing distance

The distance between sensing face to restoration distance when moving standard target in a specified method.



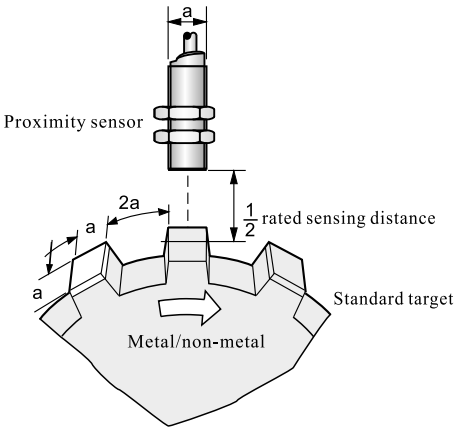
Setting distance and sensing dispersion

Influenced by ambient temperature , input voltage etc , the setting distance is 70% of rated sensing distance



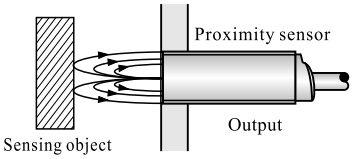
Switch Frequency

The number of output signal in 1 S when approaching the standard target repeatedly .



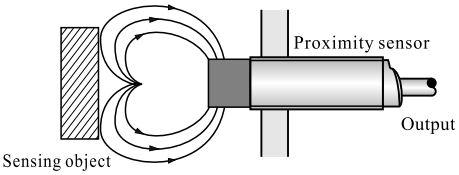
Shield

Magnetic flux concentrate on the front part of the sensor . Side part of the coil is covered by metal in this mounting method.



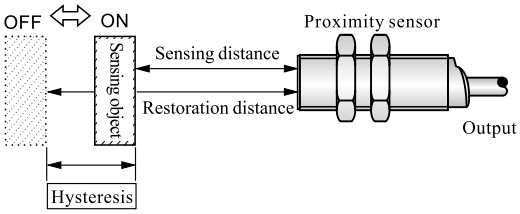
Non-Shield

Magnetic flux spread on the front part of the sensor . Side part of the coil is not covered by metal . In this mounting method , the detection might be influenced by surrounding metals .



Hysteresis

The distance between action moment and restoration moment when moving standard target in a specified method .



Influence of object material

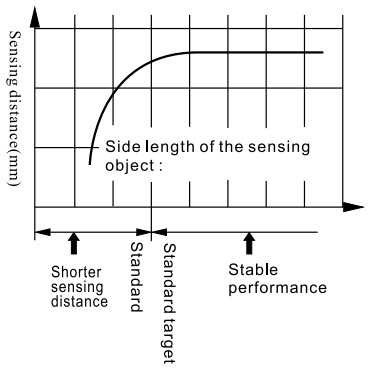
The sensing distance of Inductive proximity sensor is decided by the coil volume . To detect longer distance , larger coils are needed . Size , material , ambient temperature effect sensing distance .For ideal objects , the side length equals to diameter of inductive proximity sensors , or three times of rated sensing distance. And the thickness is 1 mm .
For example:
1、Diameter of proximity sensor: 18mm,
Sensing range: 5mm, 3 times of sensing range 15mm＜diameter of proximity sensor . Ideal size of sensing object : 18x18x1mm.
2、Diameter of proximity sensor: 18mm,
Sensing range: 8mm, 3 times of sensing range 24mm＞diameter of proximity sensor . Ideal size for sensing objects : 24×24×1mm。
Sensing distance mainly depends on the objects' material . Inductive coefficient of different materials are shown as below :

Material	Inductive coefficient
Mild steel	1.0
Aluminum foil	1.0
Stainless steel	0.85
Aluminum	0.4
Cuprum	0.3
Brass	0.3

Real sensing distance =rated sensing distance x inductive coefficient . For example (stainless steel objects) :
20mm x 0.85=17mm

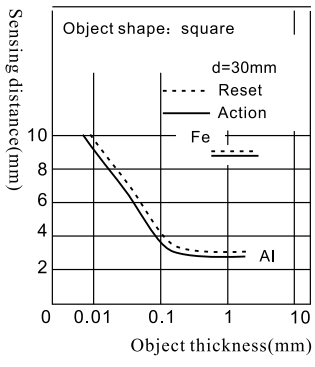
Size of the sensing object

Generally , when the sensing object is smaller than standard target , the sensing distance will be shortened .



Thickness of sensing object

1.The thickness of magnetic metal (Fe , Ni ...) have to be more than 1mm.
2. Aluminum foil with thickness less than 0.01mm is detectable. But extremely thin evaporation coating and non-conductive objects are undetectable for inductive proximity sensors .
3.Electroplating effect . After plating , the sensing distance will change . Electroplating effect to different materials is shown in table 1 (compared to the sensing distance without plating) .



Influence of plating
(percentage refers to material without plating)

Object thickness	Fe	Cu
Non-plating	100	100
Zn 5～15μm	90 ～120	95 ～105
Cd 5～15μm	100～120	95～105
Ag 5～15μm	60～90	85～100
Cu 10～20μm	70～95	95～105
Cu 5～15μm	——	95～105
Cu(5～10μm) + Ni(10～20μm)	70～95	——
Cu(5～10μm) + Ni(10μm) +Cr(0.3μm)	75～95	——

(table 1)

Mutual interfenence

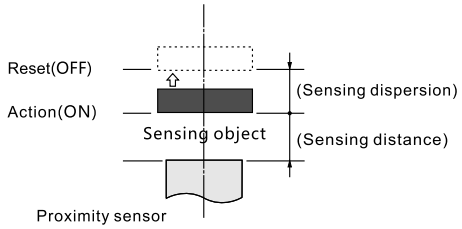
1. The magnetic or capactive influence of adjacent sensors . This influence may cause unstable output .
2. When you are required to install more than two proximity sensors with the same frequency in parallel or face to face , please install them alternatively with ones that have different frequency .

Reseting time

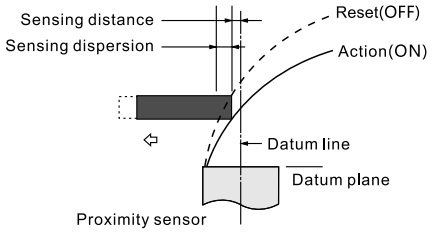
Proximity sensor enter test status within 100mS after power-on .

Sensing distance

Vertical sensing distance



Horizontal sensing distance



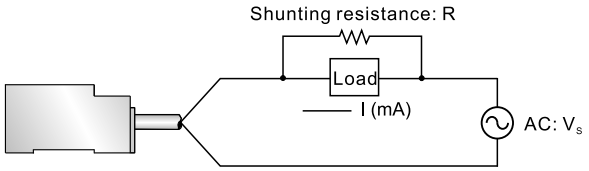
Effects of leakage current

Even if the proximity sensor is off , there will still be little amount of leakage current caused by the operating circuit . So there will remain a little amount of current in the load . Make sure residual voltage of the load is below reset voltage (leakage current is less than reset current of the load) .

Solutions of Leakage current :

AC2-wire

Add a shunting resistance to distribute the leakage current in the load to lower it below the reset current . Example : Current pass through the sensor is over 10mA . Make sure the residual voltage in the load is below reset voltage when the sensor is OFF. Please calculate the formula below to calculate advised shunting resistance value and allowed power .

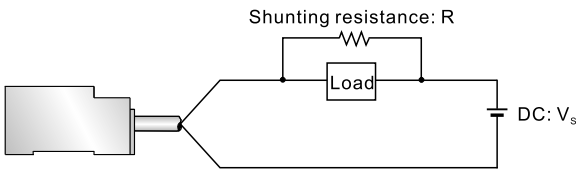


$$R \leqslant \frac{V_S}{10-I}\ (K\Omega) \qquad P \leqslant \frac{V_S^{\,2}}{R}\ (mW)$$

When using power supply AC 100V , you are advised to use shunting resistance less than 10 KΩ, power above 5W. When using power supply AC 200V , you are advised to use a shunting resistance less than 20 KΩ, power above 20W.
P: power of shunting resistance (you are advised to use multiple power in practice)
I: Load currenty (mA)

DC 2-wire

Add a shunting resistance to distribute the leakage current in the load to lower it below the reset current . Make sure : leakage current x load input resistance < reset voltage .



$$R \leqslant \frac{V_S}{I_R - i_{OFFR}}\ (K\Omega) \qquad P \leqslant \frac{V_S^{\,2}}{R}\ (mW)$$

P: power of shunting resistance (you are advised to use multiple power in practice)
i_R: leakage current of proximity sensor (mA)
i_{OFF} : reset current of the load (mA)
When using power supply DC12V , you are advised to use a shunting resistance less than 15 KΩ, power above 450mW. When using power supply DC 24V , you are advised to use a shunting resistance less than 30 KΩ, power above 0.1W.

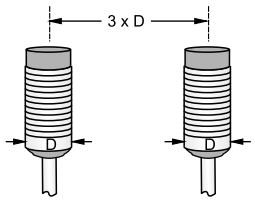
Mounting

1、Shied mounting

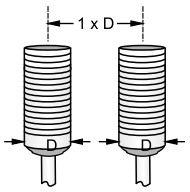
A metal ring is added to the magnetic core to prevent side induction . This mounting method shortens the sensing range .

2、Non-Shied mounting

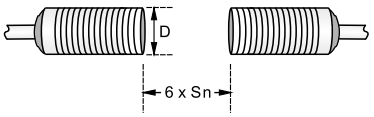
The magnetic core is wrapped with a coil . And the magnetic field is generated in all directions , including the sides . Sensing face of proximity sensor can't be flush to mounting surface . Or there will be malfunction .



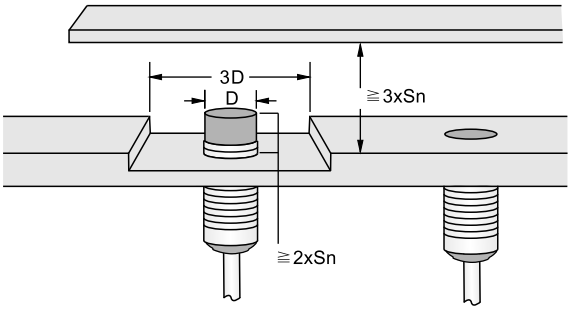
Non-Shield minimum distance



Shield minimum distance



Minimum distance



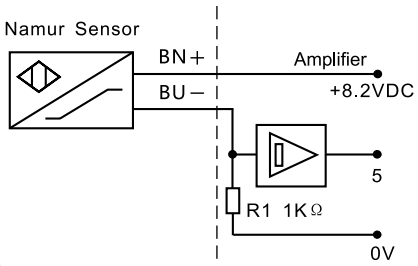
***Mounting**

When mounting 2 sensors of the same model face-to-face or in parallel, separate them as required below to avoid interference .

NOTE：D: sensor diameter，Sn: sensing distance

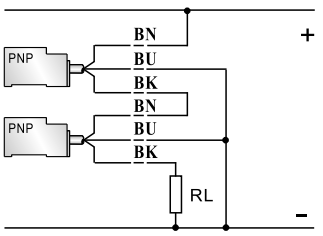
Notes for series mounting and parallel mounting

1. Namur inductive proximity sensor must be drived by a Namur isolation amplifier.
2. 2 wire DC Proximity sensors are not allowed to be mounted in series or in parallel .
3. 2 wire DC/AC Proximity sensors are not allowed to be mounted in series or in parallel .
4. For 2-wire AC Proximity sensor , voltage drop of the sensors will add together when they are mounting in parallel. Thus available load voltage will be lowered . Make sure load voltage must be above min operating voltage .
5. For 2-wire AC Proximity sensor , leakage current of the sensors will add together when they are mounting in series . Make sure the holding current is over total leakage current when choosing a small relay as load .

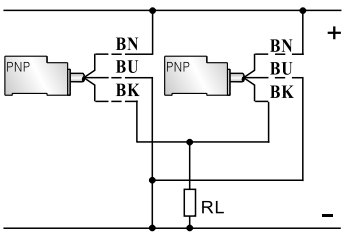


When installing two or more proximity sensors with same model in parallel , separate them as required above to avoid frequence interference .

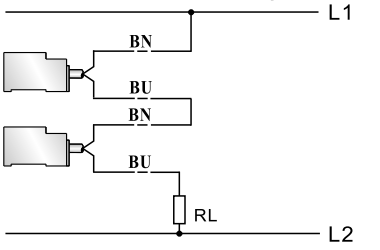
3-wire DC sensors mounting in series



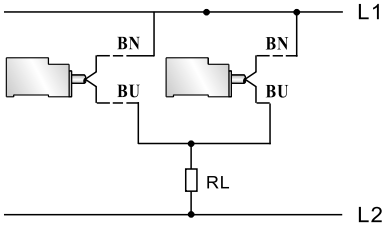
3-wire DC sensors mounting in parallel



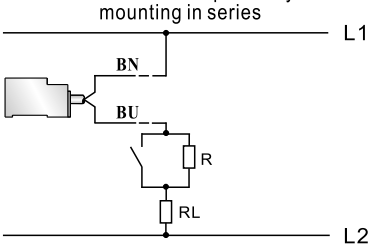
2-wire AC sensors mounting in series



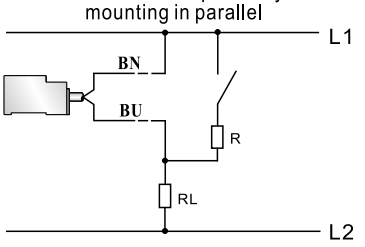
2-wire AC sensors mounting in parallel

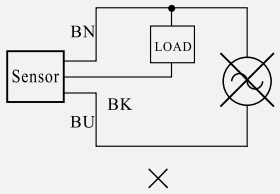
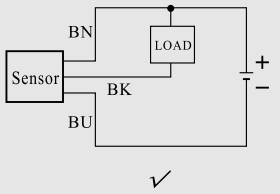
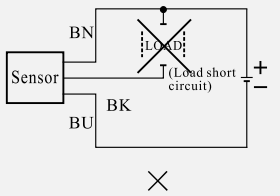
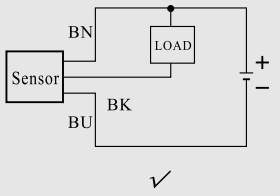
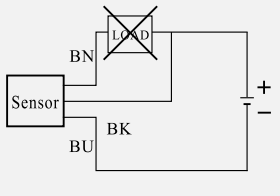
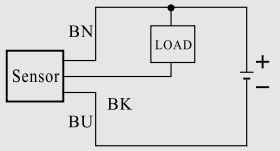
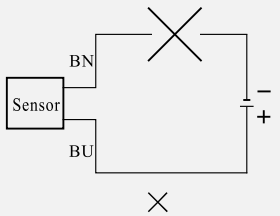
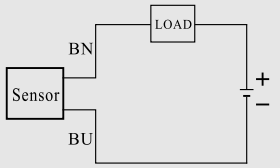
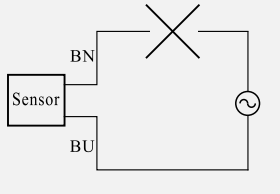
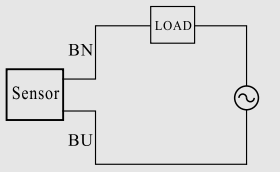


mechanical switch and proximity sensors mounting in series



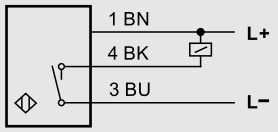
mechanical switch and proximity sensors mounting in parallel



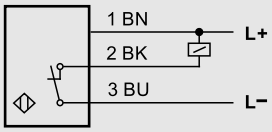
Item	Example	
Voltage of power Please don not use voltage which exceed rating voltage. If exceed the rating voltage or use the AC power(above AC100V) on the sensor which work with DC power that will cause damage .	DC 3-wire NPN  ×	DC 3-wire NPN  ✓
Shorted load Try to avoid shorted load . Or the sensor might be burned or bursted.	DC 3-wire NPN  ×	DC 3-wire NPN  ✓
Wiring error Please confirm the load is connected to the sensor correctly . Or it might cause damage to the sensor .	DC 3-wire NPN  ×	DC 3-wire NPN  ✓
Connection without load If the sensor is connected to the power supply directly, the inner components might be burned .	DC 2-wire  ×	DC 2-wire NPN  ✓
	AC 2-wire NPN  ×	AC 2-wire NPN  ✓

3 wires
Cable connection

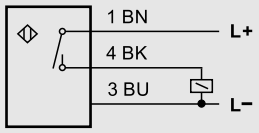
01
NPN N.O.
DC 10~30V



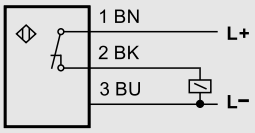
02
NPN N.C.
DC 10~30V



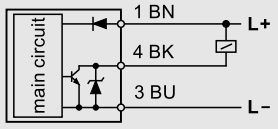
03
PNP N.O.
DC 10~30V



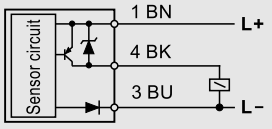
04
PNP N.C.
DC 10~30V



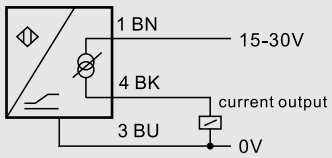
05
NPN N.O.– N.C.
DC 10~30V



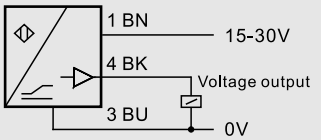
06
PNP N.O.– N.C.
DC 10~30V



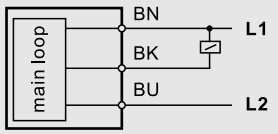
07
Analog output
DC 15~30V



08
Analog output
DC 15~30V

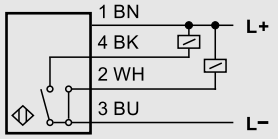


09
AC 3-wire output
AC 20~250V

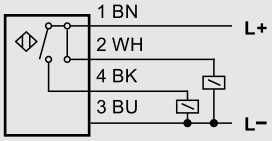


4 Wires
Cable connection

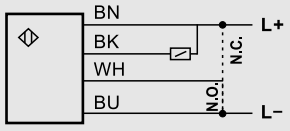
10
NPN N.O. & N.C.
DC 10~30V



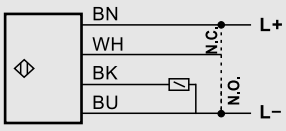
11
PNP N.O. & N.C.
DC 10~30V



12
N.O./N.C.
changeover NPN
DC 10~30V

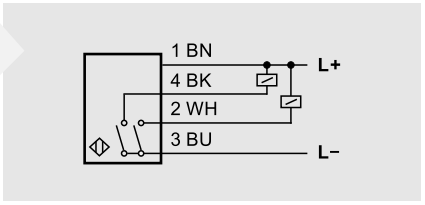


13
N.O./N.C.
changeover PNP
DC 10~30V



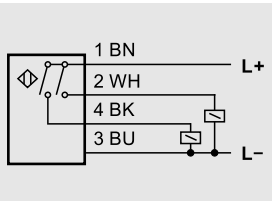
14

NPN N.O.+N.O.
DC 10~30V



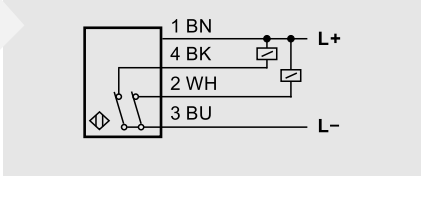
15

PNP N.O.+N.O.
DC 10~30V



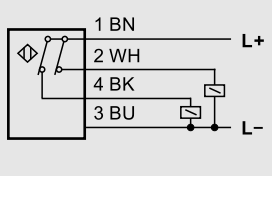
16

NPN N.C.+N.C.
DC 10~30V



17

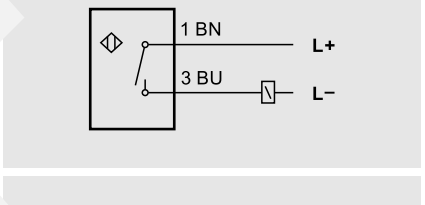
PNP N.C.+N.C.
DC 10~30V



2 wires
Cable connection

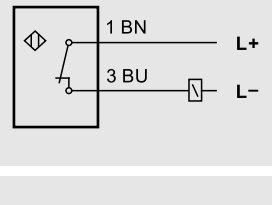
18

DC 2 wire N.O.
DC 10~30V



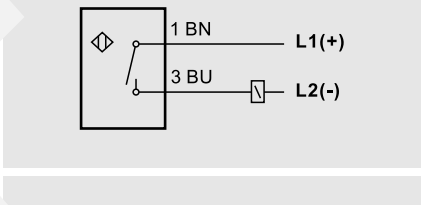
19

DC 2 wire N.C.
DC 10~30V



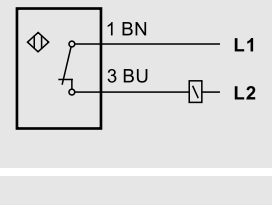
20

AC 2 wire N.O.
AC 20~250V



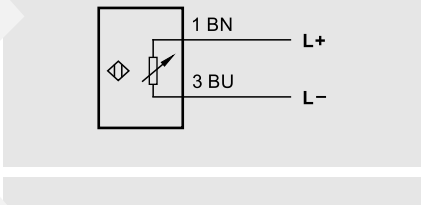
21

AC 2 wire N.C.
AC 20~250V



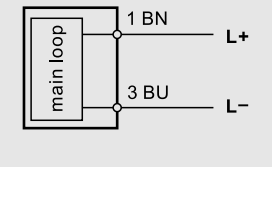
22

Namur
DC 8.2V



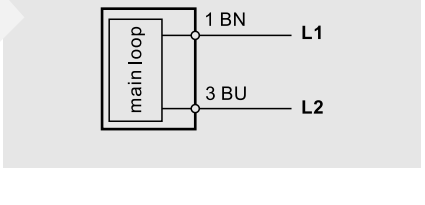
23

DC 2 wire (Emitter)
DC 10~30V



24

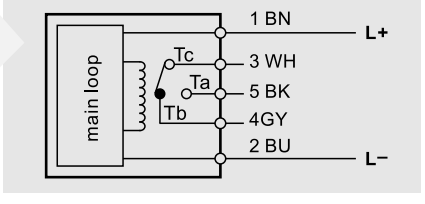
AC 2 wire (Emitter)
AC 20~250V



5 Wires
Cable connection

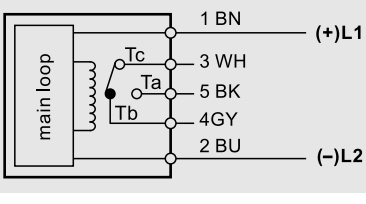
25

Relay output(DC)
DC 10~30V



26

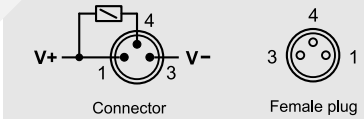
Relay output AC/DC
20~240V DC/AC



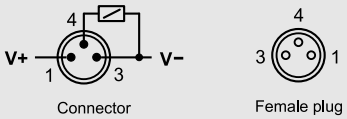
3 wires
Connector connection

1-BN 3-BU
2-WH 4-BK

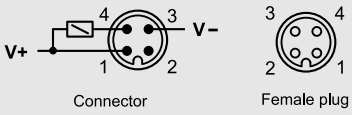
27
NPN N.O. or N.C.
DC 10~30V
(M8)



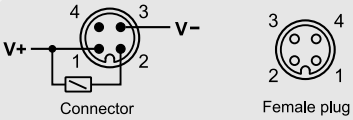
28
PNP N.O. or N.C.
DC 10~30V
(M8)



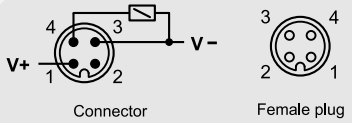
29
NPN N.O.
DC 10~30V
(M12)



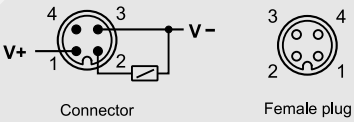
30
NPN N.C.
DC 10~30V
(M12)



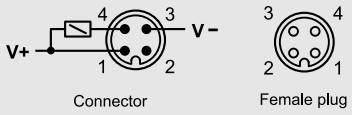
31
PNP N.O.
DC 10~30V
(M12)



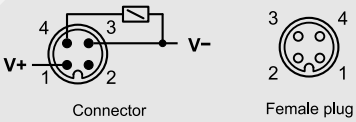
32
PNP N.C.
DC 10~30V
(M12)



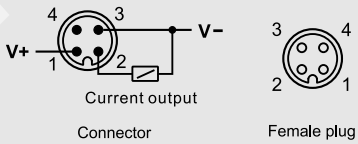
33
NPN N.O./N.C.
changeover
DC 10~30V
(M12)



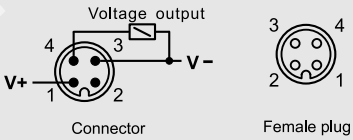
34
PNP N.O./N.C.
changeover
DC 10~30V
(M12)



35
Analog output
DC 15~30V
(M12)



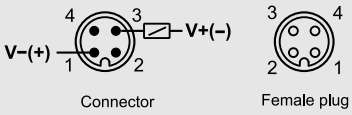
36
Analog output
DC 15~30V
(M12)



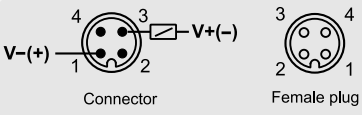
2 Wires
Connector connection

1-BN 3-BU
2-WH 4-BK

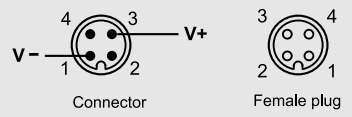
37
2 wire N.O.
DC 10~30V
(M12)



38
2 wire N.C.
DC 10~30V
(M12)



39
2 wire
(emitter of
photoelectric
proximity sensor)
DC 10~30V

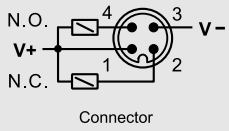


4 wires
Connector connection

1-BN
2-WH
3-BU
4-BK

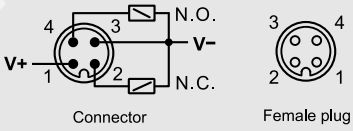
40

NPN N.O. & N.C.
DC 10~30V
(M12)



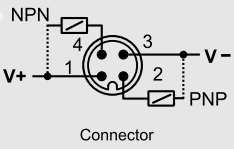
41

PNP N.O. & N.C.
DC 10~30V
(M12)



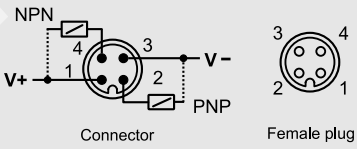
42

NPN/PNP changeover N.O.
DC 10~30V
(M12)



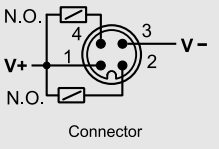
43

NPN/PNP changeover N.C.
DC 10~30V
(M12)



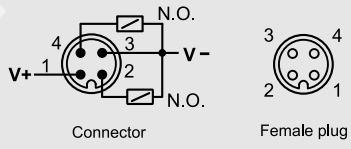
44

NPN N.O.+N.O.
DC 10~30V
(M12)



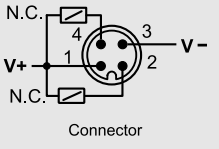
45

PNP N.O.+N.O.
DC 10~30V
(M12)



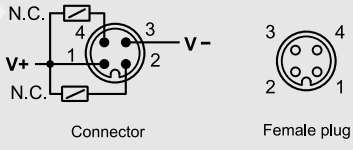
46

NPN N.C.+N.C.
DC 10~30V
(M12)

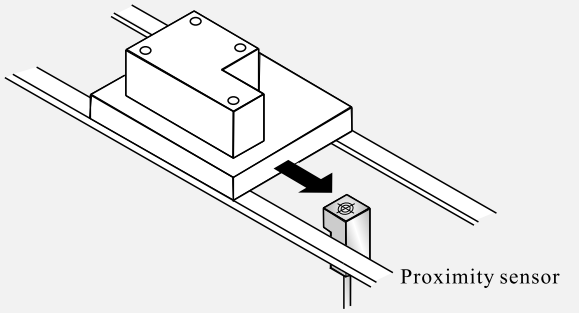


47

PNP N.C.+N.C.
DC 10~30V
(M12)

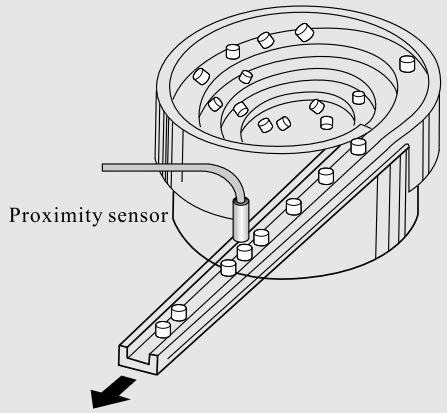


Position detection



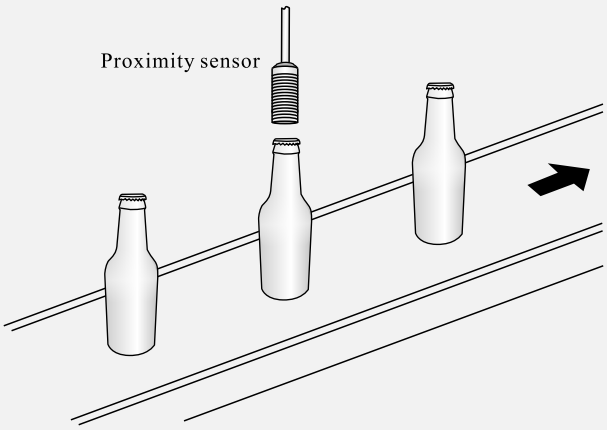
Inductive

Counting



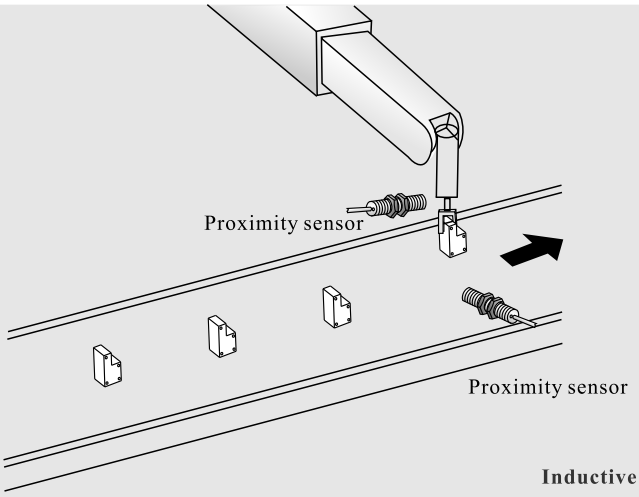
Inductive

Bottle cover detection



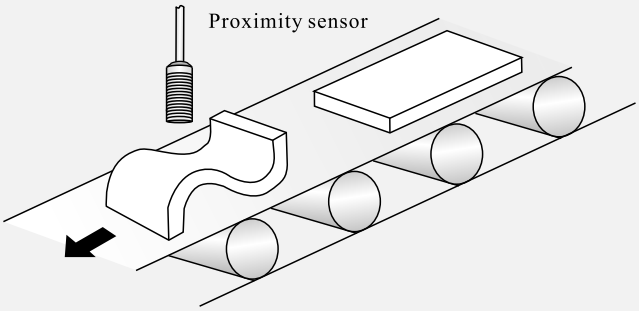
Inductive

Manipulator orientation



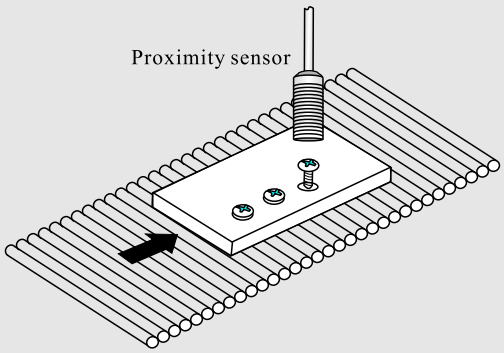
Inductive

Sensing irregular object



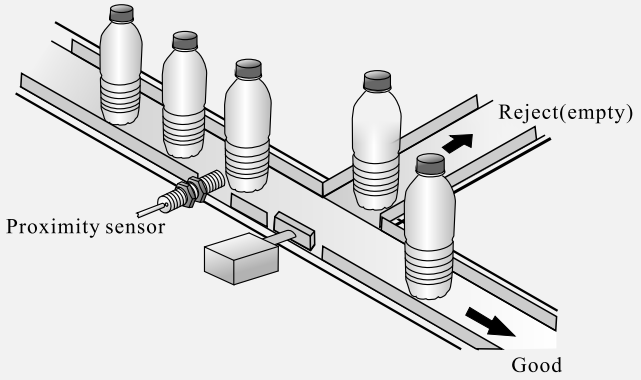
Inductive

Sensing height of screw



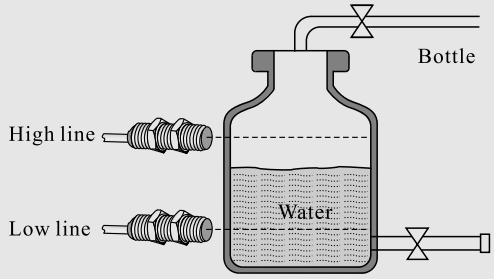
Inductive

Sensing liquid



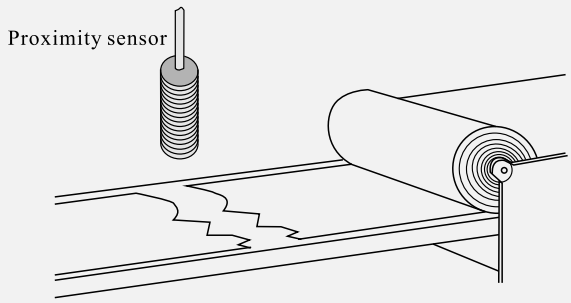
Capacitive

Sensing liquid Level



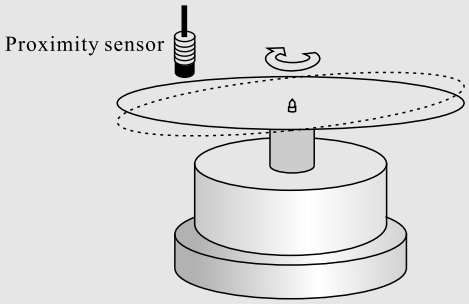
Capacitive

Sensing broken tape



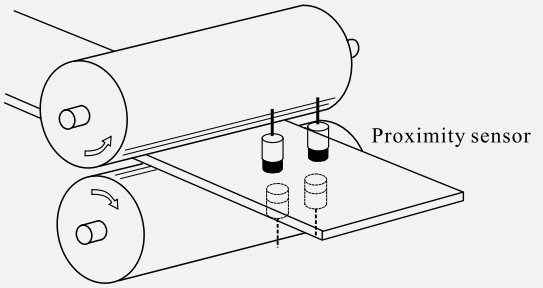
Capacitive

Sensing eccentricity and deviation



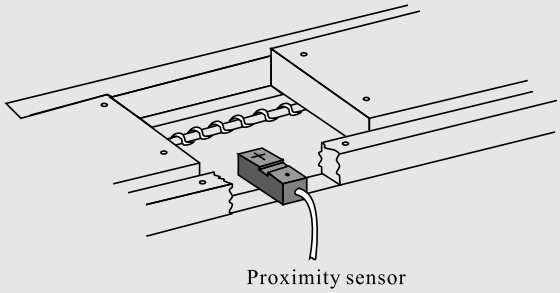
Position change

Sensing thickness and warping



Position change

Sensing object position



Inductive

⚠ **Warning:** Do not use proximity sensors for dangerous machines , as it is not a kind of safety devices . They are mostly used for counting and position detecting etc .

Notes

1. Please do not use the sensor in the flammable and explosive gaseous environment.
2. Please don't disassemble, repair, alter this product without authorization.
3. Be sure the input doesn't exceed the rated supply voltage range. Or there might be damages like crack , burn-out .
4. Try to avoid any shorted load , or there might be damages like burn-out.
5. Pay attention to power polarity to avoid any damages to the unit .

Installation

When installing proximity sensors with a spanner , please do not tight it too excessively . Or it may broken the sensor .

Operation environment

Water tolerance
Please do not immerse the sensor in water for a long time .

Avoid installation in areas as below
1. Too high or too low ambient temperature and humidity .
2. Chemicals surrounding , especially strong acid and alkali .

Maintenance and inspection

To ensure a long-time steady performance , regular maintenance and inspection are required .
1. Checkout whether the sensor is loose, deviated .
2. Checkout the wiring is loose or has bad contact .
3. Checkout no metal dirt or stain attached on the sensor .
4. Checkout whether the indicator is flashing .
5. Checkout whether the ambient temperature or surrounding is abnormal .