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Berenstein Sensors

POSITION SENSORS

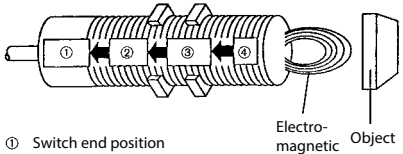
Functional principle of the sensor system

A sensor detects non-electrical physical quantities without contact and converts them into electrical quantities like currents or voltages. In this field, BERNSTEIN concentrates on inductive, capacitive and magnetic proximity switches.

Inductive Sensors

An inductive proximity switch detects metallic objects and consists of four functional groups: a coil, an oscillator, a threshold switch and a switching output stage.

The oscillator generates a high-frequency alternating magnetic field that exits the coil at the active surface. When a metal object enters this field, eddy currents are induced in it. These eddy currents draw energy from the magnetic field and thus from the oscillator; it is damped. The energy withdrawal is greater the closer the metal object is brought to the active surface. The threshold value switch switches on the switching output stage at a defined value of damping.

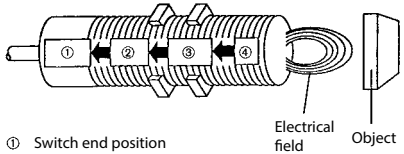


① Switch end position
② Threshold value switch
③ Oscillator
④ Coil

Capacitive Sensors

Capacitive proximity switches detect conductive and non-conductive materials in a solid or liquid state. The sensors consist of 4 functional groups: a sensor electrode, an oscillator, a threshold value switch and a switching output stage.

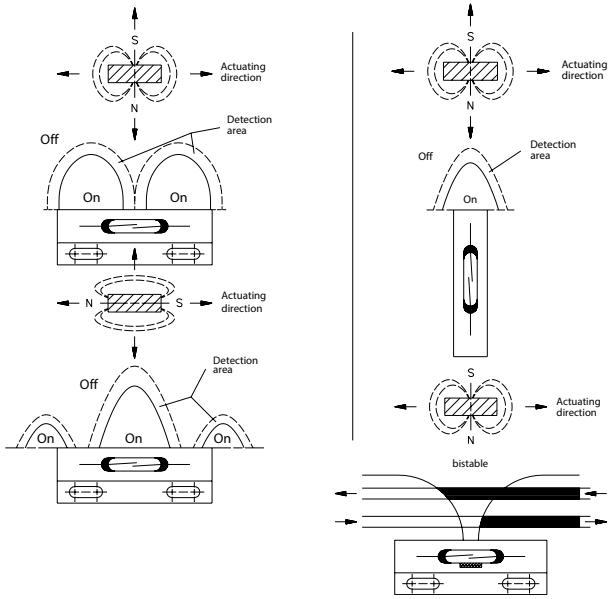
The sensor electrode, which is located behind the active surface, forms a capacitor with an actuating medium in combination with mass. An approximate medium increases the capacitance, which is why the RC oscillator begins to oscillate. The capacitance value required for oscillation can be determined by changing the amplification of the oscillator with a potentiometer. In this way, the response sensitivity/switching distance to the medium can be adjusted. The oscillator output signal is fed to an evaluation circuit which controls the respective switching amplifier.



① Switch end position
② Threshold value switch
③ Oscillator
④ Sensor electrode

Electromechanical magnetic switches

Electromechanical magnetic switches detect electro- and permanent magnets. Basic elements of these magnetic switches are reed contacts which change their electrical behaviour by approaching the actuating magnet. Under the influence of a magnetic field, the contact paddles assume an opposite polarity (south and north pole). Approaching or removing a magnet causes the contact paddles to close or open. The sensitivity of the switch and the field strength of the magnet determine the switching distance.



Electronic Magnetic Sensors

Magnetic switches with magnetoresistive elements or Hall elements detect an actuating magnet without contact. Magnetoresistive sensors react with an increase in resistance, while Hall elements generate a voltage when a magnetic field passes through them. With high switching frequencies and switching distances, as well as vibration resistance, the sensors are a good alternative to electromechanical sensors for challenging applications.

Speed sensors:
Are electronic magnetic sensors with Hall elements, which detect the rotation of ferromagnetic gears with switching distances of up to 2 mm. The high user-friendliness of Hall sensor technology is also fully effective here: high switching frequencies and insensitivity to shock impact.

Cylinder sensors

The sensors are based on the operating principles of magnetic sensors. They are defined by their design, which can be used in all common T and C profiles (e.g. type FESTO or SMC) or in space-saving applications. For this reason, they are often used for checking pneumatic cylinders.

For applications without changing the switching point, fixed sensors can be used. For this purpose, BERNSTEIN offers Hall sensors with adjusted sensitivity or reed contact versions which operate without auxiliary power.

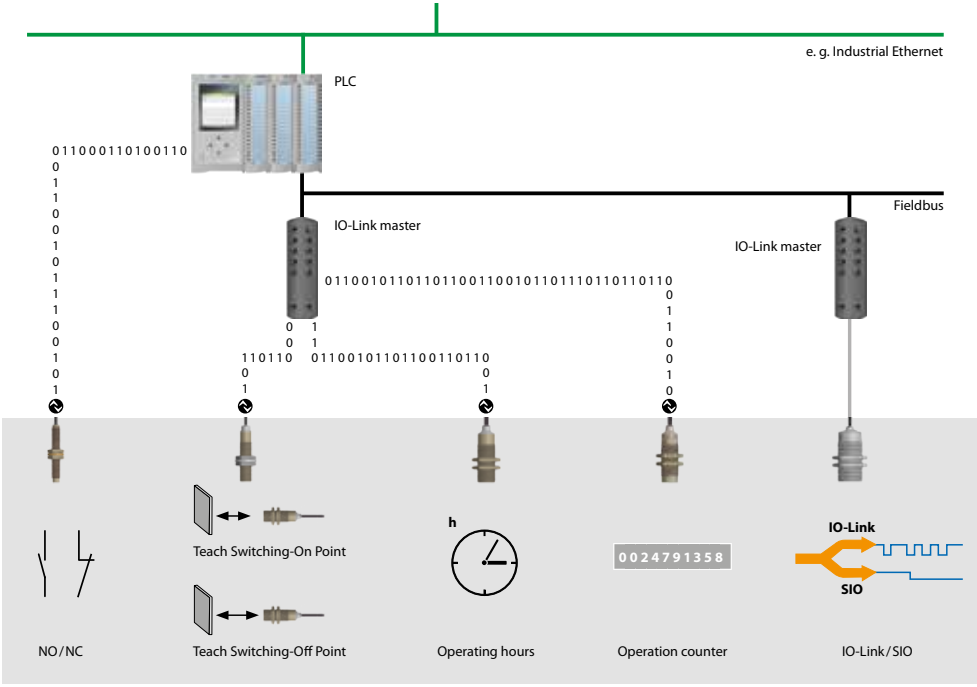
For flexible use, sensors are also offered which permit one or two freely programmable and independent switching points, as well as IO-Link sensors which permit an analog output between two teach-in end positions.

POSITION SENSORS
Technology Overview

NEW IO-Link

IO-Link is a manufacturer-independent, standardized communication interface. It enables continuous communication from the sensor to the controller. With a "wake-up command", the single-switching sensor becomes an IO-Link device. Bidirectional data packets are exchanged via the point-to-point connection, whereby not only the switching signal is transmitted, but also parameter, diagnostic and communication data.

In IO-Link mode, the switching distance and the switching function can be configured, among other things. The sensor can then be operated in IO-Link mode or in standard input/output mode (SIO mode).



AC-2 Wire

These 2-wire sensors are used in applications where AC loads need to be switched. Instead of transistors, thyristors are used as switching output stages.

Analog output

The inductive analogue sensors do not switch at a defined switching point, but instead output an assigned output signal in accordance with their specific characteristic curve at a defined switching distance. Sensors with voltage or current output are commonly used.

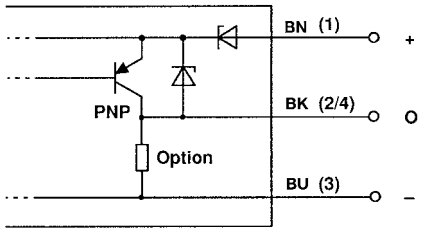
Namur

Standard Namur sensors are DC 2-wire devices consisting of a coil and an oscillator. They change their current consumption depending on the object distance. BERNSTEIN has built on this and also offers sensors that switch at a defined value.

POSITION SENSORS
Basic information

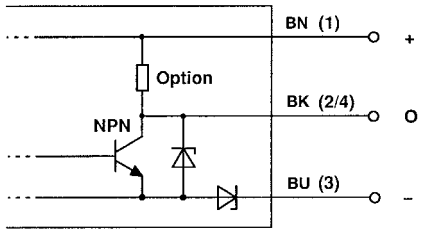
PNP output / Source output

With the source output the load is connected between the switching output and V-. The current flows at Switch V+ through the transistor and then through the load to ground.



NPN output / Sink output

With the sink output, the load is connected between the switching output and V+. The current flows at Switching from V+ via the load and then through the transistor to V-.



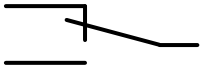
Normally-open contact

When the target enters the detection area, the load current flows. When the target is removed from the detection zone, the circuit is interrupted.

Normally-closed contact

If the target enters the detection area, the circuit is broken. When the target is removed from the detection area, the load current flows again.

Changeover contact



Is a combination of the normally open and normally closed function. When the target enters the detection zone, both elements change their state.

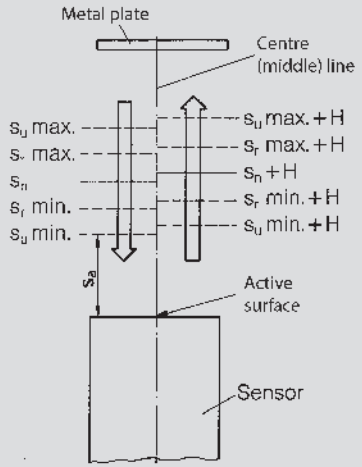
Bistable

These magnetic sensors have integrated bias magnets which keep the contacts closed or pre-tension them. The contacts remain in their switching position until an oppositely polarised stronger magnet cancels the pretensioning.

POSITION SENSORS
Basic information

Sensing distance

Refers to the distance between target and sensor when approaching causes a signal change at the output.



Nominal sensing distance (Sn)

The switching distance does not take into account manufacturing tolerances or changes due to external influences.

Real sensing distance (Sr)

This distance is the effective operating distance measured at nominal voltage and nominal temperature. For inductive and capacitive proximity switches, it must be between 90 % - 110 % of the rated operating distance.

Useable sensing distance (Su)

The measurement of this switching distance takes place within the permissible temperature and voltage ranges. The distance must be between 90 % and 110 % of the real switching distance for inductive sensors and between 80 % and 120 % of the real switching distance for capacitive sensors.

Assured switching distance (Sa)

The distance from the active surface, which ensures switching under the influence of the permissible operating conditions. For inductive proximity switches, the distance must be between 0 % and 81 %, and for capacitive proximity switches between 0 % and 72 % of the rated switching distance.

Hysteresis

Refers to the difference between the switch-on point when an object approaches and the switch-off point when it is moved away. It is given as a percentage in relation to the nominal switching distance.

The hysteresis is necessary to prevent the output from fluttering when objects slowly approach each other due to external influences such as temperature changes, and to prevent electrical interference or vibration.

Response sensitivity

Capacitive sensors react to changes in the electric field. Therefore, depending on the dielectric constant of the object to be detected, different switching distances result. Capacitive sensors often allow the sensitivity to be adjusted with a potentiometer.

Reduction factors

The definition of the switching distance for inductive sensors is based on the measurement with a standardized steel measuring plate. If other materials with the same dimensions are used, the switching distance is reduced.

Switching frequency

Specifies the maximum number of switching cycles per second.

Repeatability

Is the maximum percentage change of the real switching distance when repeated actuation occurs under specified conditions.

Residual current

Indicates the current which flows through the load circuit in the unswitched state.

Voltage drop

Is the maximum voltage which is lost in the switched state via the component resistances of the sensor.

Lowest operating current

The minimum current required at the switching output to maintain the function of the sensor.

Idle current

Is the intrinsic current of a 3-/4-wire proximity switch without a load being connected.

Ready delay

Period between the application of the supply voltage and the time at which the switching output assumes the switching state.

Short-circuit protection

The circuit arrangement protects the sensor from destruction in the event of a short circuit. The output is blocked and the status is interrogated in a clocked manner. Once the short-circuit is removed, the sensor resumes operation.

Reverse polarity protection

If the supply voltage is reversed, the Proximity switch is protected against destruction.

POSITION SENSORS
Basic information

Overload protection

The sensors are protected against destruction by overload. The output is blocked and the status is interrogated in a clocked manner. If the overload is removed, the sensor resumes operation.

Pickup delay

Is a time function integrated in the sensor, which delays the switching of the output when an object is detected.

Dropout delay

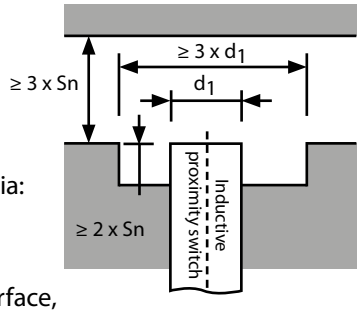
Is a time function integrated in the sensor which delays the switching of the output when an object leaves the active field.

MTTF

Stands for “mean time to failure” and means the average time until a failure. This information is used for the reliability prognosis and predicts a statistical period until failure.

Non-flush

Inductive sensors must have a free zone with the following meet criteria:



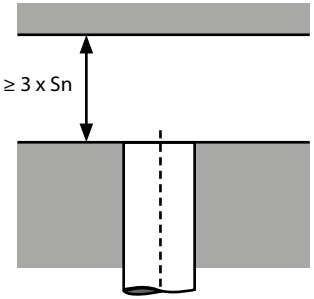
- parallel to the active surface, a free zone at a distance of ≥ 3 x rated switching distance
- laterally to the active surface, a free zone at a distance of ≥ 1 x housing diameter
- free zone of a depth to the active surface ≥ 2 x rated switching distance

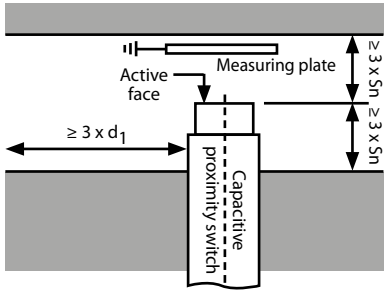
Capacitive sensors must maintain a free zone with the following criteria:

- parallel to the active surface, a free zone at a distance of ≥ 3 x rated switching distance
- laterally to the active surface, a free zone at a distance of ≥ 3 x housing diameter
- free zone of a depth to the active surface ≥ 3 x rated switching distance

Flush

- with flush sensors, the active surface can be flush with a metal surface without being influenced.





Definition of protection classes in accordance with DIN EN 60529

The protection class of an enclosed device denotes the degree of protection. The degree of protection includes the protection of persons against contact with parts under voltage and the protection of equipment against the infiltration of foreign bodies and water.

ISO 20653	DIN EN 60529	IP Protection classes International Protection
1. number		**Protection against foreign bodies and contact**
0	0	No protection
1	1	Protection against foreign bodies ≥ 50 mm/Access with the back of the hand
2	2	Protection against foreign bodies ≥ 12.5 mm/Access with one finger
3	3	Protection against foreign bodies ≥ 2.5 mm/Access with a tool
4	4	Protection against foreign bodies ≥ 1.0 mm/Access with a wire
5K	5	Protection against harmful amounts of dust/ Access with a wire
6K	6	Dust proof/Protection against access with a wire

ISO 20653	DIN EN 60529	IP Protection classes International Protection
2. number		**Protection against water**
0	0	No protection
1	1	Protection against vertical dripping water
2	2	Protection against dripping water up to 15° inclination
3	3	Protection against spray water up to 60°
4	4	Protection against splash water
4K		Protection against splash water at elevated pressure
5	5	Protection against hose water
6	6	Protection against strong hose water
6K		Protection against strong hose water at elevated pressure
7	7	Protection against temporary immersion
8	8	Protection against permanent immersion
9K	9	Protection against steam jet cleaning/ high jet water temperature