4 Steps for selecting the appropriate proximity switch

The purpose of this selection process is to determine which switch type is best suited to the application. This depends on the material properties of the target to be detected.

If the object is made of metal, then an inductive proximity switch should be used.

If the object is made of plastic or paper or if it is a liquid (oil or water), granulate or powder, then a capacitive proximity switch should be applied.

A magnetic field sensor is suitable for objects capable of carrying magnets.

Additional information on the functions of these proximity switches can be found at the beginning of the respective sections.

To find the best proximity switch for your application, proceed according to the following 4 steps:

Step 1 Housing design

Step 2 Sensing range (mm)

Step 3 Electrical data and connections

Step 4 General specifications

Step 1 Housing design

Housing material

The standard housing materials are:

- Stainless steel V2A,
- Nickel-plated or Teflon-coated brass,
- Crastin® (PBT)
- Ryton® (PPS)
- Polyamide (PA)

Crastin® is a semi-crystalline polybutyleneterephthalate (PBT) which is reinforced with fibreglass. It retains its shape extremely well, is resistant to abrasion, heat and cold, and resists hydrocarbons (for example trichloroethylene), acids (for example 28 % sulphuric acid), sea water, hot water (70 °C), etc.

Pepperl+Fuchs uses Ryton®, a crystalline polyphenylene sulphide (PPS) for temperatures up to 150 °C. The material is designed to withstand temperatures up to 200 °C. The electronics are resin-potted within a vacuum.

Cable material

- PVC (Polyvinylchloride):
  Standard quality of the electronic industry medium-resistant to all oils and greases and highly resistant to abrasion.
- PUR (Polyurethane):
  Resistant to all oils, greases and solvents, non-brittle, highly resistant to abrasion.
- Silicone:
  Ideal for extreme temperatures (-50 °C to +180 °C), medium-resistant to abrasion, oils, greases, and solvents.

	Temperature range for	
	PVC leads	**PUR leads**
Moving	-5 °C ... 70 °C	-5 °C ... 70 °C
Not moving	-30 °C ... 80 °C	-30 °C ... 100 °C

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Rectangular proximity switches

This housing design, introduced by Pepperl+Fuchs under the brand name VariKont and VariKont M, has a mounting hole configuration (IC30 and IC40 design) according to the EN 60947 European standard. This configuration is the same as for mechanical proximity switches. The VariKont consists of a robust base enclosure (PBT or metal) which is screwed onto the mounting surface and contains the terminal connections. The top part, which is made of PBT, is sealed against the base enclosure with neoprene and carries the encoded connector. The top part contains the switch amplifier. The sensor head is convertible in five directions, i.e. the active surface can be directed forward, right, left, up or down.

The main difference between the VariKont and VariKont M types is their dimensions. In addition to terminal connections, this product line is also available with V1 plug connectors. The VariKont line has recently been enlarged by the addition of the VariKont L. This design has no terminal compartment and is therefore more compact. Moreover, it can be mounted using only a screwdriver and the active face is adjustable at increments of 15° within two planes. The connection is made with a cable or V1 plug connector.

Type	Dimensions (face size) mm	Adjustments (head)
VariKont	40 x 40 or 55 x 55	Adjustable to 90°
VariKont M	30 x 30	Adjustable to 90° in 15° increments
VariKont L	40 x 40	Adjustable to 90° in 15° increments

Surface switches (FP)

These block-shaped proximity switches have a large face (80 mm x 80 mm) and a correspondingly large sensing range. They consist of two components: the base contains the terminal compartment and the top part the connector pins, sensor element and vacuum resin-potted electronics. The top part is always made of PBT and the bottom part either PBT or cast metal. The mounting hole configuration (ID80 design) conforms to the European standard EN 60947.

Cylindrical proximity switches

The active sensing zone of these switches is at the tip of the switch, perpendicular to the switch axis. They are available in diameters from 3 mm (without threading) or 4 mm (with threading) to 30 mm (with threading) or 40 mm plain (with terminal housing).

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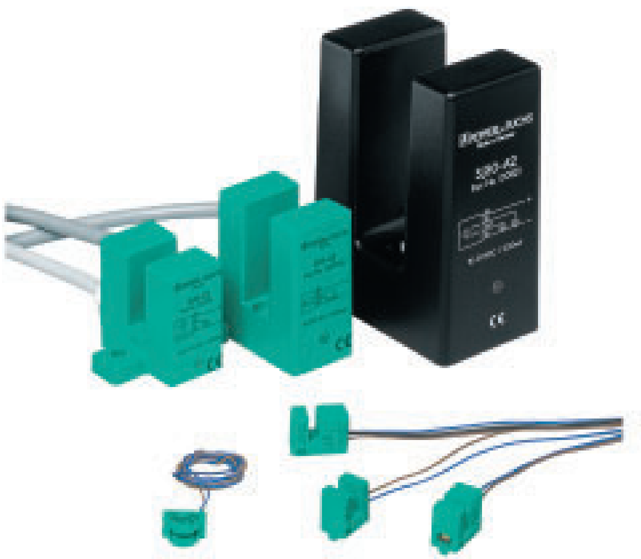
Slot type inductive proximity switches

These have a U-shaped housing made of PBT. The alternating electromagnetic field is generated between two coils which are mounted opposite each other in the shanks of the U-shape. The switching function is activated when the object (metal target) passes through the zone between the coils.



Ring type inductive proximity switches

These proximity switches are arranged in the form of a ring within which the alternating electromagnetic field is concentrated.The switching function is activated when a metallic object passes through the ring.

The housing material is made of PBT.

Screw mounted proximity switches

These small proximity switches are mounted on a designated surface with screws. Versions are available with the active sensing zone facing upwards or forwards.

The housing is normally made of PBT.

Pepperl+Fuchs produces among others the following models:

Housing	Dimensions (W x H x D), mm
F1	26 x 12 x 40
F9	16 x 16.5 x 38.5
F10	25 x 25.5 x 38.5
F11	30 x 30.5 x 52.5
F17	50 x 30 x 7
F29	27 x 10 x 7.2
F33	50 x 25 x 10
F33M	50 x 50 x 7.2
F79	16 x 8 x 4.7

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Step 2

Sensing range (mm)

The sensing range is the most important parameter of a proximity switch. It is primarily dependent on the diameter of the sensor (coil or capacitor). Other influencing factors are the dimensions and the material composition of the target as well as the ambient temperature. With magnetic proximity sensors, the alignment and field intensity of the relevant magnet must also be considered.

Definition of the sensing range

EN 60947-5-2 defines the sensing range for all types of proximity switches apart from slot and ring types.

There are two ways of operating a proximity switch:

- axially approaching objects
- radially approaching objects

The following definitions apply only to axial operation.

Nominal sensing range s_n

The nominal sensing range (according to EN 60947-2-5 "Rated Sensing Range") is a standard value for determining the operating distance. It does not take into account process tolerances or changes due to outside influences such as voltage and temperature.

Standard measuring plate

The following sensing ranges are determined with a standard target. This target is square in shape with a thickness of 1 mm and is made of steel, for example type FE 360 (ST37) with a smoothed surface.

Its profile is either

- 1 x the inner circular diameter of the active surface or
- 3 x s_n.

The greater of the values applies in each case. The standard target must be grounded when using capacitive proximity switches.

Example 1:

Proximity switch M18
Sensing range 5 mm
3 x sensing range = 15 mm < diameter

Therefore, the target must be (18 x 18 x 1) mm in size

Example 2:

Proximity switch M18
Sensing range 8 mm
3 x sensing range = 24 mm

Therefore, the target must be (24 x 24 x 1) mm in size

This standard measuring plate is designed to ensure optimal performance!

The use of different dimensions or materials will reduce the sensing range!

Effective sensing range s_r

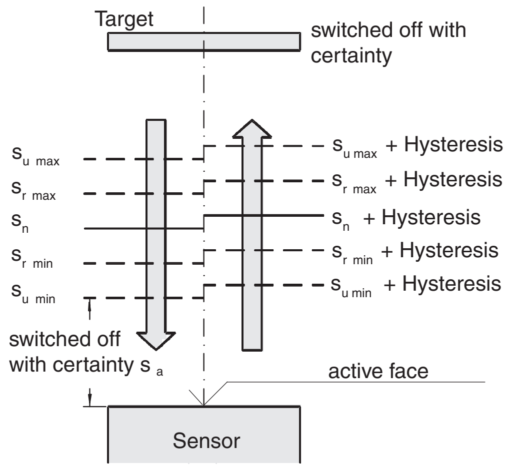
Sensing range of an *individual* proximity switch measured at an ambient temperature of (23 ±5) °C, based on the operating voltage range and the specified installation conditions:

$0.9 \cdot s_n \leq s_r \leq 1.1 \cdot s_n$

Useful sensing range s_u

The sensing range of an *individual* proximity switch measured at an ambient temperature range between -25 °C and +70 °C, at a supply voltage between 85 % and 110 % of the rated operating voltage:

$0.9 \cdot s_r \leq s_u \leq 1.1 \cdot s_r$



Assured sensing range s_a

The distance from the active sensor face in which the operation of the proximity switch is guaranteed based on established conditions:

$0 \leq s_a \leq 0.81 \cdot s_n$

Repeat accuracy R

The variation of the actual sensing range s_r, measured over a period of eight hours with a housing temperature of (23 ±5) °C, an unspecified relative humidity and a supply voltage of U_e ±5 % or an unspecified voltage of ±5 % within the rated operating voltage range:

$R \leq 0.1 \cdot s_r$

Hysteresis H

Distance between the switching points at which the target approaches and moves away from the proximity switch. This value is specified in relation to the effective sensing range s<F8>r<F0> measured at an ambient temperature of (23 ±5) °C and the rated operating voltage:

$H \leq 0.2 \cdot s_r$.

Switched off with certainty

A proximity switch is switched off with certainty when the distance from the target to the active sensor face is at least three times the nominal sensing range s_n.

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Lateral approximation

So far, we have only discussed the axial approach of the standard target. If the target is moved laterally through the active zone, however, a different sensing range (s) is obtained depending on the axial distance. This relationship is described by the response curve.

Influences on the sensing range

Besides its dimensions, the material composition of the target also plays an important role. This is described by the **reduction factor**. The reduction factor is the factor by which the sensing range is reduced based on different materials compared to steel FE 360 (St37) as a reference material for inductive proximity switches and a grounded plate for capacitive proximity switches. The smaller the reduction factor, the smaller the sensing range for the specific material. This reduction factor can vary depending on the housing and shielding material, among other criteria. For this reason, the customer should refer to the value in the relevant data sheet.

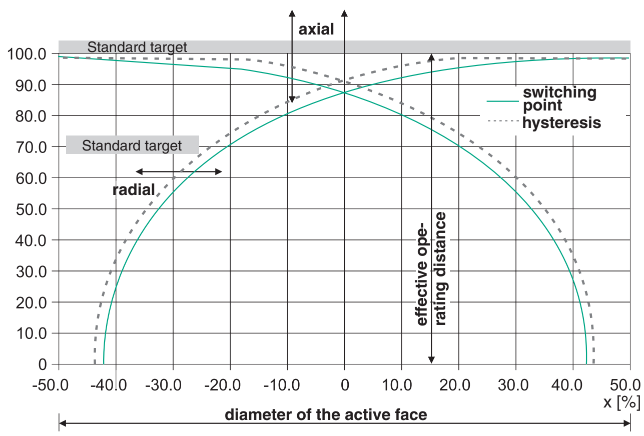
For inductive proximity switches, the conductivity/permeability quotient of the target is the parameter for the reduction factor. The following table contains some typical values for the reduction factor:

Material	Reduction factor
Steel	1
Aluminium foils	1
Stainless steel	0.85
Aluminium	0.4
Brass	0.4
Copper	0.3

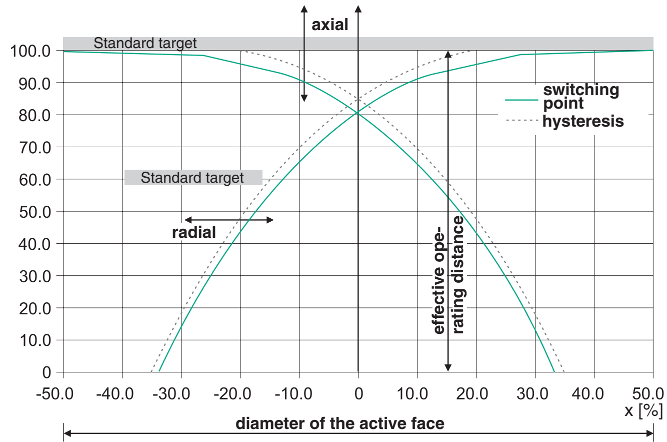
In capacitive proximity switches, the relative permittivity is the parameter for the reduction factor. The following table contains some typical values for the reduction factor:

Material	Reduction factor
Grounded plate	1
Water	1
Alcohol	0.75
Ceramic	0.6
Glass	0.5
PVC	0.45
Ice	0.3
Oil	0.28

Response curves for proximity switches



Standard response curve for capacitive proximity switch



Standard response curve for inductive proximity switch

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Condition for installation

Cylindrical proximity switches

Devices with the same diameter can have different sensing ranges. The following table shows some typical examples:

Diameter [mm]	Sensing range (mm)		
	Embed.	Non-embeddable	Increased sensing range
6.5	1.5	2	-
8	1.5	2	3
12	2	4	6
18	5	8	12
30	10	15	22

Non-embeddable proximity switches

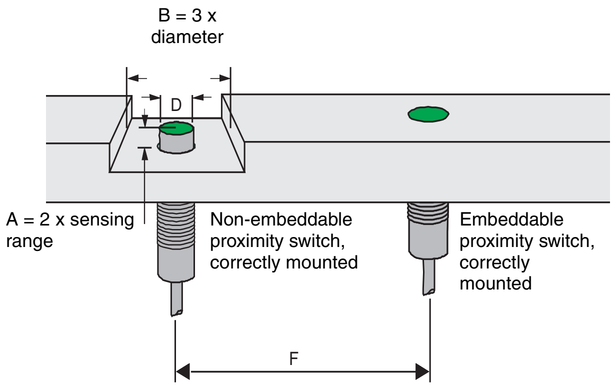
Non-embeddable proximity switches have the greatest sensing range (based on the diameter). As noted earlier, coils are used to generate electromagnetic fields in inductive proximity switches. These coils are placed in a pot core in order to produce a directed field. A portion of this field is still radiated laterally, however. A lateral effect can also be observed in capacitive proximity switches.

In order to prevent these high-range products from being damped by their environment, a space must be left around the sensor element. This space must conform to the minimum requirements shown in the following table.

Model	Dimensions [mm]				
	A		B		F
Ind.	$2 \times S_n$		3 x D		Embed. F = D Non-embeddable F = 3 x D
cap.	Plastics	Metal	Plastics	Metal	
CJ1	5	15	15	30	60
CJ4	20	35	80	120	60
CJ2	15	50	30	60	100
CJ6	40	50	80	160	100

Embeddable proximity switches

Embeddable inductive and capacitive proximity switches can be installed without leaving a space (A=0). The advantage is that they are better mechanically protected and less prone to errors than non-embeddable types. The necessary reduction of the lateral radiation of the field is obtained by special internal shielding. This entails a loss of range. These proximity switches only achieve about 60 % of the sensing range of non-embeddable models.

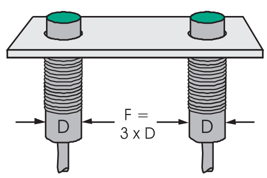


The switching characteristics of magnetic field sensors are practically unaffected by the mounting conditions, as long as the surrounding material is non-magnetisable.

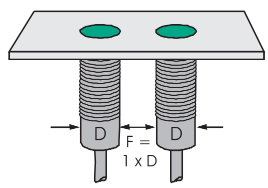
Mutual interference

The minimum distances F listed in the above table must be maintained in order to prevent mutual interference. Proximity switches with altered frequencies are also available on request in case these distances cause application-related problems. They can be mounted directly adjacent to each other.

In case of doubt, please contact us.



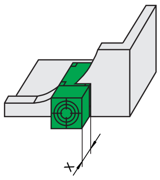
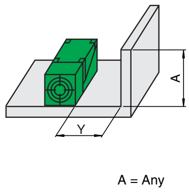
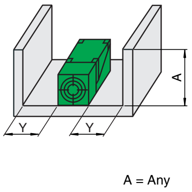
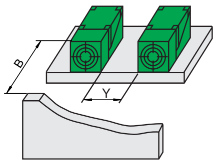
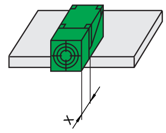
Non-embeddable proximity switch F must be 3 times the housing diameter



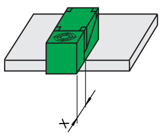
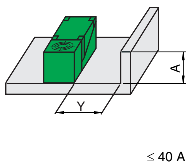
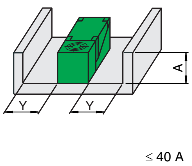
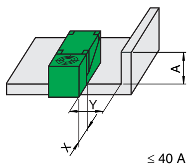
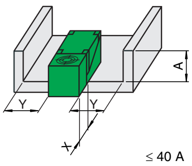
Embeddable proximity switch F must be equal to the housing diameter

Rectangular type proximity switch (Varikont)

(active surface facing forward)

Model	Mounting						
	Dimension [mm]	**X**	**Y**	**Y**	**B**	**Y**	**X**
NJ15+U1+...	**Embed.**	≥ 0	≥ 0	≥ 0	45	≥ 50	≥ 0
NCB15+U1...	**Embed.**	≥ 0	≥ 0	≥ 0	45	≥ 60	≥ 0
NJ20+U1... (AC)	**Non-embeddable**	≥ 20	-	-	60	≥ 60	≥ 5
NJ20+U1... (DC)	**Embed.**	≥ 0	≥ 0	≥ 0	60	≥ 40	≥ 0
NCN20+U1+...	**Non-embeddable**	≥ 25	-	-	60	≥ 120	≥ 10
NJ30+U1+...	**Non-embeddable**	≥ 35	-	-	90	≥ 120	≥ 20
NCN30+U1+...	**Non-embeddable**	≥ 30	-	-	90	≥ 100	≥ 20
NJ40+U1+... (head 55 x 55 mm)	**Non-embeddable**	-	-	-	120	≥ 160	≥ 25
NCN40+U1+...(AC) (head 55 x 55 mm)	**Non-embeddable**	-	-	-	120	≥ 240	≥ 25
NCN40+U1+...(DC) (head 40 x 40 mm)	**Non-embeddable**	-	-	-	120	≥ 160	≥ 25

(active surface facing up)

Model	Mounting							
	Dimension [mm]	**X**	**Y**	**Y**	**X**	**Y**	**X**	**Y**
NJ15+U1+...	**Embed.**	≥ 0	≥ 0	≥ 0	≥ 0	≥ 0	≥ 0	≥ 0
NCB15+U1...	**Embed.**	≥ 0	≥ 0	≥ 0	≥ 0	≥ 0	≥ 0	≥ 0
NJ20+U1... (AC)	**Non-embeddable**	≥ 0	-	-	≥ 30 ≥ 40	≥ 5 ≥ 0	≥ 30 ≥ 40	≥ 5 ≥ 0
NJ20+U1... (DC)	**Embed.**	≥ 0	≥ 0	≥ 5	≥ 0	≥ 0	≥ 0	≥ 0
NCN20+U1+...	**Non-embeddable**	≥ 0	≥ 10	≥ 20	≥ 0	≥ 10	≥ 0	≥ 20
NJ30+U1+...	**Non-embeddable**	≥ 15	-	-	≥ 40	≥ 15	≥ 40	≥ 20
NCN30+U1+...	**Non-embeddable**	≥ 0	-	-	≥ 30 ≥ 40	≥ 5 ≥ 0	≥ 30 ≥ 40	≥ 10 ≥ 5
NJ40+U1+... (head 55 x 55 mm)	**Non-embeddable**	≥ 0	-	-	≥ 45	≥ 0	≥ 55	≥ 0
NCN40+U1+...(AC) (head 55 x 55 mm)	**Non-embeddable**	≥ 0	-	-	≥ 50	≥ 0	≥ 55	≥ 0
NCN40+U1+...(DC) (head 40 x 40 mm)	**Non-embeddable**	≥ 30	-	-	≥ 40	≥ 15	≥ 40	≥ 20

Deviations caused by specific scattering patterns are possible in individual cases

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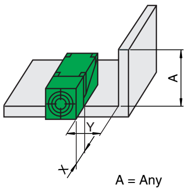
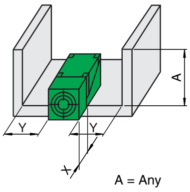
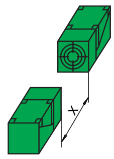
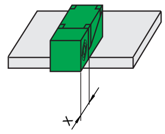
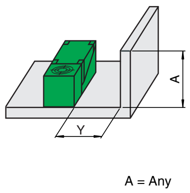
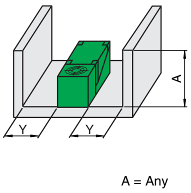
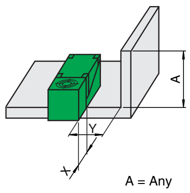
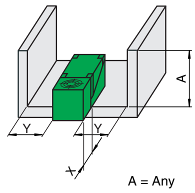
(active lateral surface)

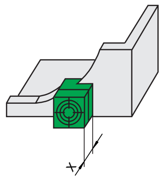
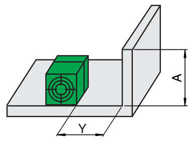
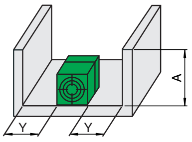
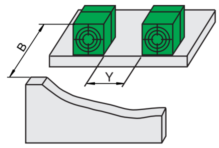
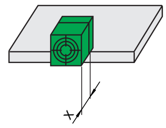
				
X	Y	X	Y	X
≥ 0	≥ 0	≥ 0	≥ 0	≥ 50
≥ 0	≥ 0	≥ 0	≥ 0	≥ 80
≥ 10 ≥ 20	≥ 5 ≥ 0	≥ 10 ≥ 20	≥ 15 ≥ 0	≥ 60
≥ 0	≥ 0	≥ 0	≥ 0	≥ 50
≥ 20	≥ 0	≥ 20	≥ 0	≥ 120
≥ 30	≥ 0	≥ 30 ≥ 40	≥ 10 ≥ 0	≥ 160
≥ 30 ≥ 40	≥ 10 ≥ 0	≥ 40	≥ 0	≥ 100
≥ 30	≥ 0	≥ 30 ≥ 40	≥ 20 ≥ 0	≥ 180
≥ 30	≥ 0	≥ 40	≥ 0	≥ 300
≥ 30 ≥ 40	≥ 10 ≥ 0	≥ 30 ≥ 40	≥ 15 ≥ 0	≥ 300

	**Model**
X	
≥ 0	**NJ15+U1+...**
≥ 0	**NCB15+U1...**
≥ 20	**NJ20+U1... (AC)**
≥ 0	**NJ20+U1... (DC)**
≥ 25	**NCN20+U1+...**
≥ 30	**NJ30+U1+...**
≥ 30	**NCN30+U1+...**
≥ 45	**NJ40+U1+... (head 55 x 55 mm)**
≥ 45	**NCN40+U1+...(AC) (head 55 x 55 mm)**
-	**NCN40+U1+...(DC) (head 40 x 40 mm)**

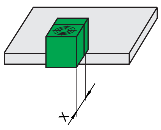
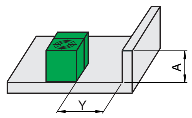
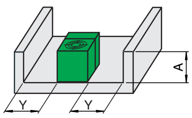
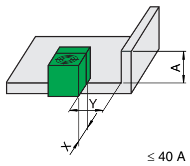
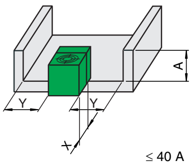
						**Model**
Y	Y	X	Y	X	Y	
≥ 0	≥ 5	≥ 0	≥ 0	≥ 0	≥ 5	**NJ15+U1+...**
≥ 0	≥ 0	≥ 0	≥ 0	≥ 0	≥ 0	**NCB15+U1...**
-	-	≥ 30 ≥ 40	≥ 5 ≥ 0	≥ 30 ≥ 40	≥ 5 ≥ 0	**NJ20+U1... (AC)**
≥ 0	≥ 5	≥ 0	≥ 0	≥ 0	≥ 5	**NJ20+U1... (DC)**
≥ 10	≥ 20	≥ 0	≥ 10	≥ 0	≥ 20	**NCN20+U1+...**
-	-	≥ 40	≥ 15	≥ 40	≥ 20	**NJ30+U1+...**
-	-	≥ 30 ≥ 40	≥ 5 ≥ 0	≥ 30 ≥ 40	≥ 10 ≥ 5	**NCN30+U1+...**
-	-	≥ 50	≥ 0	≥ 55	≥ 5	**NJ40+U1+... (head 55 x 55 mm)**
-	-	≥ 50	≥ 0	≥ 55	≥ 5	**NCN40+U1+...(AC) (head 55 x 55 mm)**
-	-	≥ 40	≥ 15	≥ 40	≥ 20	**NCN40+U1+...(DC) (head 40 x 40 mm)**

Rectangular type proximity switch (Varikont-L)

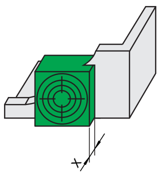
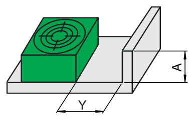
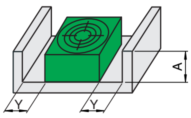
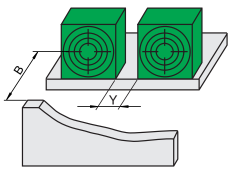
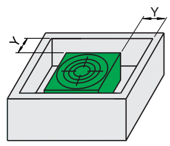
(active surface facing forward)

Model	Mounting		 A = Any	 A = Any			
	Dimension [mm]	**X**	**Y**	**Y**	**B**	**Y**	**X**
NBB20-L2...	**Embed.**	≥ 0	≥ 0	≥ 0	60	≥ 80	≥ 0
NBN30-L2...	**Non-embeddable**	≥ 35	-	-	90	≥ 160	≥ 20
NBN40-L2...	**Non-embeddable**	40	-	-	120	≥ 160	≥ 20

(active surface facing up)

Model	Mounting		 ≤ 40 A	 ≤ 40 A	 ≤ 40 A		 ≤ 40 A	
	Dimension [mm]	**X**	**Y**	**Y**	**X**	**Y**	**X**	**Y**
NBB20-L2...	**Embed.**	≥ 0	≥ 0	≥ 0	≥ 0	≥ 0	≥ 0	≥ 0
NBN30-L2...	**Non-embeddable**	≥ 25	-	-	≥ 30 ≥ 40	≥ 20 ≥ 10	≥ 30 ≥ 40	≥ 30 ≥ 20
NBN40-L2...	**Non-embeddable**	≥ 0	≥ 28	≥ 35	≥ 0	≥ 28	≥ 0	≥ 35

Surface switches (FP)

Model	Mounting		 ≤ 40 A	 ≤ 40 A			
	Dimension [mm]	**X**	**Y**	**Y**	**B**	**Y**	**Y**
NCB40-FP...	**Embed.**	≥ 0	≥ 0	≥ 0	120	≥ 225	≥ 0
NCN50-FP...	**Non-embeddable**	≥ 25	≥ 20	≥ 30	150	≥ 450	≥ 45
NCB50-FP...	**Embed.**	≥ 5	≥ 0	≥ 0	150	≥ 120	≥ 10
NJ40-FP...	**Non-embeddable**	≥ 40	≥ 0	≥ 0	120	≥ 150	≥ 20
NJ40-FP_B1...	**Embed.**	≥ 0	≥ 0	≥ 0	120	≥ 100	≥ 0
NJ50-FP...	**Non-embeddable**	≥ 40	≥ 0	≥ 0	150	≥ 240	≥ 45

Deviations caused by specific scattering patterns are possible in individual cases

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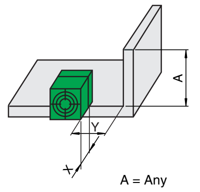
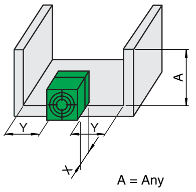
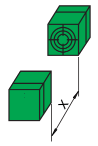
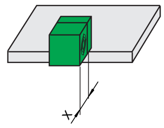
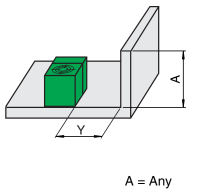
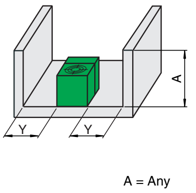
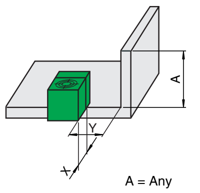
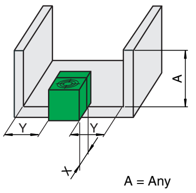
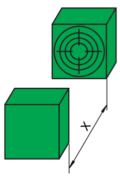
(active lateral surface)

				
X	**Y**	**X**	**Y**	**X**
≥ 0	≥ 0	≥ 0	≥ 0	≥ 70
≥ 30	≥ 10	≥ 30	≥ 10	≥ 140
≥ 40	≥ 0	≥ 40	≥ 0	
≥ 30	≥ 10	≥ 30	≥ 15	≥ 300
≥ 40	≥ 0	≥ 40	≥ 0	

	**Model**
X	
≥ 0	**NBB20-L2...**
-	**NBN30-L2...**
-	**NBN40-L2...**

						**Model**
Y	**Y**	**X**	**Y**	**X**	**Y**	
≥ 5	≥ 10	≥ 0	≥ 5	≥ 0	≥ 10	**NBB20-L2...**
-	-	≥ 30	≥ 20	≥ 30	≥ 30	**NBN30-L2...**
		≥ 40	≥ 10	≥ 40	≥ 20	
≥ 36	≥ 42	≥ 0	≥ 36	≥ 0	≥ 42	**NBN40-L2...**

	**Model**
X	
≥ 290	**NCB40-FP...**
≥ 530	**NCN50-FP...**
≥ 240	**NCB50-FP...**
≥ 400	**NJ40-FP...**
≥ 290	**NJ40-FP_B1...**
≥ 500	**NJ50-FP...**

Mutual interference

As already stated, the minimum distances listed in the adjacent table must be maintained in order to prevent mutual interference. Proximity switches with shifted frequencies are available upon request in case these ranges cause application related problems. They can be mounted directly adjacent to each other.

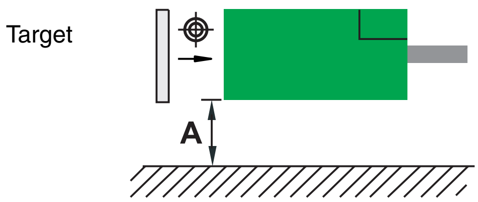
In case of doubt, please contact us.

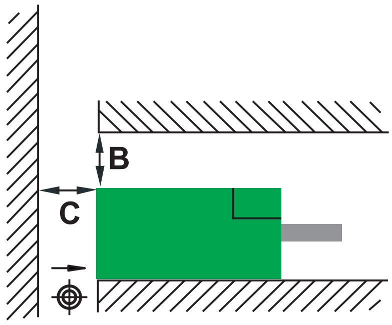
Screw mounted proximity switches

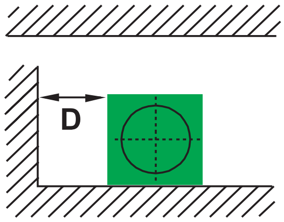
Model	Mounting	Distance [mm]						
		A	B	C	D	E	F	G
NJ2-F1-	Embed.	0	0	6	0	0	12	16
NBB2-V3-	Embed.	0	0	6	0	0	0	10
NJ4-F1	Non-embeddable	0	12	12	18	24	24	32
NBB5-F9-...	Embed.	0	0	15	0	0	16	20
NBN5-F7-...	Non-embeddable	0	0	15	0	0	17	20
NJ6-F-...	Embed.	0	0	18	0	0	22	25
NBB7-F10-...	Embed.	0	0	20	0	0	25	30
NBN10-F10-...	Non-embeddable	0	0	30	0	5	25	40
NCB10-F17...	Embed.	7.5	0	30	0	0	40	40
NBN15-F11-...	Non-embeddable	0	0	45	0	10	30	60

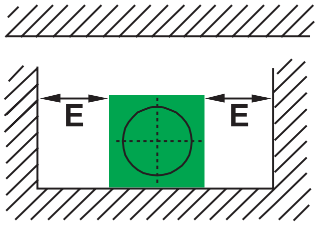
Note:

Non-embeddable proximity switches must not be surrounded on all sides by metal.





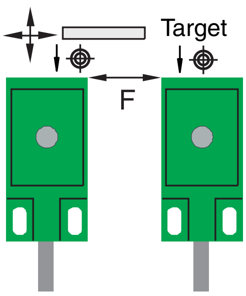


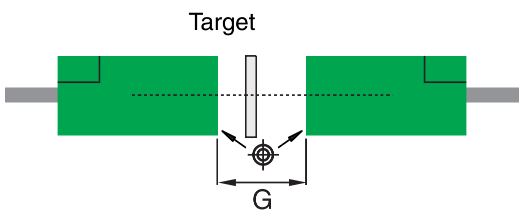


Mutual interference

As already stated, the minimum distances F listed in the above table must be maintained in order to prevent mutual interference.

Proximity switches with shifted frequencies are available upon request in case these ranges cause application related problems. They can be mounted directly adjacent to each other.

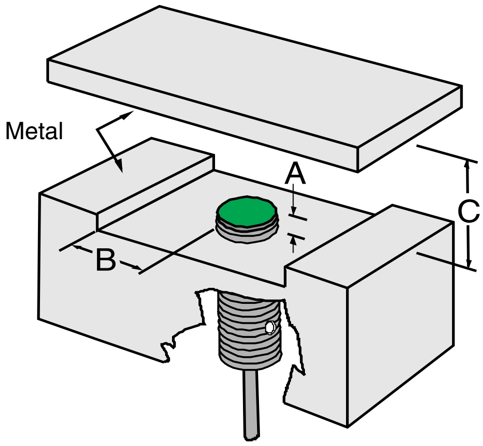




Proximity switches with increased sensing range

These extremely high-range sensors are not fully embeddable. They are known as "semi-embeddable" sensors.

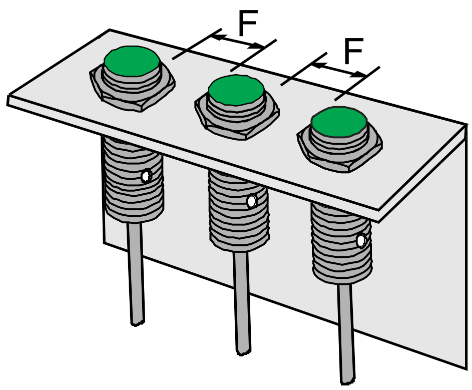
Model	Distance [mm]				
	A (steel, non-ferrous metal)	A (stainless steel)	B	C	F
NEB 3-8...	1.0	0	3	9	8
NEB 6-12...	2.0	1.0	6	18	18
NEB 12-18...	4.0	1.5	12	36	26
NEB 22-30...	6.0	1.5	22	66	50
NEN 6-8...	8	8	8	18	20
NEN 10-12...	12	12	12	30	30
NEN 20-18...	22	22	22	60	60
NEN 40-30...	40	40	40	120	120



Mutual interference

As already stated, the minimum distances F listed in the adjacent table must be maintained in order to prevent mutual interference. Proximity switches with shifted frequencies are available upon request in case these ranges cause application related problems. They can be mounted directly adjacent to each other.

In case of doubt, please contact us.



Step 3

Electrical data and connections

Pepperl+Fuchs supplies proximity switches which can be operated using an AC and/or DC voltage supply.

The following list provides an exemplary overview.

DC proximity switches, two-wire, model Z

These are operated in series with the load. Most are reverse-polarity tolerant (capable of functioning regardless of the connection polarity) and in most cases short-circuit proof; others are reverse-polarity protected (functions only with the correct polarity, otherwise the proximity switch remains in the high-impedance state) and short-circuit proof. In the OFF state, a low residual current is present. In the ON state, a small voltage drop passes across the switch. These switches are available in the following versions:

- Normally open contact (NO) (Z/Z0, Z3, Z4),
- Normally closed contact (NC) (Z1, Z5),
- Connection-programmable (Z2).

DC proximity switches, three-wire, model E

These switches have separate connections for load and power supply. They are overload, short-circuit and reverse-polarity protected. The residual current is negligible. These switches are available in the following versions:

- NO, current sinking npn (E or E0),
- NC, current sinking npn (E1),
- NO, current sourcing pnp (E2),
- NC, current sourcing pnp (E3),
- NO/NC switchable, current sinking npn (E4)
- NO/NC switchable, current sourcing pnp (E5)
- NO, dual channel (E8),

DC proximity switches, four-wire, model A

These proximity switches correspond to the E-models, but are equipped with NC and NO outputs:

- NC and NO, current sinking npn (A or A0).
- NC and NO, current sourcing pnp (A2)

AC proximity switches, two-wire, model W

These are operated in series with the load. In the closed state, a low residual current is present and a voltage drop occurs at the conductive switch. These switches are available in the following versions:

- NC (WO),
- NO (WS),
- NC or NO (W)
  (connection-programmable).

Universal current proximity switches, two-wire, model U

These are operated in series with the load. They can be connected to DC as well as AC power supplies. They are overload and short-circuit proof. In the closed state, a low residual current is present and a voltage drop occurs at the conductive switch. These switches are available in the following versions:

- NC (UÖ),
- NO (US),
- NC or NO (U) (connection-programmable).

NAMUR proximity sensors, two-wire, N

NAMUR proximity switches (**N**ormen**a**rbeitsgemeinschaft für **M**ess- **u**nd **R**egelungstechnik der chemischen Industrie = Standards Working Group for Control and Instrumentation in the Chemical Industry) according to EN 60947-5-6 (VDE 0660 Part 212) are two-wire sensors which have a constant or non-constant current path characteristic. These switches are available in the following versions:

- NC (N/N0),
- NO (1N),
- NC dual-channel (N4).

NAMUR sensors are connected to external switch amplifiers which convert the current change to a binary output signal. Pepperl+Fuchs GmbH offers a wide range of switch amplifiers for applications in hazardous and non-hazardous areas.

Proximity sensors for use in safety-related applications, two-wire, SN

These proximity sensors correspond to the N model sensors, but with a special function: in case of a fault in the sensor/control interface/common connection system, the output of the control interface automatically switches to the safe "Off" state.

The proximity sensors are available in the following versions:

- NC (SN) and
- NO (S1N).

AS-Interface proximity switches

This type of proximity switch is connected directly to the AS-Interface bus. The communication capacity of these devices allows an increased range of functions:

- Pre-fault indicator
- Lead monitoring
- Oscillator monitoring
- Parameterisation (NO/NC)
- On/Off delay

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Parallel and series connection

Proximity sensors can be connected in parallel or series in order to perform AND, OR, NAND and NOR functions. For this purpose, the following must be taken into account:

Series connection of proximity switches

Two-wire and three-wire proximity switches can be operated in series with the exception of NAMUR sensors (EN 60947-5-6).

The maximum number of proximity switches which can be connected in series in a given application depends on the following parameters:

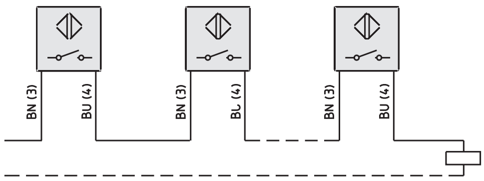
- the function-specific voltage drop at the switch
- the necessary operating voltage of the load
- the applied supply voltage

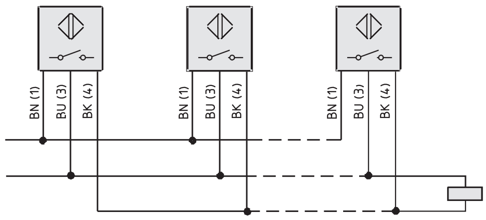
The built-in time delay before availability can lead to an increased reaction time in the case of three-wire proximity switches.

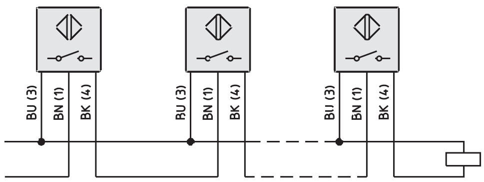
Parallel operation of proximity switches

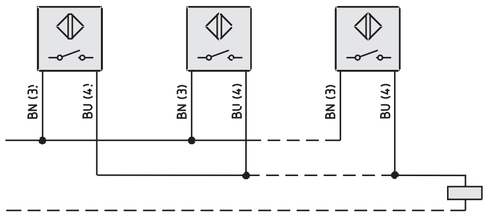
In the case of two-wire switches, the sum of all residual currents flows through the load and can prevent the deactivation of the load under certain circumstances. This limits the maximum number of two-wire proximity switches that can be operated in parallel.

In the case of three-wire switches, parallel operation is non-critical.









Interconnecting mechanical and electronic switches

Three-wire proximity switches can be operated without difficulty in parallel with mechanical switches. In all other cases, the time delay before availability results in an increased reaction time. The parallel operation of two-wire proximity switches with mechanical switches can lead to a brief deactivation of the load.

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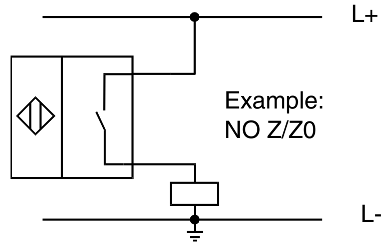
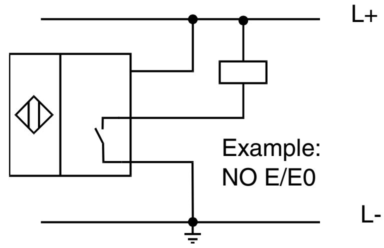
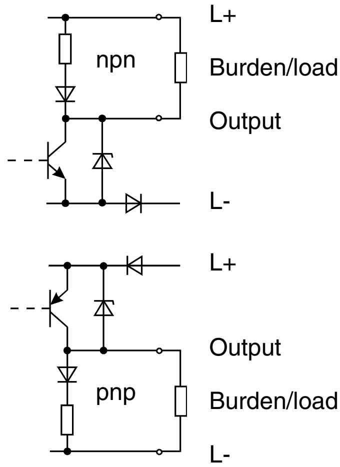
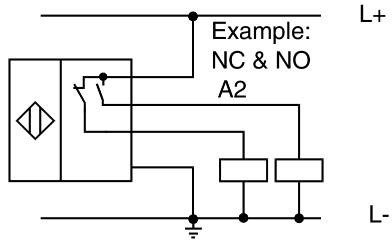
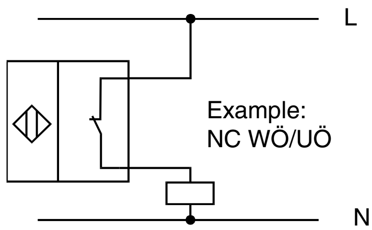
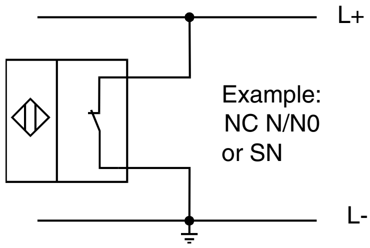
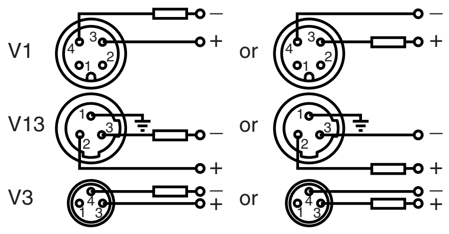
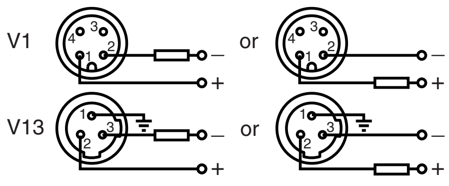
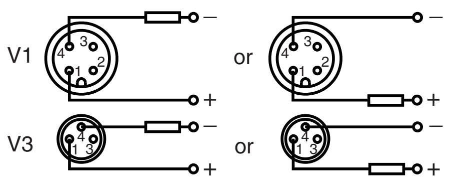
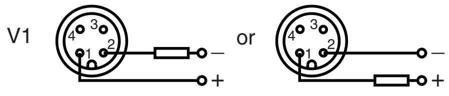
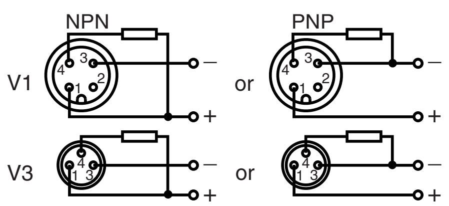
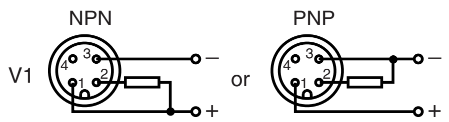
Electrical version	Code	Standard symbol	Typical circuitry/data
DC 10 V ... 60 V	Two-wire Z/Z0, Z1, Z2, Z3, Z4, Z5 reverse-polar-ity protected Standard short-circuit proof	 NO or NC	Basic line 5 V/4 mA ... 100 mA Standard line 4 V/2 mA ... 200 mA Off-state current 0.7 mA0.5
Basic line 10 V ... 30 V 100 mA Standard line 10 V ... 60 V 200 mA	Three-wire E/E0, E1, E2, E3, E5, E8 short-circuit proof reverse-polar-ity protected	 NO or NC	 Data as for type A/A2
	Four-wire A A2 short-circuit proof reverse-polar-ity protected	 NC and NO	Voltage drop 2.5 V Residual current 0.3 mA Operating current 0 mA ... 200 mA No-load current 20 mA
AC 20 V ... 250 V	WS WÖ W W4	NC and NO  	Voltage drop "on": 6 V Residual current 1 mA Operating current 5 mA ... 500 mA
AC/DC 20 V ... 250 VAC 45 Hz ... 65 Hz 30 V ... 300 VDC	US UÖ	NC or NO	Voltage drop "on": 5 V Residual current 1.5 mA Operating current 5 mA ... 500 mA
DC 8 V DC	NAMUR N 1N SN S1N EN 60947-5-6	 NC or NO	Nominal voltage 8 V Output current < 1 mA damped > 3 mA undamped

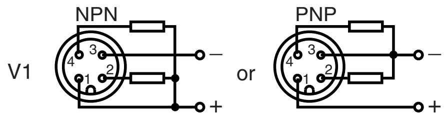
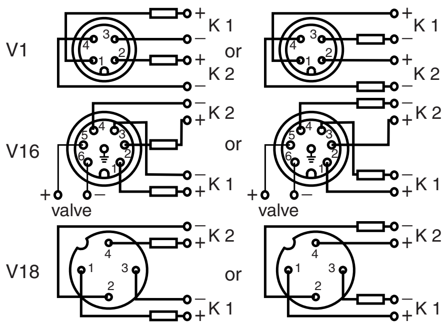
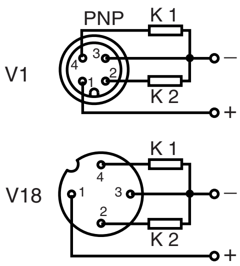
Core colours and connector assignment
(EN 60947-5-2)

Model	Function	Connection	Wire colour	Pin number[2)]	Connector
2 terminals AC	NO (make)		Any colour [1)] except yellow/ green or yellow	3 4	
2 terminals DC unpolarised	NC (break)			1 2	
2 terminals DC polarised	NO (make)	+ -	Brown (BN) Blue (BU)	1 4	
	NC (break)	+ -	Brown (BN) Blue (BU)	1 2	
3 terminals DC Polarised	NO (make)	+ - Output	Brown (BN) Blue (BU) Black (BK)	1 3 4	
	NC	+ - Output	Brown (BN) Blue (BU) Black (BK)	1 3 2	

1) It is advisable to use two wires of the same colour.
2) The terminal numbers (except in the case of AC proximity switches and 3-pin 8 mm connectors) must coincide with the integral connector pin numbers.

Proximity switches without class II insulation require a protective earthing connection for voltages above 50 V AC or 120 V DC.

Core colours and connector assignment (EN 60947-5-2)

Model	Function	Connection	Wire colour	Pin number	Connector
4 terminals DC polarised	Change over (make/ break)	+ - NO (make) -Output NC (break) -Output	Brown (BN) Blue (BU) Black (BK) White (WH)	1 3 4 2	
2 terminals DC and NAMUR polarised	NO (make) and NC (break)	Channel 1+ Channel 1- Channel 2+ Channel 2- Valve + Valve -	Brown (BN) Blue (BU) White (WH) Black (BK) Red (RD) Yellow (YE)	1 3 2 4 5 6	
3 terminals DC polarised	NO (make) and NC (break)	Supply + Supply - Output Channel 1 Output Channel 2	Brown (BN) Blue (BU) Black (BK) White (WH)	1 3 4 2	 K 1 = Channel 1 K 2 = Channel 2

Step 4

General specifications

The **no-load current** I_o indicates the current consumption of the proximity switch. It is measured without a load.

The **operating current** I_L (rated operating current I_e acc. to EN 60947-5-2) indicates the maximum load current for continuous operation.

The **short-term current** I_K is the current that may occur on activation without destroying the proximity switch.

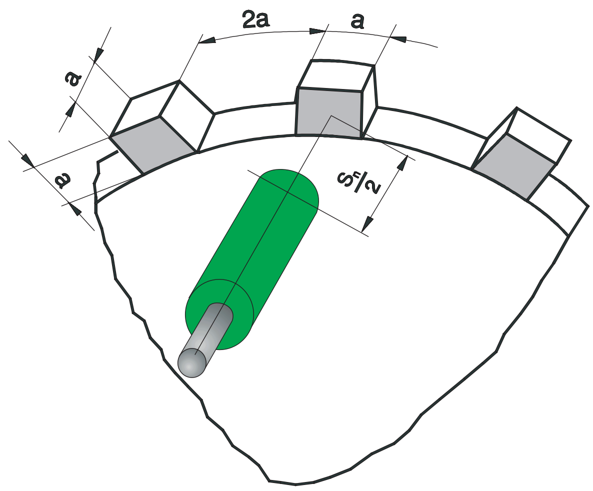
The **residual current** I_R is the current which flows over the load when the proximity switch is closed.

The **operating voltage** U_B is indicated by the maximum and minimum values of the supply voltage. Safe operation of the proximity switch is guaranteed within this range. In the case of NAMUR proximity sensors, the nominal voltage is indicated.

The **voltage drop** U_d is measured over the activated proximity switch or output.

The **switching frequency** f is the maximum number of changes from the damped state to the undamped state expressed in Hertz (Hz). See the diagram based on EN 60947-5-2.

Measurement a is the greater value of the diameter or the edge length and 3 times the rated sensing range.



Measuring flag for determining the maximum switching frequency.

The **ripple voltage** is the alternating voltage (peak-peak) overlapping the operating voltage and is expressed as a percentage of the arithmetic mean. Pepperl+Fuchs GmbH proximity switches conform to DIN EN 60947-5-2 with a max. residual ripple of 10 %.

Admissible noise peaks
Short-term voltage peaks on the supply lines can destroy unprotected proximity switches. Transient protection for all Pepperl+Fuchs switches suppresses noise in accordance with EN 60947-5-2.

The **time delay before availability** t_v is the time required for the proximity switch to become operational after the operating voltage is applied. Pepperl+Fuchs proximity switches conform to EN 60947-5-2 with a max. value of 300 ms.

Start-up signal suppression
This function, which is a feature of most proximity switches, suppresses false signals from the output on application of the operating voltage within the period t_v.

Short-circuit protection
With switched short-circuit protection, which is a feature of most Pepperl+Fuchs GmbH proximity switches, the output stage is switched "on" and "off" periodically when the current limit is exceeded until the short-circuit is eliminated.

The admissible **ambient temperature** is the temperature range within which the proximity switch functions correctly. The following values apply to the standard Pepperl+Fuchs series:

-25 °C... +70 °C or 248 K ... 343 K.

The following values apply to special designs:

-25 °C ... +100 °C or 248 K ... 373 K

-40 °C ... +150 °C or 233 K ... 423 K

0 °C ... +200 °C or 273 K ... 473 K

0 °C ... +250 °C or 273 K ... 523 K

Degree of protection
Pepperl+Fuchs GmbH proximity switches conform to the protection classes IP65, IP67 or IP68
(EN 60529) depending on the design (see page 318).

Admissible shock and vibrational stress
The shock test is conducted at 30 times gravitational acceleration for a duration of 11 ms. The vibration test is performed with a resonant frequency between 10 Hz and 55 Hz and an amplitude of 1 mm (IEC 60068-2-6).

Admissible mounting torque [Nm]

	Stainless steel	Brass	PBT	PPS
M5 x 0.5	3.0	-	-	-
M8 x 1	10.0	3.0	-	-
M12 x 1	15.0	10.0	0.75	-
M18 x 1	30.0	30.0	1.5	5
M30 x 1.5	30.0	30.0	3.0	10

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Type codes of inductive, capacitive and magnetic field sensors

B 10 - 30 G M 50 - E2 - C - V1

Electrical Output

A, A0 — 4-wire, DC, NPN, antivalent
A2 — 4-wire, DC, PNP, antivalent
B3 — AS-Interface Spec. 2.0
B3B — AS-Interface Spec. 2.1
E, E0 — 3-wire, DC, NPN, NO
E1 — 3-wire, DC, NPN, NC
E2 — 3-wire, DC, PNP, NO
E3 — 3-wire, DC, PNP, NC
E4 — 3-wire, DC, NPN, NO or NC
E5 — 3-wire, DC, PNP, NO or NC
E8 — 4-wire, DC, PNP, dual, NO
I3 — 3-wire, DC, PNP, analogue
N, N0 — NAMUR, NC
N3 — NAMUR, bistable
N4 — NAMUR, dual, NC
1N, N1 — NAMUR, NO
U — 2-wire, AC/DC, programm. wiring
UÖ — 2-wire, AC/DC, NC
US — 2-wire, AC/DC, NO
W — 2-wire, AC, programm. wiring
WÖ — 2-wire, AC, NC
WS — 2-wire, AC, NO
Z0 — 2-wire, DC, NO
Z1 — 2-wire, DC, NC
Z2 — 2-wire, DC, NC or NO
Z3 — 2-wire, DC, NO
Z4 — 2-wire, DC, NO
Z5 — 2-wire, DC, NC
Z8 — 2-wire, DC, PNP, dual, NO

Cylindrical
usable
threaded length
(mm)

M — Metal
(V2 or brass,
nickel plated)
K — Plastic
KK — Plastic
terminal
compartment

G — Threading

— Diameter in mm
— Rectangular type
F1, F9, F10, F11, F17, F23, F24, F25,
F29, F31, F33, F41, V3, F46
M — VariKont M® (M1, M1A, M1K)
L2 — VariKont L®
U — VariKont®
FP — Surface switch

Operating range
0.6 mm ... 100 mm

B — flush
N — non-flush

– **B** — Basis series
C — Comfort series
E — Extended operating range
J — Initiator
M — Metal face
R — Reduction factor 1

— Capacitive
— Inductive analogue output sensor
– Magnetic
– Inductive
– Ring type (ind.)
– Slot type (ind.)

Special Features

C — Welding field resistant
DW — Rotation speed monitoring
D — Pressure-proof
FE — Iron
NE/FE — Iron/nonferrous
P or NFE — nonferrous
SN — Safety function
T — Higher temperatures up to 100 ˚C
150, 200, 250 — Maximum applicable temperature

Connection Elements

V1 — M12 x 1 device connector for DC proximity switches
V3 — M8 device connector for DC proximity switches
V5 — Faston connector
V13 — M12 x 1 device connector for AC proximity switches
V16 — Rd24 x 1/8 device connector for dual sensors in F31 housing

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