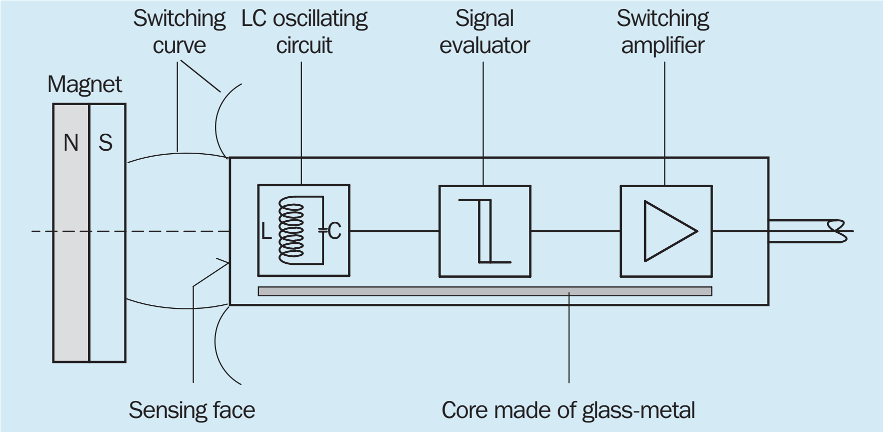
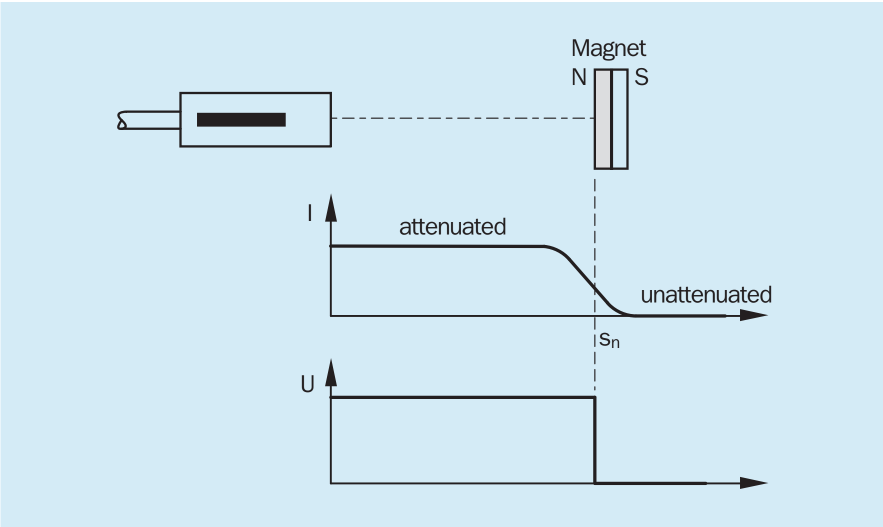
Operating principle

As with inductive proximity sensors, magnetic proximity sensors also have an LC oscillating circuit, a signal evaluator, and a switching amplifier. They also have a core (strip) made of amorphous, highly permeable, and magnetically soft glass-metal.



This strip attenuates the oscillating circuit using eddy-current losses. The core becomes magnetically saturated very quickly if a magnetic field is applied, e.g. if a magnet is brought closer. The eddy-current losses attenuating the oscillating circuit are reduced and the oscillating de-attenuates. The power consumption of a magnetic proximity sensor therefore increases as a magnet is brought closer, in contrast to inductive proximity sensors where the oscillator current is reduced as the switching trigger is brought closer. For this reason, the starting curves are not the lines of an electro-magnetic field, but “limit lines” which describe the saturation of the glass-metal strip by a magnet and the associated “switch-through” of the sensor.

A major advantage of this technology is that large sensing ranges are possible even with small sensor types.



Permanent magnets are usually used to trigger magnetic proximity sensors. They comprise magnetically hard substances – steel alloyed with other metals such as aluminium, cobalt and nickel. Magnetically hard ferrite with similar properties can be also be produced from sintered compounds containing iron oxide and other metal oxides.

Glossary

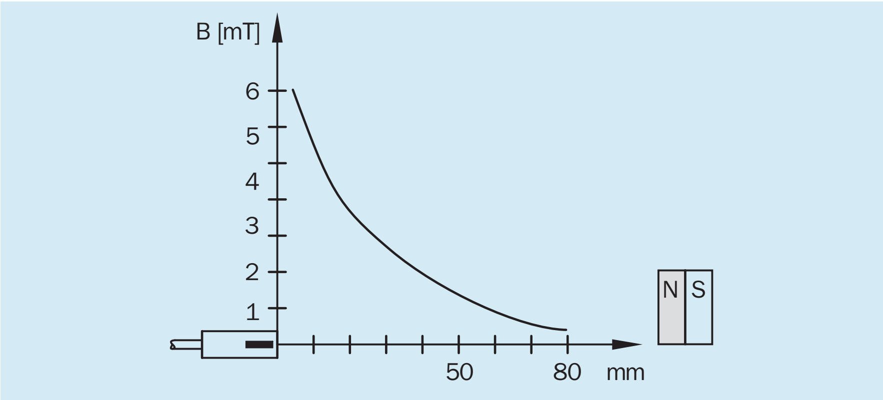
Rated response sensitivity

The response sensitivity applies to both magnetic field poles without external field interference. In rooms and industrial plants, external magnetic fields are caused by the earth's magnetic field, electrical conductors, magnetic coils, permanent magnets, and steel objects containing residual magnetism. Neighbouring iron parts may increase external interference or have a shielding effect. External magnetic fields are usually constant or periodically effective and can therefore be taken into consideration. If necessary, magnetic shielding plates must be used or the sensors must be installed flush in the steel.

Type	Response sensitivity
MM08	0.1 mT
MM12	0.1 mT
MM18	0.9 mT
MQ10	0.1 mT

Magnetic induction

The illustration shows magnetic induction as a function of the distance to the actuating magnet. Electric coils or permanent magnets are used to adjust the response sensitivity of the sensors and also for comparative measurements. An oxide magnet made of barium ferrite with a 30 mm diameter and 10 mm in height (M4.0) is used as the standard measure.



Glossary

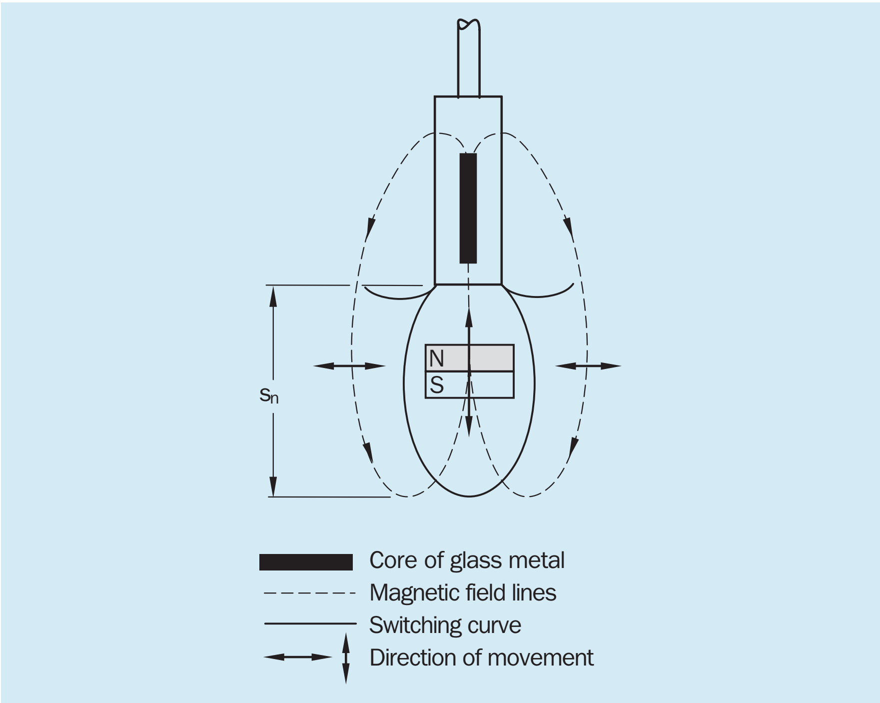
Approach curves

In the case of magnetic proximity sensors, it must be remembered that the alignment of the magnet relative to the sensor axis changes the sensing range. The lines of magnetic flux have to be in one line with the core of glass metal.

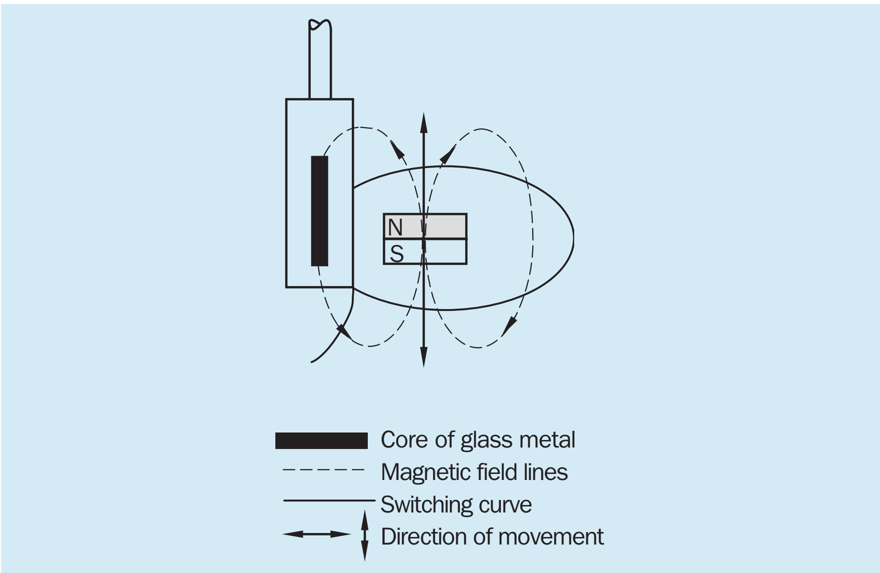
A distinction can be made between the following cases:

Sensor and magnet axis are in alignment with each other

Case 1: The sensor responds as soon as the magnet reaches the switching curve. It can approach the proximity sensor axially or pass in front of the sensor inside the sensing range.



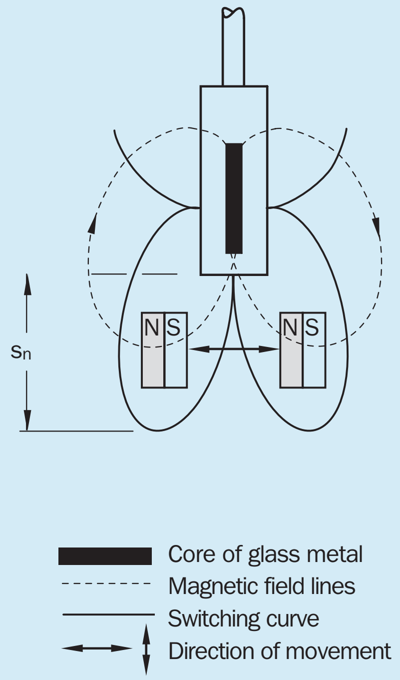
Case 2: The sensor responds if the magnet approaches the switching curve laterally. If the sensor leaves the switching curve, the sensor switches back again. This principle is largely used for magnetic cylinder sensors.



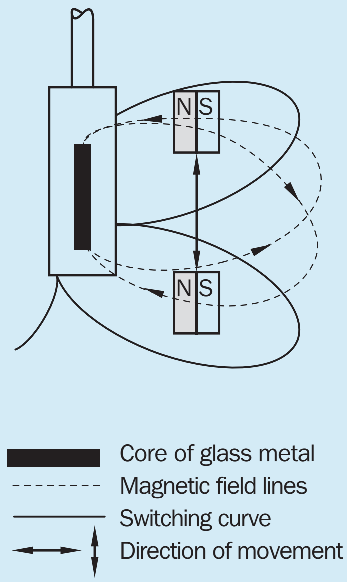
Glossary

Sensor and magnet axis are offset by 90°

Case 3: If the magnet passes radially in front of the proximity sensor, the sensing range is smaller than that in the case 1. If, for example, the sensor enters the left-hand switching curve from the right-hand switching curve, it passes through an area in which the magnetic field is reversed. This briefly de-attenuates the proximity sensor before it is re-attenuated in the left-hand switching curve. Whether or not the evaluation unit can detect this interruption depends on the actuating speed and the axial distance of the traversing magnet.



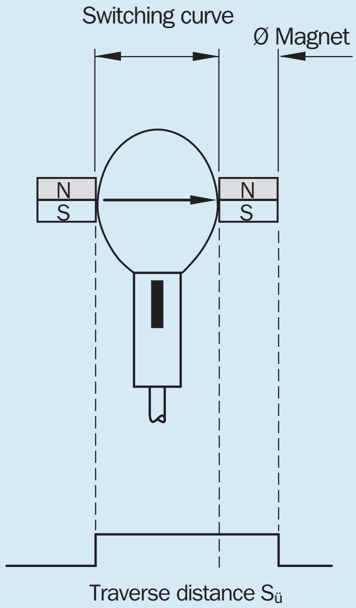
Case 4: In this case, the magnet passes through two switching curves. The magnetic field reverses at the boundary of these curves and two switching points are produced. The detection of this interruption again depends on the actuating speed and the radial distance relative to the sensor axis.



Glossary

Traverse distance $S_ü$

The traverse distance $s_ü$ is the distance between the left- and right-hand boundary of the switching curve plus the diameter of the magnet. If a magnet approaches the switching curve from the left-hand side, the sensor responds. If the magnet leaves the switching curve at the opposite side, the sensor only switches if the magnet has completely left the envelope curve.



Traverse time $t_ü$

$$t_ü = \frac{s_ü}{v_ü}$$

$s_ü$ = Traverse distance
$v_ü$ = Traverse velocity

Sensing range and switching curves

The following tables show the sensing ranges S_n and switching curve diameter (s_D) relative to the actuating magnets:

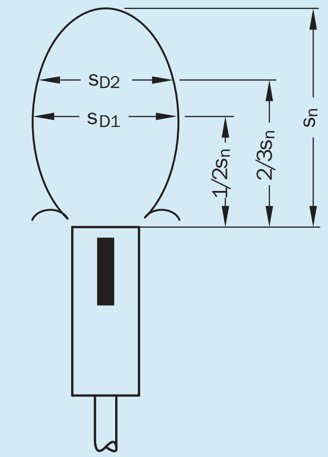
Series MM 08 - 60 A..., MQ 10 - 60 A..., MM 12 - 60 A...				
Magnet type	**S_n mm**			
	On	**Off**	**s_{D1} mm**	**s_{D2} mm**
MAG-1003-S (M1.0)	23	25	28	23
MAG-0625-A (M2.0)	24	25	30	27
MAG-2006-B (M3.0)	36	37	41	36
MAG-3010-B (M4.0)	**60**	61	68	60
MAG-3015-B (M5.0)	68	70	80	67

Series MM 18 - 70 A...				
Magnet type	**S_n mm**			
	On	**Off**	**s_{D1} mm**	**s_{D2} mm**
MAG-1003-S (M1.0)	24	25	30	26
MAG-0625-A (M2.0	25	26	36	32
MAG-2006-B (M3.0)	38	39	45	40
MAG-3010-B (M4.0)	**70**	72	75	65
MAG-3015-B (M5.0)	85	87	86	75

Glossary

Sensing range and switching curves

The difference between S_n “ON” and S_n “OFF” describes the hysteresis of each sensor.



Magnet material

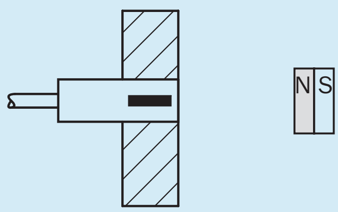
MAG-1003-S	Somarium cobalt (Ø 10 x 3 mm)
MAG-0625-A	AlNiCo (Ø 6 x 25 mm)
MAG-2006-B	Barium ferrite (Ø 20 x 6.5 mm)
MAG-3010-B	Barium ferrite (Ø 30 x 10 mm)
MAG-3015-B	Barium ferrite (Ø 30 x 15 mm)
MAG-3515-B	Barium ferrite (Ø 35 x 15 mm)

The magnet MAG-3010-B (M4.0) is used as the standard measure.

Installation notes

Flush sensor installation

Magnetic proximity sensors can be installed flush in all materials and metals (with the exception of magnetizable material) without any detrimental effects to the sensing range.



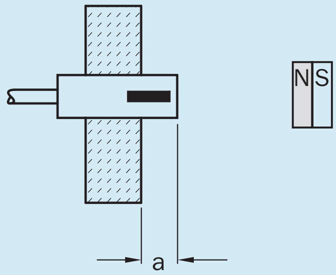
Installation notes

Non-flush sensor installation

The table shows how much the proximity sensor must protrude when installed in magnetizable material so that a reduction in sensing range of more than 5 % is avoided.

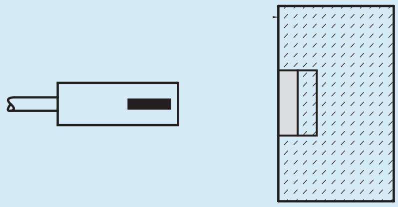
Standard measure MAG-3010-B (M4.0)

Type	Free zone (a)
MM08-60A-...	10 mm
MM12-60A-...	10 mm
MM18-70A-...	15 mm
MQ10-60A-...	10 mm



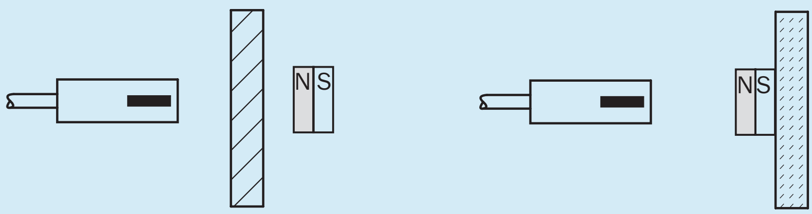
Flush magnet installation

The sensing range is reduced up to 60 % if the magnets are installed in magnetizable material.



Penetration of material

Since magnetic fields do not penetrate all non-magnetizable material, magnetic proximity sensors can be used to detect magnets e.g. behind a non-ferrous metal, plastic, or wooden panel.



Mounting on magnetizable material

If the magnets are mounted on magnetizable material, the sensing range increases to the values printed in bold in the table below:

Series	Actuating magnets S_n [mm]				
	MAG-1003-S (M1.0)	MAG-0625-A (M2.0)	MAG-2006-B (M3.0)	MAG-3010-B (M4.0)	MAG-3015-B (M5.0)
MM08-60A-...	23 **36**	24 **32**	36 **45**	60 **67**	68 **73**
MM12-60A-...	23 **36**	24 **32**	36 **45**	60 **67**	68 **73**
MM18-70A-...	24 **38**	25 **35**	38 **50**	70 **82**	85 **95**
MQ10-60A-...	23 **36**	24 **32**	36 **45**	60 **67**	68 **73**

Selection table

Series	Housing Design, size in mm, material	Sensing range S_n in mm	Switching output P [1]	Switching output N [2]	Output function NO	Connection C [3]	Connection Co. [4]	Electr. config.	from page
	Cylinder with thread								
MM 08	M8, Brass	60						DC 3-w.	386
MM 12	M12, Brass	60						DC 3-w.	388
MM 18	M18, Brass	70						DC 3-w.	394
	Cuboid								
MQ 10	10x28/37x16, Plastic	60						DC 3-w.	400
	Cylinder with thread								
MM 12	M12, Brass	60						NAMUR	392
MM 18	M18, Brass	70						NAMUR	398

1) P = PNP
2) N = NPN
3) C = Cable
4) Co. = Connector

Type code

MQ 10 – 60A P S – K U 0

Sensor technology	
M	Magnetic
Design	
H	Barrel
M	Cylinder with thread
Q	Cuboid
Housing shape, diameter or edge dimension on the sensing face	
08	08
10	10
12	12
18	18
Sensing range/magnetic field	
60	In mm relative to
70	Stand. magnet M4.0
A	Axial
Interface	
P	DC (3-wire) PNP
N	DC (3-wire) NPN
–	NAMUR
Output	
S	NO
N	NAMUR
Housing material	
Z	MS, nickel-plated
K	Plastic
Cables and connectors	
W	Cable, PVC
U	Cable, PUR-PVC
T	Connector, M8 x 1
C	Connector, M12 x 1
Other codes	
0	–