2

Capacitive proximity switches – Check fluid levels and more

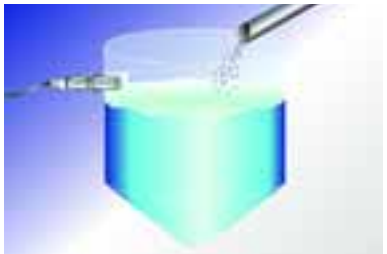
Capacitive proximity switches are also non-contact sensors and respond to the same degree almost instinctively when conducting and non-conducting materials in solid, powder or liquid state are to be measured. They impress customers especially in the case of fill level monitoring through non-metallic materials such as plastic or glass and through various materials in the case of counting objects.

Highlights

- Detection of all materials (e.g. plastics, wood, paper)
- Measurement of liquids through plastic tubes or glass pipes
- Measurement of aggressive chemicals
- Adjustable compensation of operating distance on the object

Application examples

Recognition of milk in cartons



Level control for bulk material in vessel

Standards

The same standards are applicable as for the inductive proximity switches.

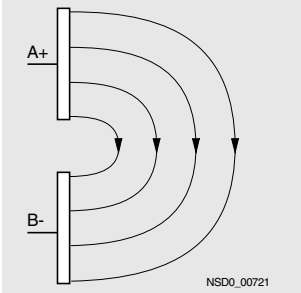
Types

The proximity switches are available in DC or AC versions:

- The DC versions can activate electronic controllers (SIMATIC) or relays directly.
- With the AC version, the load (contactor relay, solenoid valve) is connected directly to the AC supply network (preferably 230 V, 50 Hz) in series with the proximity switches.

Function

The sensing face of a capacitive sensor is formed by two concentrically arranged metal electrodes that are equivalent to the electrodes of an unwound capacitor. The electrode surfaces A and B are connected into the feedback branch of a high-frequency oscillator that is tuned such that it does not oscillate when the surface is free.



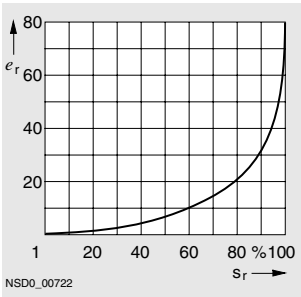
When an object approaches the active face of the sensor, it enters the electric field in front of the electrode surfaces and causes a change in the coupling capacitance. The oscillator starts to oscillate; the amplitude is recorded by an evaluation circuit and converted into a switching command.

Switching rate

The build-up characteristics specific to other pulse/interval conditions may result in higher switching frequencies than those specified.

Operating distance

The stated values are applicable to a target of metal which is grounded and whose area corresponds to the sensing face of the proximity switch. The real operating distance s_r for non-conductive targets is dependent on the relative dielectric constant ε_r and the characteristic value (see characteristic curve).



Dielectric constants of various materials

Material	ε_r	Material	ε_r
Alcohol	25.8	Polyethylene	2.3
Araldite	3.6	Polypropylene	2.3
Bakelite	3.6	Polystyrene	3
Glass	5	Polyvinylchloride	2.9
Mica	6	Porcelain	4.4
Vulcanized rubber	4	Pressboard	4
Hard paper	4.5	Quartz glass	3.7
Wood	2 ... 7	Quartz sand	4.5
Cable insulating compound	2.5	Silicone rubber	2.8
		Teflon	2
Air, vacuum	1	Turpentine oil	2.2
Marble	8	Transformer oil	2.2
Oiled paper	4	Vacuum air	1
Paper	2.3	Water	80
Paraffin	2.2	Soft rubber	2.5
Petroleum	2.2	Celluloid	3
Plexiglas	3.2		
Polyamide	5		

Built-in protection

The protective circuits built into the DC versions make them easy to handle and protect the devices from damage.

- Spurious signal suppression
- Short-circuit and overload protection
- Polarity reversal protection for connections
- Inductive interference protection

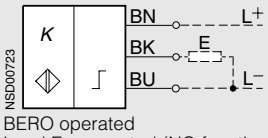
Technical specifications

Type	**DC**	**AC**
Operational voltage	10 ... 65 (30) V	20 ... 250 V
• Residual ripple	Max. 10 %	–
No-load supply current I_0	6 ... 12 mA	Max. 1.7 mA
Switching frequency f	100 Hz	20 Hz
Repeat accuracy R	Max. 2 %	
Differential travel H	0.02 ... to 0.2 s_r	
Outputs:		
Rated operating current I_e		
• For DC	200 mA	–
• For 230 V AC (contactor up to size S3)	–	
- Continuous		500 mA
- Up to 20 ms		5 A
Smallest operating current I_m	–	
• Mainly inductive load		10 mA
• Mainly resistive load		5 mA
Residual current I_r	6 ... 12 mA	Max. 1.7 mA
Voltage drop	Max. 1.8 V	Max. 7 V
Lead length, max. permissible	300 m	
Degree of protection	IP67	
Ambient temperature		
• Operation	–20 ... +70 °C	
• Storage	–40 ... +85 °C	
Shock resistance	30 × g, 11 ms duration	
Resistance to vibration	10 ... 55 Hz, 1 mm amplitude	

Circuit diagrams

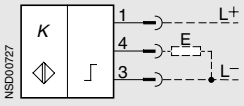
DC

Fig. 1



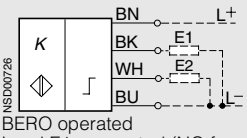
BERO operated
Load E connected (NO function)
e.g. auxiliary contactors, solenoid valves

Fig. 2



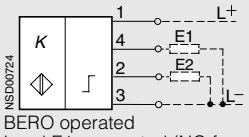
BERO operated
Load E connected (NO function)
e.g. auxiliary contactors, solenoid valves

Fig. 3



BERO operated
Load E1 connected (NO function)
Load E2 disconnected (NC function)
e.g. auxiliary contactors, solenoid valves

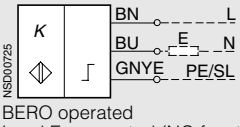
Fig. 4



BERO operated
Load E1 connected (NO function)
Load E2 disconnected (NC function)
e.g. auxiliary contactors, solenoid valves

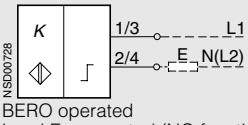
AC

Fig. 5



BERO operated
Load E connected (NO function)
Load E disconnected (NC function)
e.g. auxiliary contactors, solenoid valves
NO or NC function according to type

Fig. 6



BERO operated
Load E connected (NO function)
Load E disconnected (NC function)
e.g. auxiliary contactors, solenoid valves
NO or NC function, programmable

10 to 65 V DC

Technical specifications

No. of connecting wires		**3**	**3**	**4**
Form		**M18**	**Cubic 20 mm × 32 mm**	**M30**
Embeddable in metal		**Shielded**	**Shielded**	**Shielded**
Rated operating distance s_n	1)	**5 mm**	**5 mm**	**10 mm**
Real operating distance s_r	2)	Adjustable	Fixed comparison	Adjustable
Enclosure material		Molded plastic	Metal	Metal with molded-plastic head
Operational voltage (DC)	V	10 ... 65	10 ... 30	10 ... 65
Rated operating current I_e	mA	200	200	200
Displays				
• Switching status		Red LED	Yellow LED	Red LED
• Operational voltage		–	Green LED	–
Degree of protection		IP67	IP67	IP67
Type		3RG16 13–0AB00	3RG16 73–.AG00	3RG16 14–0AC00

1) For target made of earthed metal.

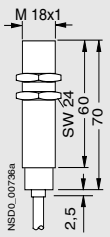
2) With an alignment $s_r > s_n$, the differential travel can increase significantly.

Selection and ordering data

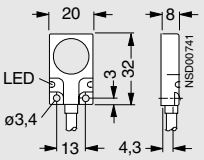
Switching output	Ckt. diag. No.	Connector type	Order No.	Order No.	Order No.
With 2 m cable, LiYY			3 × 0.5 mm²	3 × 0.25 mm²	4 × 0.34 mm²
NO contact, pnp	1		**3RG16 13–0AB00**	**3RG16 73–0AG00**	**–**
NO and NC contacts, pnp (compatible)	3		**–**	**–**	**3RG16 14–0AC00**
With connector, Ø 8 mm					
NO contact, pnp	2	A, C	**–**	**3RG16 73–7AG00**	**–**

Dimension drawings

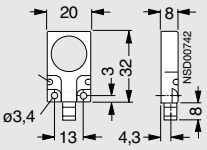
3RG16 13–0AB00



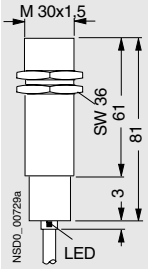
3RG16 73–0AG00



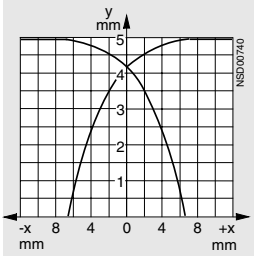
3RG16 73–7AG00



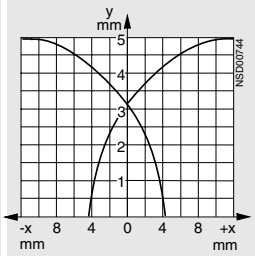
3RG16 14–0AC00



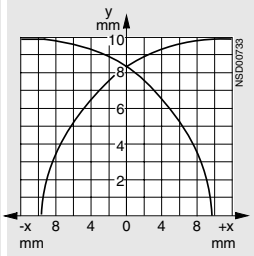
Characteristics



Standard target:
Metal, 20 mm × 20 mm × 1 mm,
with direct connection to ground



Standard target:
Metal, 20 mm × 20 mm × 1 mm,
with direct connection to ground



Standard target:
Metal, 30 mm × 30 mm × 1 mm,
with direct connection to ground

Technical specifications

No. of connecting wires		**4**	**4**	**4**
Form		**M30**	**Ø 40 mm**	**Cubic 40 mm × 40 mm**
Embeddable in metal		**Shielded**	**Shielded**	**Shielded**
Rated operating distance s_n	1)	**10 mm**	**20 mm**	**20 mm**
Real operating distance s_r	2)	Adjustable	Adjustable	Adjustable
Enclosure material		Molded plastic	Molded plastic	Molded plastic
Operational voltage (DC)	V	10 ... 65	10 ... 65	10 ... 65
Rated operating current I_e	mA	200	200	200
Displays				
• Switching status		Yellow LED	Yellow LED	Yellow LED
• Operational voltage		Green LED	Green LED	Green LED
Degree of protection		IP67	IP67	IP67
Type		3RG16 14–6AC00	3RG16 55–6AC00	3RG16 30–6AC00

1) For target made of earthed metal.

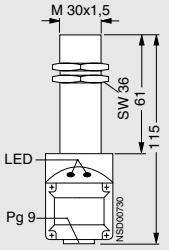
2) With an alignment $s_r > s_n$, the differential travel can increase significantly.

Selection and ordering data

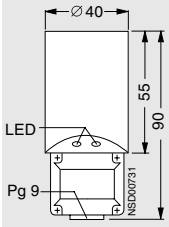
Switching output	Ckt. diag. No.	Connector type	Order No.	Order No.	Order No.
With terminal compartment			Up to 2.5 mm²	Up to 2.5 mm²	Up to 2.5 mm²
NO and NC contacts, pnp (compatible)	4		**3RG16 14–6AC00**	**3RG16 55–6AC00**	**3RG16 30–6AC00**

Dimension drawings

3RG16 14–6AC00

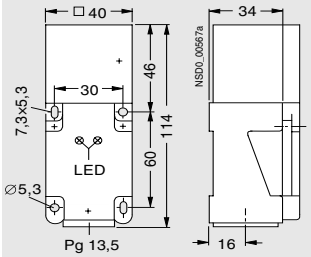


3RG16 55–6AC00

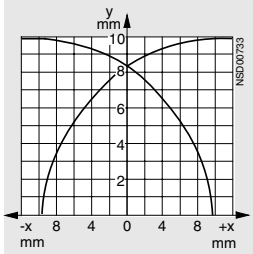


Mounting clamp with Ø 40 mm included in scope of supply

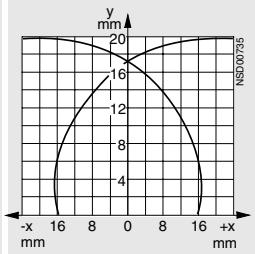
3RG16 30–6AC00



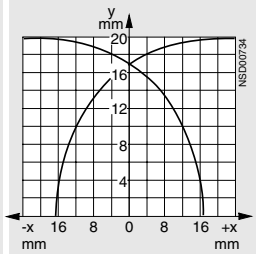
Characteristics



Standard target:
Metal, 30 mm × 30 mm × 1 mm, with direct connection to ground



Standard target:
Metal, 60 mm × 60 mm × 1 mm, with direct connection to ground



Standard target:
Metal, 60 mm × 60 mm × 1 mm, with direct connection to ground

20 to 250 V AC

Technical specifications

No. of connecting wires		**2 + PE**	**2**	**2**	**2**
Form		**M30**		**Ø 40 mm**	**Cubic 40 mm × 40 mm**
Embeddable in metal		**Shielded**		**Shielded**	**Shielded**
Rated operating distance s_n	1)	**10 mm**		**20 mm**	**20 mm**
Real operating distance s_r	2)	Adjustable		Adjustable	Adjustable
Enclosure material		Metal with molded-plastic head	Molded plastic	Molded plastic	Molded plastic
Operational voltage (AC)	V	20 ... 250		20 ... 250	20 ... 250
Rated operating current I_e	mA	500		500	500
Displays					
• Switching status		Red LED	Red LED	Red LED	Red LED
• Operational voltage		–	Green LED	Green LED	Green LED
Degree of protection		IP67		IP67	IP67
Type		3RG16 14–0LB00, 3RG16 14–0LA00	3RG16 14–6LD00	3RG16 55–6LD00	3RG16 30–6LD00

1) For target made of earthed metal.

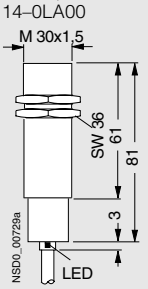
2) With an alignment $s_r > s_n$, the differential travel can increase significantly.

Selection and ordering data

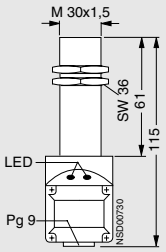
Switching output	Ckt. diag. No.	Connector type	Order No.	Order No.	Order No.
With 2 m cable, LiYY			3 × 0.5 mm²		
NO contact	5		**3RG16 14–0LB00**	–	–
NC contact	5		**3RG16 14–0LA00**	–	–
With terminal compartment			Up to 2.5 mm²	Up to 2.5 mm²	Up to 2.5 mm²
NO or NC contact programmable	6		**3RG16 14–6LD00**	**3RG16 55–6LD00**	**3RG16 30–6LD00**

Dimension drawings

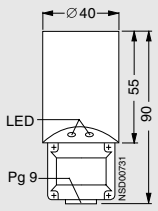
3RG16 14–0LB00, 3RG16 14–0LA00



3RG16 14–6LD00

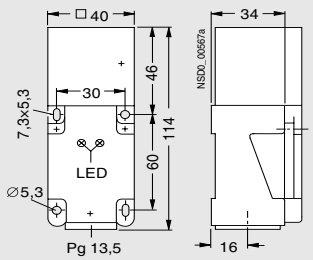


3RG16 55–6LD00

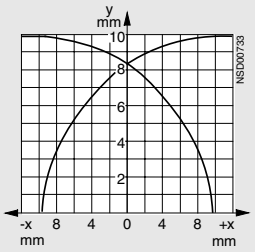


Mounting clamp with Ø 40 mm included in scope of supply

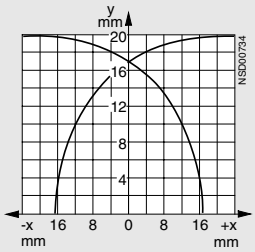
3RG16 30–6LD00



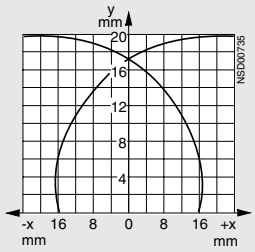
Characteristics



Standard target:
Metal, 30 mm × 30 mm × 1 mm, with direct connection to ground



Standard target:
Metal, 60 mm × 60 mm × 1 mm, with direct connection to ground



Standard target:
Metal, 60 mm × 60 mm × 1 mm, with direct connection to ground