



Figure 11a – Type T, emitter and receiver



Figure 11b – Type R, emitter-receiver and reflector



Figure 11c - Type D, emitter-receiver and object





Figure 11 – Testing of the sensing range (see 8.4)



-54-

- 1 = proximity switch
- 2 = target
- 3 = disc in non-magnetic and non-conducting material

NOTE To avoid angular influence from one target to another, the disc shall be constructed to include at least 10 targets, if the rated operating distance (s_n) is less than 10 mm, or 6 targets for higher operating distances.

Figure 12 – Methods for measuring the operating frequency of inductive, capacitive and non-mechanical magnetic proximity switches (if applicable)

8.5 Testing for the frequency of operating cycles

When the proximity switch frequency of operating cycles exceeds the limit of the measuring method described, the manufacturer shall state the method of measurement.

8.5.1 Method for measuring the frequency of operating cycles

a) Inductive, capacitive and non-mechanical magnetic proximity switches

As shown in Figure 12, the targets are fixed on the front (method 1) or sides (method 2) of teeth on a rotating disc, the spaces between the teeth being 2a, in such a manner that they can pass in front of the sensing face of the proximity switch at a distance equal to half of the rated operating distance.

Each target shall have the same dimensions as those specified in 8.3.2.1. The output signal of the proximity switch is measured with the speed of rotation of the disc increasing from 0.

The targets of the rotating disc shall be connected to earth when capacitive proximity switches are tested.

An illustration of the output signal of proximity switches is given in Figure 14.

With the speed increasing, the durations t_1 and t_2 decrease.

For direct current proximity switches, the rated value of the operating frequency is obtained when t_1 or t_2 correspond to 50 µs, or when the characteristics of the output signal, in the "ON" or "OFF" states, reaches the values specified in the relevant annexes.

For alternating current proximity switches, the rated value of the operating frequency is obtained when either t_1 or t_2 corresponds to one-half period of the supply frequency (f_b).

7

-55-

b) Ultrasonic proximity switch

As shown in Figure 13 the targets are fixed on the front (method 1) or sides (method 2) of teeth on a rotating disc.

The spaces between the teeth being 3*a* in such a manner that they can pass in front of the sensing face at the minimum operating distance and the proximity switch shall be adjusted to this operating distance.



1 = proximity switch

2 = target

3 = disc in non-magnetic and non-conducting material

NOTE 1 To avoid angular influence from one target to another, the disc shall be constructed to include at least 10 targets.

NOTE 2 Method 2 is only applicable to narrow-beam angled proximity switches.







- 56 -

The operating frequency *f* is determined from the following formula:

$$f = \frac{1}{t_1 + t_2}$$

8.5.2 Results to be obtained

The values obtained shall be not less than those given in the relevant annexes.

8.5.3 Photoelectric proximity switches

8.5.3.1 Measurement means

As shown in Figure 15, a rotating disc with one or more targets is fixed parallel to the sensing face of the proximity switch at a distance chosen by the manufacturer, and in such a way that the reference axis of the proximity switch passes through the centre of the target.



Figure 15 – Measurement means for turn-on time t_{on} and turn-off time t_{off}

For types T and R, the effective beam shall be fully broken by the rotating target.

For type D, the surface of the rotating target shall be made of the same material as the standard target.

If the operating distance affects the tests, then the manufacturer shall state the test distance.

A reference sensor having a switching frequency at least ten times higher than the equipment under test (EUT) is also put around the disc.

A recorder (for example, a memory oscilloscope) can draw simultaneously curves delivered by the proximity switch and by the reference sensor (see Figures 16 and 17).

8.5.3.2 Measurement of turn-on time (t_{on})

The positional relationship between the reference sensor and the EUT shall be adjusted while moving the disc slowly so that the output of the reference sensor changes its state simultaneously with the output of the EUT.

To measure t_{on} , the disc speed is adjusted so that the EUT is operated at approximately half of the maximum operating frequency stated by the manufacturer.

-57-

The turn-on time t_{on} is the maximum observed delay between the output of the reference sensor and the change of state of the EUT output (see Figure 16).



NOTE The diagram refers to logical states A and B. A and B will differ according to the type of proximity switch.

Figure 16 – Turn-on time *t*_{on} measurement

8.5.3.3 Measurement of turn-off time (t_{off})

The positional relationship between the reference sensor and the EUT shall be adjusted while moving the disc slowly so that the output of the reference sensor changes its state simultaneously with the output of the EUT.

To measure t_{off} , the disc speed is adjusted so that the EUT is operated at approximately half of the maximum operating frequency stated by the manufacturer.

The turn-off time t_{off} is the maximum observed delay between the noted output of the reference sensor and the change of state of the EUT output (see Figure 17).



NOTE The diagram refers to logical states A and B. A and B will differ according to the type of proximity switch.

Figure 17 – Turn-off time *t*_{off} measurement

8.5.3.4 Results to be obtained

The frequency of operating cycles f determined by the formula given in 7.2.1.6.2 shall be not less than that given by the manufacturer.

8.6 Verification of the electromagnetic compatibility

8.6.1 General

The tests shall be performed under the following conditions:

- the proximity device mounted in free air shall be connected to a load corresponding to the rated operational current (I_e) and supplied with its rated operational voltage (or the maximum voltage of its voltage range) (U_e) ;
- the connecting leads shall be $2^{+0,1}$ m. For proximity devices not having integral cables, the

type of cable used shall be specified by the manufacturer and recorded in the test report.

The test shall be performed:

- a) with the target set at a position such that the switching element is in the OFF-state;
- b) with the target set at a position such that the switching element is in the ON-state;
- for inductive and capacitive proximity devices, the target shall be positioned at 1/3 s_n or 3 s_n ;
- for photoelectric proximity devices, two tests shall be performed. The target shall firstly be positioned such that the excess gain is 2, then:
 - without the target for type D, or
 - without the reflector for type R, or
 - without the emitter for type T.

For the test according to 7.2.6.2.4, the following additional mounting conditions apply:

- cylindrical proximity devices shall be mounted in a non-embedded manner according to Figure A.2 (IA) b). A metal washer, clamped between the lock-nuts of the device, shall be connected to the reference ground plane;
- rectangular proximity devices shall be mounted in a non-embedded manner on a flat metal plate which shall be connected to the reference ground plane;
- the method of connection to the reference ground plane shall be in accordance with the manufacturer's instructions, if given, and shall be stated in the test report.

8.6.2 Immunity

8.6.2.1 Electrostatic discharges

The test shall be performed according to IEC 61000-4-2 and 7.2.6.2.2, and shall be repeated 10 times at each measuring point, with a minimum time interval of 1 s between pulses.

8.6.2.2 Radiated radio-frequency electromagnetic fields

The test shall be performed according to IEC 61000-4-3 and 7.2.6.2.3.

-59-

8.6.2.3 Electrical fast transients/bursts

The test shall be performed according to IEC 61000-4-4 and 7.2.6.2.4, with all the connecting leads placed in the capacitive coupling clamp.

8.6.2.4 Conducted disturbances induced by radio-frequency fields

The test shall be performed according to IEC 61000-4-6 and 7.2.6.2.6.

8.6.2.5 **Power-frequency magnetic fields**

The test shall be performed according to IEC 61000-4-8 and 7.2.6.2.7.

8.6.2.6 Voltage dips and interruptions

The test shall be performed according to IEC 61000-4-11 and 7.2.6.2.8.

8.6.2.7 Harmonics in the supply

Test levels are under study for the future.

8.6.3 Emission

The test shall be performed according to CISPR 11, group 1, class A, and 7.2.6.3.

These limits are given for proximity devices exclusively built for an industrial environment (environment A). When they may be used in a domestic environment (environment B), the following notice shall be included in the instructions for use:

NOTICE

This is a class A product. In a domestic environment this product may cause radio interference, in which case the user may be required to take adequate measures.

8.7 Test results and test report

The test results shall be documented in a comprehensive test report. The test report shall present the objective, the results and all relevant information of the tests. The test report shall define the proximity device under test, including the cable layout and the necessary auxiliary equipment. Any deviation from the test plan shall be mentioned.

Where a range of proximity devices are made according to the same principle and design, and using the same type of components, tests may be performed on representative samples. Furthermore based on first results, the testing laboratory may limit the tested frequency range for radiation or conduction tests and shall include in the report the frequency range used.

- 60 -

Annex A (informative)

Typical dimensions and operating distances of proximity switches

NOTE These dimensions and operating distances were normative for many years. The status of this annex is now changed to "informative", to avoid limiting technological progress.

MODEL IA

INDUCTIVE CYLINDRICAL PROXIMITY SWITCHES WITH THREADED BARREL

A.1 (IA) Dimensions

The dimensions and thread sizes shown in Figure A.1 (IA) shall be according to Table A.1 (IA). Within the dimensional limits of d_1 and l_2 all rigid parts of the connecting leads shall be included. The diameter of unthreaded portion d_2 shall not exceed the minor diameter of the thread. For type I1 embeddable, the thread can be omitted and the diameter reduced to d_2 on a length not exceeding $l_3 = 1$ mm. For type I2 the thread can be omitted and the diameter reduced to d_2 on a length not exceeding $l_3 = 2 s_n$.



Figure A.1 (IA) – Dimensions

Sensing means: inductive (I)		Dimensions						
1 embeddable	2 non- embeddable	Body				Nuts		
Ту	pe	d ₁ Thread size	l ₁ min.	l ₂ max.	AF	<i>m</i> +0,15	d ₃ a max.	
I1A08	I2A08	$M8 \times 1$	40	60	13	4	15	
I1A12	I2A12	M12 imes 1	40	80	17	4	20	
I1A18	I2A18	M18 imes 1	50	100	24	4	28	
I1A30	I2A30	M30 × 1,5 50 100			36	5	42	
^a d _a min. = 1,13 AF.								

Table A.1 (IA) – Dimensions in millimetres

A.2 (IA) Rated operating distances

The rated operating distance, for embeddable and non-embeddable proximity switches, shall be according to Table A.2 (IA). The rated operating distance is a conventional quantity, it does not take into account either manufacturing tolerances or variations due to external conditions such as voltage and temperature (see 2.3.1.1 and 7.2.1.3.1).

Table A.2 (IA) – R	Rated operating	distances in	millimetres
--------------------	-----------------	--------------	-------------

Type I1 – E	mbeddable	Type I2 – Non-embeddable		
Form and size Rated operating distance		Form and size	Rated operating distance	
A08	1	A08	2	
A12	2	A12	4	
A18	5	A18	8	
A30	10	A30	15	

A.3 (IA) Installation (mounting)

Embeddable proximity switches, when installed in damping material shall be according to Figure A.2 (IA) a.

Non-embeddable proximity switches when installed in damping material shall be according to Figure A.2 (IA) b.

BS EN 60947-5-2:2007+A1:2012 EN 60947-5-2:2007+A1:2012 (E)



-62 -

a) Embedded in metal

b) Not embedded in metal

Figure A.2 (IA) – Installation (mounting)

A.4	(IA)	Frequency of operating cycles (f) in operating cycles per second –
	Mini	mum requirements

		Switching element function: A or B Type of output				
Form and size	Installation					
		P or N	D	F		
A08	1	500	300			
	2	300	200			
A12	1	400	200			
	2	200	100			
A18	1	200	100	5		
	2	100	50			
A30	1	70	50			
	2	50	30			
NOTE The frequency of operating cycles are only stated for the most common types. For all other possible types (according to Table 1: Classification) the frequency of operating cycles shall be stated by the manufacturer.						

MODEL IB

-63-

INDUCTIVE CYLINDRICAL PROXIMITY SWITCH WITH SMOOTH BARREL

A.1 (IB) Dimensions

The dimensions shown in Figure A.1 (IB) shall be according to Table A.1 (IB). Within the dimensional limits of d_1 and l_2 , all rigid parts of the connecting leads shall be included.

No part of the proximity switch within the length I_2 shall exceed the diameter d_1 .



Figure A.1 (IB) – Dimensions

Table A.1	(IB) ·	- Dimer	nsions	in	millimetres
-----------	--------	---------	--------	----	-------------

Sensing means: inductive (I)	Dimensions					
1 Embeddable type	d ₁	l ₁ min.	l ₂ max.	Ι ₃ max.		
I1B04	4	25	50	0,5		
I1B06	6,5	40	60	1		

A.2 (IB) Rated operating distances

The rated operating distance shall be according to Table A.2 (IB). The rated operating distance is a conventional quantity. It does not take into account either manufacturing tolerances or variations due to external conditions such as voltage and temperature (see 2.3.1.1 and 7.2.1.3).