Ultrasonic Sensors
Discrete output
Analogue output

General information

- Switch or analogue outputs
- Sensing distances up to 6m
- Stainless steel housing
- Quick disconnect

Ultrasonic Sensors

Ultrasonic sensors
Description

Applications

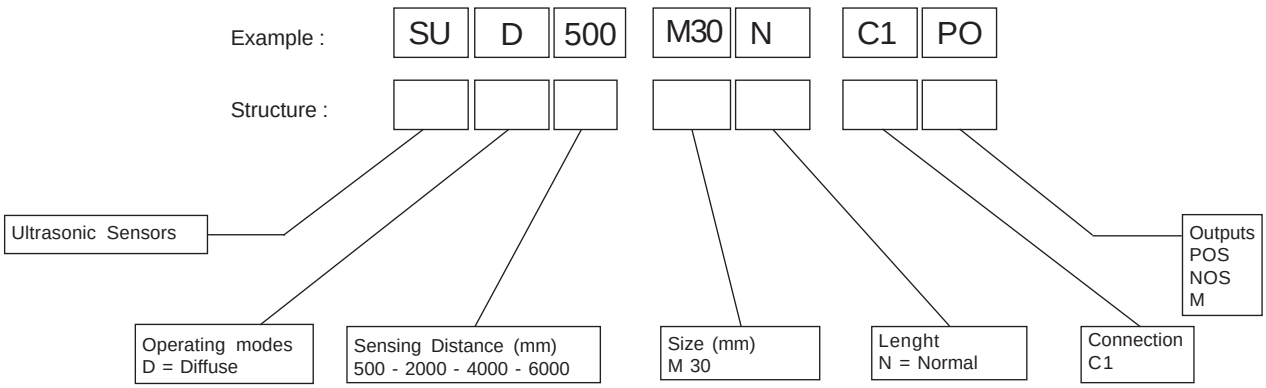
Ultrasonic sensors, with their special characteristics, provide the possiblity for new appications in the field of position detection. They detect objects independently of their colour, in particular if these objects are aligned perpendicularly with respect to the sensor axis or have a rough surface. They clean themselves if deposits occur on the measuring head, and operate with temperature compensation in order to compensate for the differing speed of sound at varying temperature. They can also be used to detect objects not easily accessible because the ultrasonic signal can be deflected accordingly with a reflector.

Description

The Ultrasonic sensors are available in 1 housing :

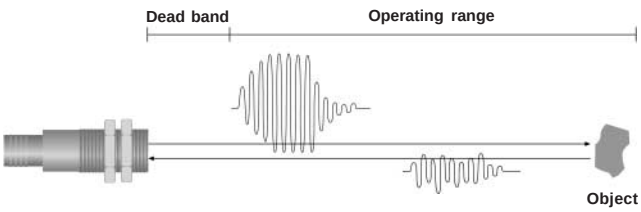
Cylindrical Housing Ø 30
Different heads depending on the sensing distance

Part Nº Structure



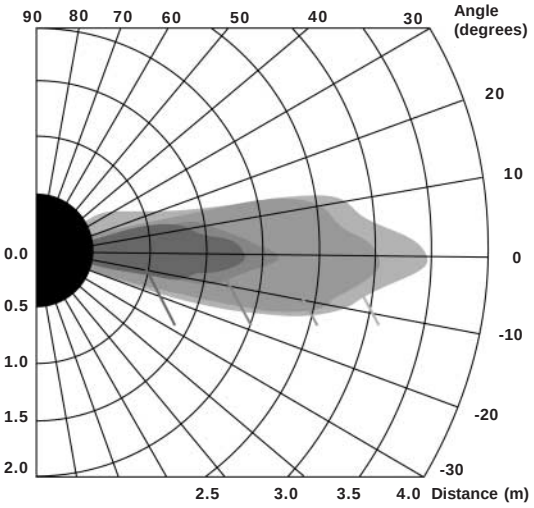
Basic Mode of Operation

Ultrasonic sensors operate in diffuse mode. An ultrasonic transducer summits and receives the ultrasonic signals. Within a stipulated distance range, the incoming echo is checked, the time taken for the sound to travel the distance is determined and a corresponding output signal is emitted. If the distance between sensorand object is too small, the echo arrives before the ultrasonic transducer has reached steady state and is ready to receive. Objects in this dead band cannot be detected reliably.



Sound cone and response curve

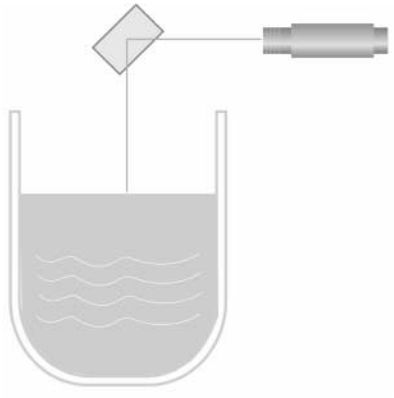
Objects may be moved towards the ultrasonic sensor either frontally or from the side. If it has a smooth surface, the objectmust enter the sensor's range perpendiculary with respected to the sensor axis. If its position deviates from this axis, the results in a so-called sound cone as a function of response distance to angle. The minimum size of the object also determines its nature and surface. This means that different sound cones result for different objects and sensors with a longer range require larger objects.



Response curve of the sensor
SUD2000-M30N-C1-POS for :
A: Level target, 700 x 700 mm
B: Level target, 100 x 100 mm
C: Felt tube ∅ 16 mm
D: Round bar smooth ∅ 25 mm

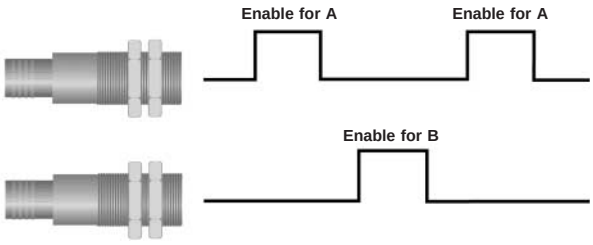
Deflecting and Beaming

One special aspect of the ultrasonic technique is the capability of deflecting sound with smooth reflectors. This allows the level of an agressive fluid to be measured for instance. By contrast, meauring errors occur if the sound is to be beamed r deflected with smooth tubes for instance.



Mutual interaction

Neighbouring ultrasonic sensors influence each other mutually, and the extent of this influence can generally be determined only experimentally. The sync. Input with which the measurement operation can be disabled alternately offers one advantageous solution.the disable times must be selected depending on the times taken for the sound to travel the distance.



To set the switching points:

The ultrasonic sensor is provided with a switching output with two teachable switch points. These are set up by applying the supply voltage $-U_B$ or $+U_B$ to the teaching input. The supply voltage should be applied to the teaching input for at least 1 s. During the teaching process the LED's indicate whether the sensor has recognised the target. The switch points A1 and A2 are taught by voltage $-U_B$ and $+U_B$ respectively

Five functions can be set:

1. Window mode, normally open function
2. Window mode, normally closed function
3. One switch point, normally open function
4. One switch point, norm. closed function
5. Detection of presence of object

1. Teach window operation, normally open function

- Set target at near switch point
- Teach switch point A1 with $-U_B$
- Set target at far switch point
- Teach switch point A2 with $+U_B$

2. Teach window operation, normally closed function

- Set target at near switch point
- Teach switch point A2 with $+U_B$
- Set target at far switch point
- Teach switch point A1 with $-U_B$

3. Teach one switch point, normally open function

- Set target at near switch point
- Teach switch point A2 with $+U_B$
- Cover sensor with the palm of the hand, or remove all objects from the detection range of sensor.
- Teach switch point A1 with $-U_B$

4. Teach one switch point, normally closed function

- Set target at near switch point
- Teach switch point A1 with $-U_B$
- Cover sensor with the palm of the hand, or remove all objects from the detection range of sensor.
- Teach switch point A2 with $+U_B$

5. Teach detection of presence of object

- Cover sensor with the palm of the hand, or remove all objects from the detection range of sensor.
- Teach switch point A1 with $-U_B$
- Teach switch point A2 with $+U_B$

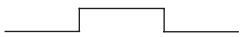
Presetting of the switch points:

A1: Near range
A2: Nominal range
Note: A programming unit SZP > PROG is obtainable for the basic setting of the switch points and output functions.

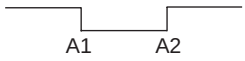
Operating condition-Indications	LED green	LED red	LED yellow
Switch point teaching			
Object detected	flashing	off	off
No object detected	flashing	off	on
Object uncertain (teaching invalid)	off	flashing	off
Normal operation	on	off	switch condition
Interference (e.g. comp. air)	off	flashing	last condition

Programmed switching output function

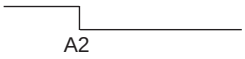
Window operation, normally open function
A1 < A2:



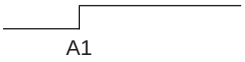
Window operation, normally closed function
A2 < A1:



One switch point, normally open function
A1 – i :



One switch point, normally closed function
A2 – i :



Synchronisation:

In order to suppress mutual interference, the sensor operates via one sychronised input. If the input is unswitched, the sensor operates at an internally generated pulse rate. The sensor can be synchronised by the super position of the square-shaped voltage. One synchronising pulse at the synchronisation input enables one measuring cycle to be completed. The pulse width must be greater than 100 µs. The measuring cycle compences with the descending flank. The state of the switching output changes after the switching threshold has been exceeded five times, as determined internally by five measurements. A low level ≥ 1 s, or an open synchronisation input results in normal operation of the sensor. Synchronisation cannot take place during teaching and vice versa.

Two operating modes are possible:

1. Multiple sensors are controlled with the same synchronising signal. The sensors operate on the same pulse.
2. The synchronising pulses are fed cyclically to only one sensor at a time. The sensor operate in multiplex mode. A high level at the synchronisation input deactivates the sensor.

To set the function

These ultrasonic sensors are equipped with a four pin temperature / programming plug which can be inserted in 4 directions

that have the following function:

A1	Program evaluation limit A1
A2	Program evaluation limit A2
E2/E3	Changeover between falling / rising slope
T	Temperature compensation (Normal operation)

Programming

Only possible under following conditions:
- The programming plug is not inserted
- Less than 5 min after power on. After this time the sensor works without temperature compensation.

Programming procedure:
- Switch power supply off
- Switch power supply on (Reset)

Evaluation limit A1 or A2
- Position target at A1 or A2
- Insert programming plug at position A1 or A2 respective
- Green LED flashes when targed is recognized
- Remove programming plug (saving of the target position)

Output function
- Insert programming plug in position E2 / E3: Changes output from falling to rising edge or vice versa
- The yellow LEDs indicate the output function: E2: Falling slope E3: Rising slope
- Remove programming plug

Temperature compensation

Insert programming plug in position T.

***) Resolution:**

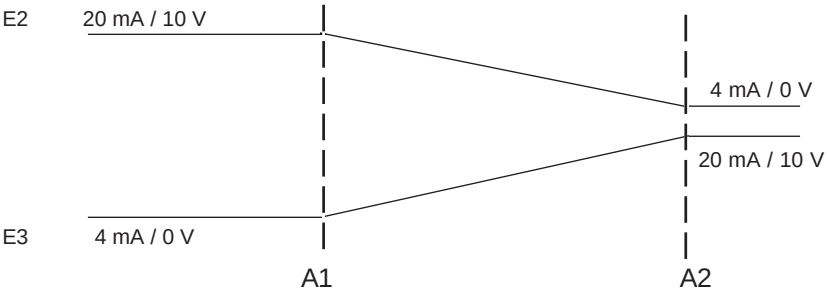
The propagation time is measured within the sensors with a resolution of 1 µs (corresp. to approx. 0.172 mm).
The highest resolution is 0.172 mm is achieved when the difference between evaluation limits A1 and A2 is less than 705 mm (4096x0.172 mm).
For larger ranges the resolution is (A2-A1) / 4096 (A2, A1 in mm).

LED-Indicators

Displays depending upon programming plug position	DuaL LED Green	Dual LED Red	Yellow LED A1	Yellow LED A2
Program evaluation limit 1				
Object detected	Flashing	Off	Flashing	Off
Object not detected	Off	Flashing	Flashing	Off
Program evaluation limit 2				
Object detected	Flashing	Off	Off	Flashing
Object not detected	Off	Flashing	Off	Flashing
Program fslope				
Falling slope	ON	OFF	Flashing	OFF
Rising slope	ON	OFF	OFF	Flashing
Normal operation with Temperature compensation	ON	OFF	ON/OFF 1)	ON/OFF 1)
Programming plug removed or shortet out	OFF	ON	ON/OFF 1)	ON/OFF 1)
Disturbance (e.g. compressed air)	OFF	Flashing	Last status	Last status

1) ON: Object in evaluation range, OFF: No object in evaluation range

Analog output in accordance with E2/E3 programming:



near distance of evaluation — far distance of evaluation

Ultrasonic Sensors: Discrete Output
Cylindrical ∅30 mm
Technical Data

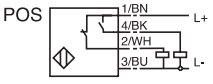
Size

M30 x 1.5

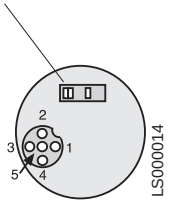
SUD500-M30N-C1-POS

Model	SUD500-M30N-C1-POS	... NOS	SUD2000-M30N-C1-POS	... NOS
Sensing range **Output**	**60 mm ...500 mm** **PNP, programmable**	**... NPN**	**200 mm ...2000 mm** **PNP, programmable**	**... NPN**
Operating specifications				
Standard test target (min.flat surface) Beam divergence angle Transducer frequency	100 mm x 100 mm approx. 5° at -3 dB approx. 375 kHz		100 mm x 100 mm approx. 5° at -3 dB approx. 175 kHz	
Response time Hysteresis Reproducibility Temperature drift	approx. 38 ms ≤ 1 % of the set operating distance ≤ 1 % 0.2 % / K		approx. 145 ms ≤ 1 % of the set operating distance ≤ 1 % 0.2 % / K	
Electrical specifications				
Supply voltage U_B / ripple Reverse polarity protection Current consumption Switch output (PNP)	20 ... 30 VDC / +/- 10 % $_{pp}$ yes ≤ 60 mA 200 mA, U_B -3V circuit / overload proof		20 ... 30 VDC / +/- 10 % $_{pp}$ yes ≤ 60 mA 200 mA, U_B -3V circuit / overload proof	
Teaching input (2): Near switch point Far switch point	-U_B Near switch point +U_B Far switch point		-U_B Near switch point +U_B Far switch point	
Synchronisation input (5) for continuous measuring	≥ 1s low or not connected		≥ 1s low or not connected	
Synchronisation (used if 2 or more sensors) Measuring time / repetition rate Each sensor needs to change output signal Synchronisation pules / pause length Synchronisation levels (5) / Impedance	Starts with falling edge of the sync. input approx. 6.5 ms/ ≤ 13Hz 5 pulses / ≥ 60 ms ≥ 100 µs / ≥ 100 ms Low P. 0...1 V, High P. 5V ...+U_B approx. 27 kΩ		Starts with falling edge of the sync. input ≥ 25 ms / ≤ 3.4 Hz 5 pulses / ≥ 150 ms ≥ 100 µs / ≥ 100 ms Low P. 0...1 V, High P. 5V ...+U_B approx. 27 kΩ	
Indicators: LED green LED red LED yellow	"Power on", teaching funct., object detected "Fault", object uncertain Switching condition indicator teaching function, no object detected		"Power on", teaching funct., object detected "Fault", object uncertain Switching condition indicator teaching function, no object detected	
Mechanical Specifications				
Operating temperature range Storage temperature range Protection class to EN / IEC	-25°C ... +70°C -40°C ... +85°C IP 65		-25°C ... +70°C -40°C ... +85°C IP 65	
Housing material	303 Nickel plated brass		303 Nickel plated brass	
Transducer material	Epoxy resin / silica composite Polyurethane foam		Epoxy resin / silica composite Polyurethane foam	
Cover and head	PBT (Crastin)		PBT (Crastin)	
Permissible shock and vibration loading	b ≤ 30 g, T ≤ 11 ms f ≤ 55 Hz, a ≤ 1 mm		b ≤ 30 g, T ≤ 11 ms f ≤ 55 Hz, a ≤ 1mm	
Connection In compliance with Drawing No.	Connector M12 EN 60974-5-2 CU000001		Connector M12 EN 60974-5-2 CU000001	

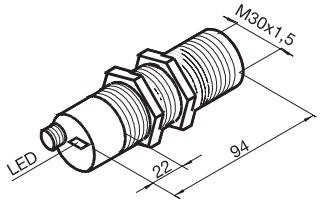
Wiring diagrams



Connector side of the sensor
LEDs: green / red / yellow



LS000014



CU000001

Ultrasonic Sensors: Discrete Output
Cylindrical ∅30 mm
Technical Data

Size

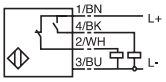
M30 x 1.5

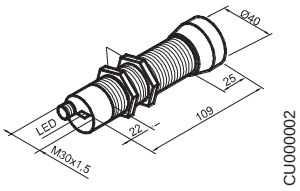
SUD4000-M30N-C1-POS

Model	SUD4000-M30N-C1-POS	...NOS	SUD6000-M30N-C1-POS	...NOS
Sensing range **Output**	**500 mm ... 4000 mm** **PNP, programmable**	**...NPN**	**800 mm ... 6000 mm** **PNP, programmable**	**...NPN**
Operating specifications				
Standard test target (min. flat surface) Beam divergence angle Transducer frequency	100 mm x 100 mm approx. 5 ° at -3 dB approx. 85 kHz		100 mm x 100 mm approx. 5° at -3 dB approx. 65 kHz	
Response time Hysteresis Reproducibility Temperature drift	approx. 280 ms ≤ 1 % of the set operating distance ≤ 1 % 0.2 % / K		approx. 480 ms ≤ 1 % of the set operating distance ≤ 1 % 0.2 % / K	
Electrical specifications				
Supply voltage U_B / ripple Reverse polarity protection Current consumption Switch output (PNP)	20 ... 30 VDC / +/- 10 % $_{pp}$ yes ≤ 60 mA 200 mA, U_B -3V short-circuit / overload proof		20 ... 30 VDC / +/- 10 % $_{pp}$ yes ≤ 60 mA 200 mA, U_B -3V short-circuit / overload proof	
Teaching input (2): Near switch point Far switch point	-U_B Near switch point +U_B Far switch point		-U_B Near switch point +U_B Far switch point	
Synchronisation input (5) for continuous measuring	≥ 1s low or not connected		≥ 1s low or not connected	
Synchronisation (used if 2 or more sensors) Measuring time / repetition rate Each sensor needs to change output signal Synchronisation pules / pause length Synchronisation levels (5) / Impedance	Starts with falling edge of the sync. input approx. 48 ms / ≤ 1.7 Hz 5 pulses / ≥265 ms ≥ 100 µs / ≥ 100 µs Low P. 0...1 V, High P. 5V ...+U_B approx. 27 kΩ		Starts with falling edge of the sync. input approx. 66 ms / ≤ 1.2 Hz 5 pulses / ≥ 355 ms ≥ 100 µs / ≥100 µs Low P. 0...1 V, High P. 5V ...+U_B approx. 27 kΩ	
Indicators: LED green LED red LED gelb	"Power on", teaching funct., object detected "Fault", object uncertain Switching condition indicator teaching function, no object detected		"Power on", teaching funct., object detected "Fault", object uncertain Switching condition indicator teaching function, no object detected	
Mechanical Specifications				
Operating temperature range Storage temperature range Protection class to EN / IEC	-25°C ... +70°C -40°C ... +85°C IP 65		-25°C ... +70°C -40°C ... +85°C IP 65	
Housing material	303 Nickel plated brass		303 Nickel plated brass	
Transducer material	Epoxy resin / silica composite Polyurethane foam		Epoxy resin / silica composite Polyurethane foam	
Cover and head	PBT (Crastin)		PBT (Crastin)	
Permissible shock Schwingbeanspruchung	b ≤ 30g, T ≤ 11 ms f ≤ 55Hz, a ≤ 1mm		b ≤ 30g, T ≤ 11 ms f ≤ 55Hz, a ≤ 1mm	
Connection In compliance with	Connector M12 EN 60974-5-2		Connector M12 EN 60974-5-2	
Drawing No.	CU000002		CU000003	

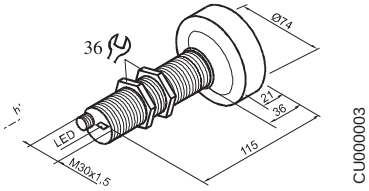
Wiring diagrams

POS





CU000002



CU000003

Ultrasonic Sensors: Analogue Output
Cylindrical ∅30 mm
Technical Data

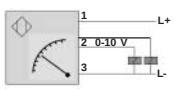
Size

M30 x 1.5

SUD2000-M30N-C1-M

Model	SUD500-M30N-C1-M	SUD2000-M30N-C1-M
Sensing range	**60 mm ...500 mm**	**200 mm ...2000 mm**
Output	**Analogue**	**Analogue**
Operating specifications		
Standard test target (min. flat surface)	100 mm x 100 mm	100 mm x 100 mm
Beam divergence angle	approx. 5° at -3 dB	approx. 5° at -3 dB
Transducer frequency	approx. 380 kHz	approx. 175 kHz
Response time	≤ 35 ms	≤ 100 ms
Resolution		
- Evaluation range < 705 mm	0.172 mm	0.172 mm
- Evaluation range □≥ 705 mm	Evaluation range (mm)/ 4096	Evaluation range (mm)/ 4096
Reproducibility	≤ 0.1 % of full scale	≤ 0.1 % of full scale
Linearity	≤ 0.1 % of full scale	≤ 0.1 % of full scale
Temperature drift	compensated (0.2 % / K without temp. compensation)	compensated (0.2 % / K without temp. compensation)
Electrical specifications		
Supply voltage U_B / ripple	10 ... 30 VDC / +/- 10 % $_{pp}$	10 ... 30 VDC / +/- 10 % $_{pp}$
Reverse polarity protection	yes	yes
Off-load power input P_L	≤ 800 mW	≤ 800 mW
Current output	4 mA ... 20 mA, R_L ≤ 500 Ω	4 mA ... 20 mA, R_L ≤ 500 Ω
Voltage output	0 V... 10 V, R_L ≥ 1000 Ω	0 V... 10 V, R_L ≥1000 Ω
Temperature / Memorising insert	Evaluation limits and output function (Falling, rising slope) are memorised by means of the temperture / memorising insert In normal operation, memorising insert must be in pos. T	Evaluation limits and output function (Falling, rising slope) are memorised by means of the temperture / memorising insert In normal operation, memorising insert must be in pos. T
Indicators:		
Dual-LED green	"Power on", teaching funct., object detected	Power on, teaching funct., object detected
red	"Fault", teaching funct., no object detected	"Fault", teaching funct., no object detected
LED yellow	Evaluation limit A1, falling slope	Evaluation limit A1, falling slope
LED yellow	Evaluation limit A2, rising slope	Evaluation limit A2, rising slope
Mechanical Specifications		
Operating temperature range	-25°C ... +70°C	-25°C ... +70°C
Storage temperature range	-40°C ... +85°C	-40°C ... +85°C
Protection class to EN / IEC	IP 65	IP 65
Housing material	Stainless steel	Stainless steel
Transducer material	Epoxy resin / hollow glass sphere mixture Polyurethane foam	Epoxy resin / hollow glass sphere mixture Polyurethane foam
Cover and head	PBT (Crastin)	PBT (Crastin)
Permissible shock and vibration loading	b ≤ 30 g, T ≤ 11 ms f ≤ 55 Hz, a ≤ 1mm	b ≤ 30 g, T ≤ 11 ms f ≤ 55 Hz, a ≤ 1mm
Connection	Connector M12	Connector M12
In compliance with	EN 60974-5-2	EN 60974-5-2
Drawing No.	CU000004	CU000004

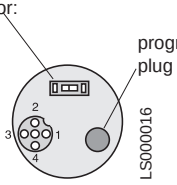
Wiring diagram

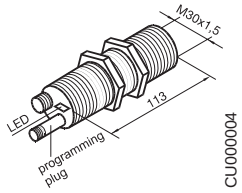


Connector side of the sensor:

LED's from left:

yellow:	limit A1
green:	power on
red:	disturbance
yellow:	limit A2





Ultrasonic Sensors: Analogue Output
Cylindrical ∅30 mm
Technical Data

Size

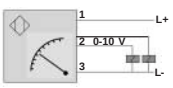
M30 x 1.5

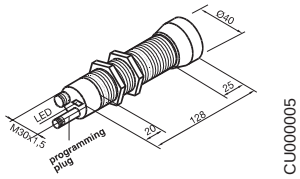
SUD4000-M30N-C1-M

Model	SUD4000-M30N-C1-M	SUD6000-M30N-C1-M
Sensing range **Output**	**500 mm ... 4000 mm** **Analogue**	**800 mm ...6000 mm** **Analogue**
Operating specifications		
Standard test target (min. flat surface) Beam divergence angle Transducer frequency	100 mm x 100 mm approx. 5° at -3 dB approx. 85 kHz	100 mm x 100 mm approx. 5° at -3 dB approx. 65 kHz
Response time	≤ 300 ms	≤ 500 ms
Resolution - Evaluation range ≤ 705 mm - Evaluation range ≥ 705 mm Reproducibility Linearity Temperature drift	 0.172 mm Evaluation range [mm] / 4096 ≤ 0.1 % of full scale ≤ 0.1 % of full scale compensated (0.2 % / K without temp. compensation)	 0.172 mm Evaluation range [mm] / 4096 ≤ 0.1 % of full scale ≤ 0.1 % of full scale compensated (0.2 % / K without temp. compensation)
Electrical specifications		
Supply voltage U_B / ripple Reverse polarity protection Off-load power input P_L Current output Voltage output Temperature / Memorising insert	10 ... 30 VDC / +/- 10 % $_{SS}$ yes ≤ 800 mW 4 mA ... 20 mA, R_L ≤ 500 Ω 0 V... 10 V, R_L ≥ 1000 Ω Evaluation limits and output function (Falling, rising slope) are memorised by means of the temperture / memorising insert In normal operation, memorising insert must be in pos. T	10 ... 30 VDC / +/- 10 % $_{SS}$ yes ≤ 800 mW 4 mA ... 20 mA, R_L ≤ 500 Ω 0 V... 10 V, R_L ≥ 1000 Ω Evaluation limits and output function (Falling, rising slope) are memorised by means of the temperture / memorising insert In normal operation, memorising insert must be in pos. T
Indicators:		
Dual-LED green	"Power on", teaching funct., object detected	Power on, teaching funct., object detected
red	"Fault", teaching funct., no object detected	"Fault", teaching funct., no object detected
LED yellow	Evaluation limit A1, falling slope	Evaluation limit A1, falling slope
LED yellow	Evaluation limit A2, rising slope	Evaluation limit A2, rising slope
Mechanical Specifications		
Operating temperature range Storage temperature range Protection class to EN / IEC Housing material Transducer material Cover and head Permissible shock and vibration loading Connection In compliance with Drawing No.	-25°C ... +70 °C -40°C ... +85 °C IP 65 Stainless steel Epoxy resin / hollow glass sphere mixture Polyurethane foam PBT (Crastin) b ≤ 30 g, T ≤ 11 ms f ≤ 55 Hz, a ≤ 1 mm connector M12 EN 60974-5-2 CU000005	-25°C ... + 70 °C -40°C ... + 85 °C IP 65 Stainless steel Epoxy resin / hollow glass sphere mixture Polyurethane foam PBT (Crastin) b ≤ 30 g, T ≤ 11 ms f ≤ 55 Hz, a ≤ 1mm connector M12 EN 60974-5-2 CU000006

Wiring diagram

M





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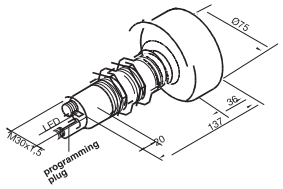

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Notes