Baumer

Passion for Sensors

Operating Instructions

AlphaProx

Inductive distance measuring sensors (linearized)

Version: 4.0

Contents

1 General information

1.1 Applicability

This document is applicable for Baumer's *AlphaProx* sensors – i.e. inductive distance measuring sensors or analog inductive sensors – with a linearized output:

- IRxx.DxxL
- IRxx.DxxF
- IRxx.DxxM
- IRxx.DxxK

1.2 Concerning the contents of this document

This manual contains information about the installation and commissioning of Baumer analog inductive sensors. It is a supplement to the mounting instructions supplied with each sensor. The teach-in procedure for each sensor is described in a dedicated manual.

Read these operating instructions carefully and follow the safety instructions!

1.3 Intended use

The Baumer analog inductive sensors are able to detect the position of a metallic object within the sensor specific measuring range.
They were especially developed for easy handling, flexible use, and precise measurement.

1.4 Safety notes

NOTE

Provides helpful operating instructions or other general recommendations.

ATTENTION!

Indicates a potentially hazardous situation. Non-adherence can lead to minor or slight injuries and may damage the device.

2 Connection

ATTENTION!

Incorrect supply voltage may destroy the device!

ATTENTION!

Connection, installation and commissioning may only be performed by qualified personnel.

ATTENTION!

The IP protection class is valid only if all connections are connected as described in the technical documentation.

2.1 Connection cable

The sensors do not require a shielded cable in standard conditions. If EMC requirements are higher a shielded cable may be used on the connector versions of these sensors. Depending on the screening concept the shield must be connected accordingly.

2.2 Pin assignment and connection diagram

In the mounting instructions, which are delivered with every sensor and can be downloaded at www.baumer.com, the pin configuration of the connector or the assignment of the wires is defined. In addition, the supply voltage range is also stated there.

NOTE

How to connect pins that are not needed in an application:

- teach-in: connect to GND (0V)
- digital output: do not connect
- analog output: do not connect

3 Installation

ATTENTION!

Connection, installation and commissioning may only be performed by qualified personnel.

3.1 Mounting

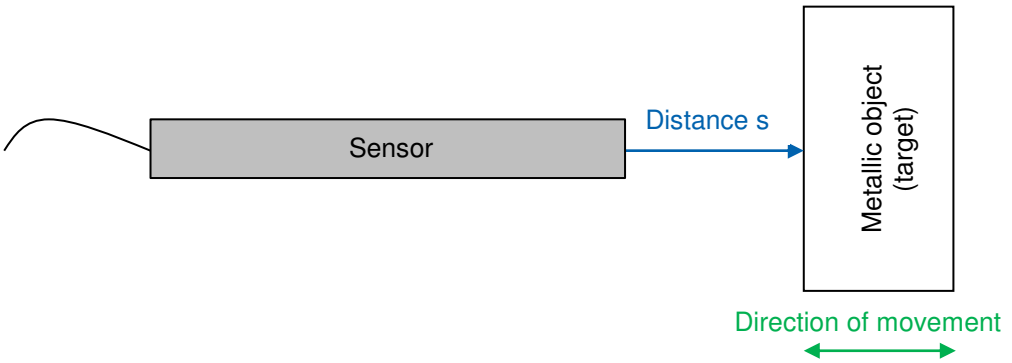
The sensors have a threaded housing and can be fixed using the nuts which are part of the delivery. The maximal mounting torque depends on the housing material as well as the thread size and is specified in the datasheet. The position and the material of the nuts can have an influence on the analog output curve, see chapter 4.5.

3.2 Factory settings

In the mounting instructions it is described how the sensors perform on leaving the factory or after having gone through a factory reset teach procedure.

3.3 Sensor alignment

In standard applications the sensor is mounted at a right angle (90°) to the object (standard installation). The sensor axis is oriented to the middle of the target.



NOTE

Angular or axial deviations may affect measuring accuracy.

Other sensor alignments are possible; please contact Baumer for further information.

3.4 Installation accessories

To ensure optimal mounting, various mounting brackets are available as accessories at www.baumer.com.

4 Functions and definitions

4.1 General function

An analog inductive sensor changes its output value (typically current or voltage) depending on the position of electrically conductive material in the vicinity of the sensing head. Hence, it can be used to measure the position of a moving object (called target).

4.2 Standard conditions

Both the geometry and the material of the target have an influence on the analog output curve of an inductive sensor. In addition, the conductive material which is in the vicinity of the sensor front face might influence the sensor output. Therefore, the standard measurement conditions are defined as follows:

- Standard target (according EN 60947-5-2): The standard target is defined as a square plate, 1 mm thick, made of Fe 360 (mild steel). The length of its side is defined as the larger of either the sensing face diameter or three times the maximal sensing distance as noted in the datasheet. For example: the standard target for an M12 sensor with 6mm sensing range has a side length of 3x6=18mm.
- Standard installation conditions: In order to have repeatable measurement conditions the standard installation of these sensors is non-flush. This means there is no electrically conductive material (except the target) within the vicinity (2x maximal sensing range) of the sensor front face. For an M18 sensor with 8mm sensing range, this means for example that the nut may only be positioned 2x8=16mm away from the sensing face.

The technical data shown on the datasheet are valid for these standard conditions only (in particular: linearity and maximal sensing range).

4.3 Definitions of parameters

In the datasheets of inductive analog sensors certain technical parameters are given which are defined as follows.

4.3.1 Resolution

Resolution represents the smallest possible change in distance which will produce a measurable signal change at the sensor's output.

Static resolution

The static resolution is the smallest distance change which can be measured with a slow measurement device (e.g. volt meter). The static resolution is in general higher than the dynamic resolution as a slow measurement corresponds to a low pass filtering of the measurement noise. The values given in the datasheet are valid for an averaging period of maximal 1 second. To achieve the maximal resolution in an application the target shall move slowly.

Dynamic resolution

The dynamic resolution is the smallest change in distance which can be measured with a fast measurement device (e.g. oscilloscope). Due to the noise, the dynamic resolution is in general not as good as the static resolution. The dynamic resolution is relevant for measuring fast movements and is limited by the response time of the sensor.

4.3.2 Repeat accuracy

Repeat accuracy defines the difference between the measured values of successive measurements within a period of 8 hours at an ambient temperature of 23 °C ± 5 °C. For many applications of inductive analog sensors this is a very important value.

4.3.3 Linearity error

The linearity error defines the maximal deviation between the output signal and the ideal output within a certain measuring range (sd_min to sd_max). The ideal output signal is a line between the two points defined by the minimal distance (sd_min) and minimal output (out_min) and the corresponding maximal values (sd_max and out_max). Another interpretation is that the sensor output always lies within two lines which are parallel to the ideal output and shifted by the maximal linearity error.

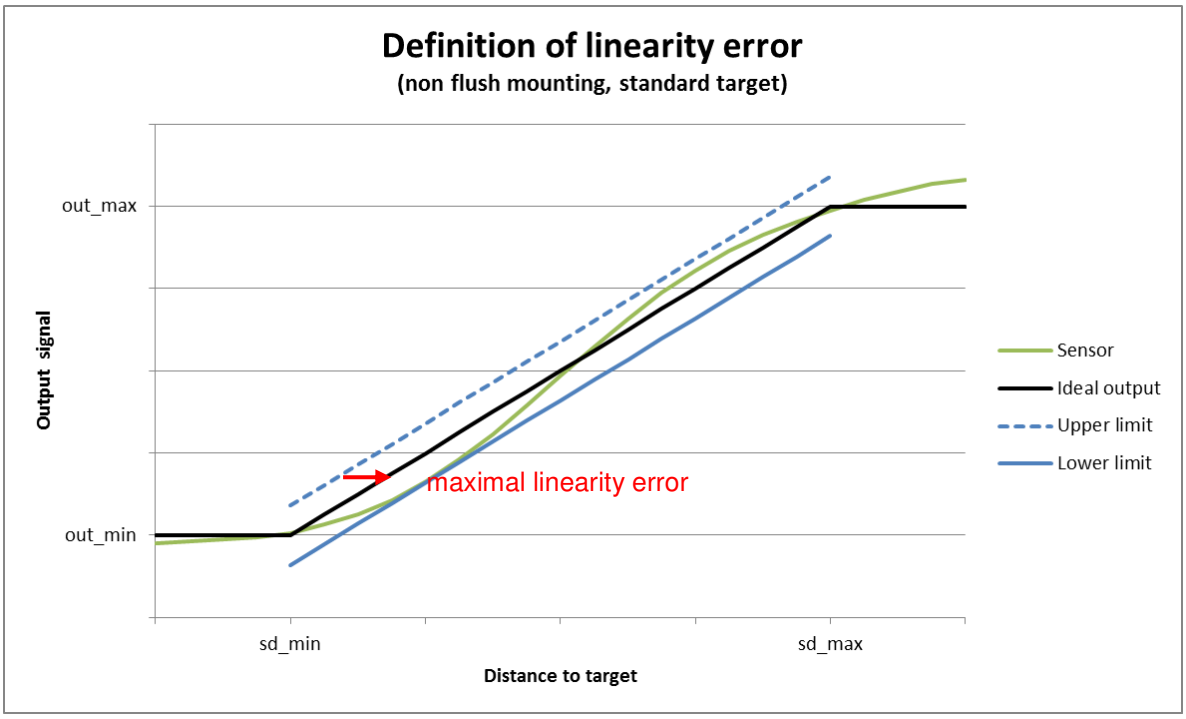


Diagram linearity error: The linearity error is the maximal deviation from an ideal line.

The linearity error is specified for non-flush mounting with the standard target. If either the mounting situation or the target deviates from that, the linearity error will be different. Baumer is able to offer linearized sensors for customer specific setups, please contact Baumer for more information.
If not otherwise stated, the linearity error mentioned on the datasheet is given for the entire measuring range sd. For certain sensors, the linearity error is stated for two ranges as the output curve might have a very linear part within a reduced range.

4.4 Target

In practice, the geometry and the material of the target will differ from the standard target. The influences can be estimated as described in the following paragraphs.

4.4.1 Target size

If the target is smaller than the standard target, the maximal sensing range will be reduced. This means that the output will reach its maximum (out_max) at a distance shorter than sd_max. If the target is larger than the standard target, there will be only minimal influences.

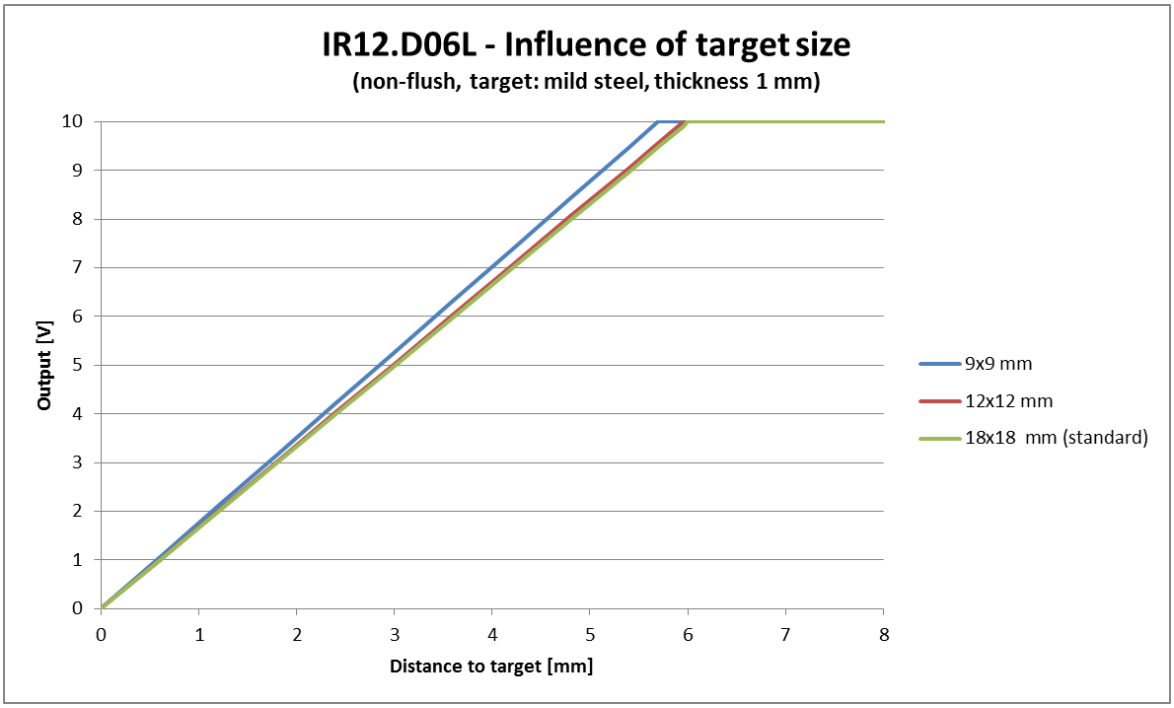


Diagram IR12-D06L sensors: Sensor output (typical values) influenced by targets of different size when the sensor is mounted non-flush. The slope of the 9x9mm target is approximately 8% steeper than the standard target (18x18mm); the 12x12mm target is only approximately 2% steeper.

4.4.2 Target material

Provided the target is not made of mild steel, the sensing range is typically reduced and thus the maximal sensing distance will be smaller. The following diagram shows the influence of the target material:

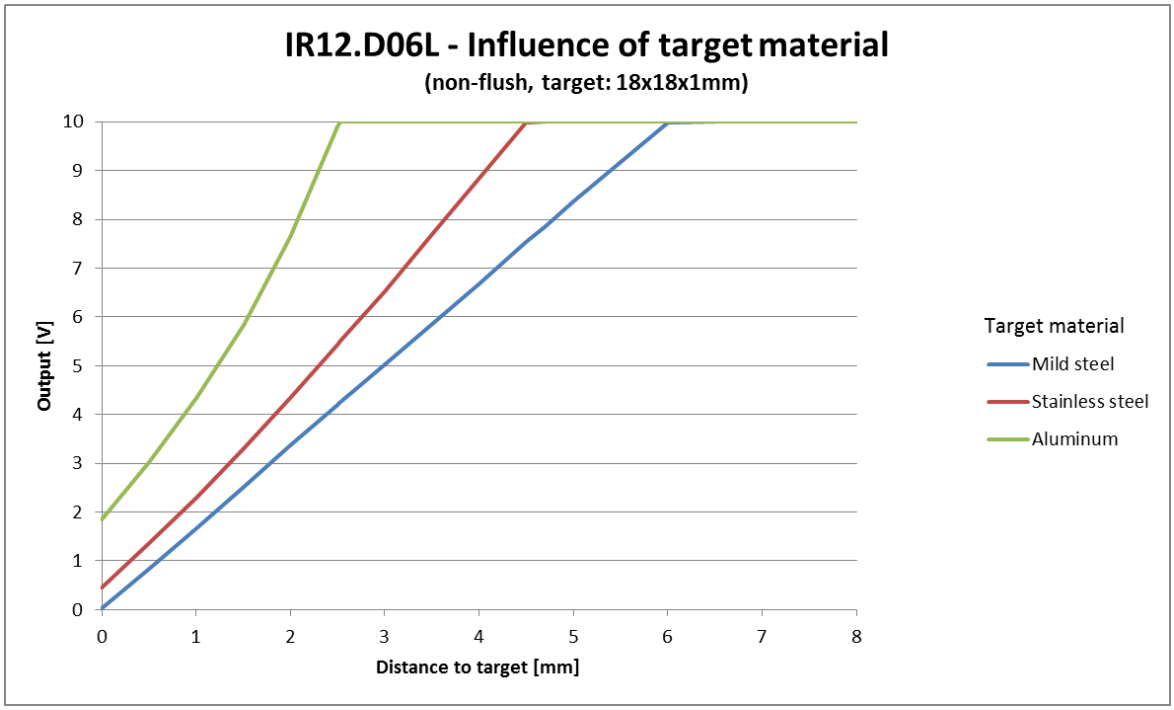
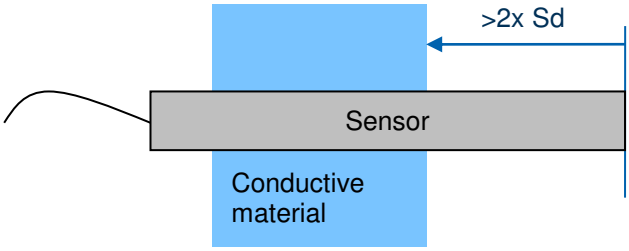
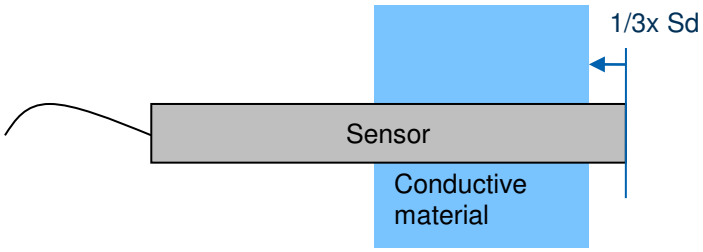
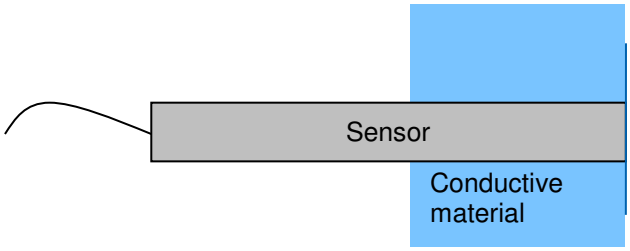


Diagram IR12-D06L sensors: Sensor output (typical values) for different target materials when the sensor is mounted non-flush.

The diagrams above show that the linearity and the output curve of inductive linear sensors depend on the target material. The sensors are optimized for mild steel targets, which can be identified by its distinctive attraction to magnets (magnetically soft, permeability coefficient >>1) – i.e. a magnet sticks to it after contact. Please consult Baumer if you need sensors optimized for other materials.

4.5 Influence of mounting situation

The largest influence on the output of an inductive sensor is conductive material is close to the sensing face. Depending on the material of the sensor housing and the conductivity of the material which is close to the sensor, the output curve is changed more or less. The following mounting situations can be distinguished:

Mounting situation	*Sketch of mounting situation*
Non-flush: There is no conductive material in the vicinity (>2x maximal sensing range) of the sensing face.	
Quasi-flush mounting: There is no conductive material directly surrounding the sensing face, but at a small distance behind (1/3x Sd).	
Flush mounting (in conductive material): The sensor is fully embedded in conductive material. Flush mounting in non-conductive material, e.g. plastic, does not influence the sensing behavior.	

The following diagram shows the influence of the mounting situation in different materials and different distances to the sensing face.

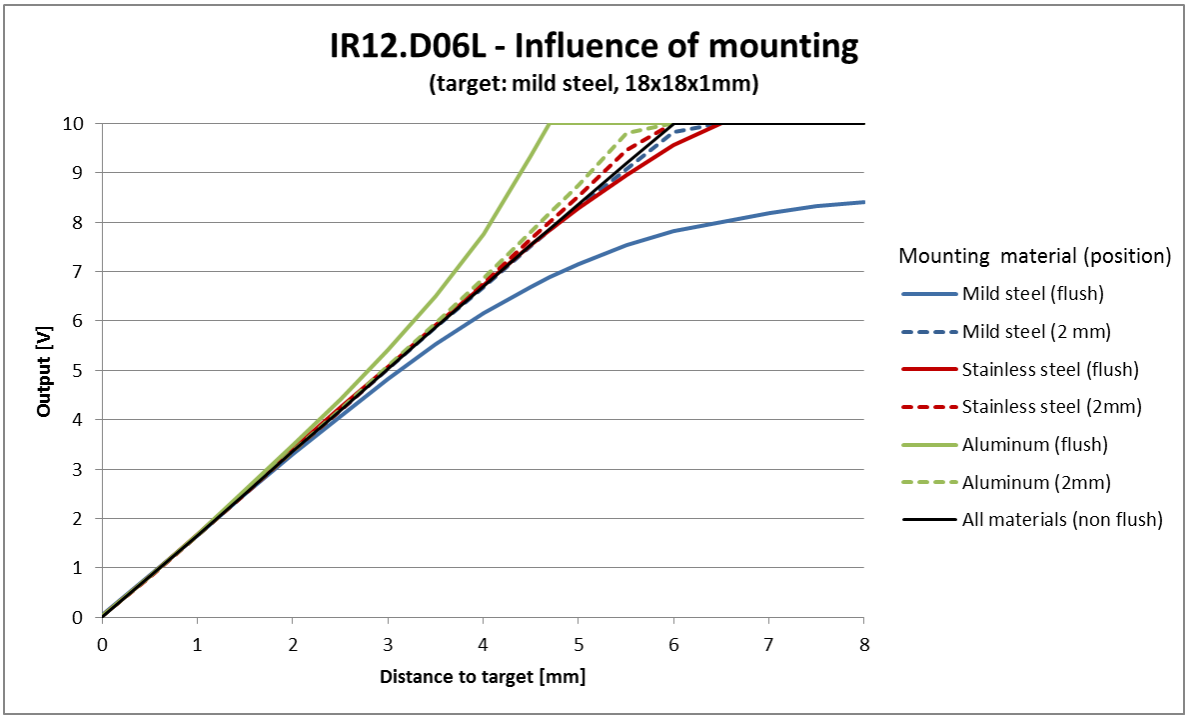


Diagram IR12-D06L sensors: Sensor output (typical values) influenced by different mounting situations (material and position). The output curves show only very little effect for sensing distances smaller than 3mm (50% of Sd) as well as for quasi-flush (protruding by 1/3 Sd) and non-flush mounting. Nonferrous materials, such as brass or copper, show similar results as aluminum.

4.6 Temperature influence

Inductive sensors are susceptible to temperature changes – i.e. the output value at a given distance between sensor and target changes slightly if the temperature varies.
Baumer analog inductive sensors are optimized to have minimal temperature drift over the entire operating temperature range. Please note that the values mentioned in the datasheet do also include production tolerances, so a single sensor can have even smaller drifts. For limited temperature ranges, further optimization of the temperature drift is possible. Please consult Baumer for further information.

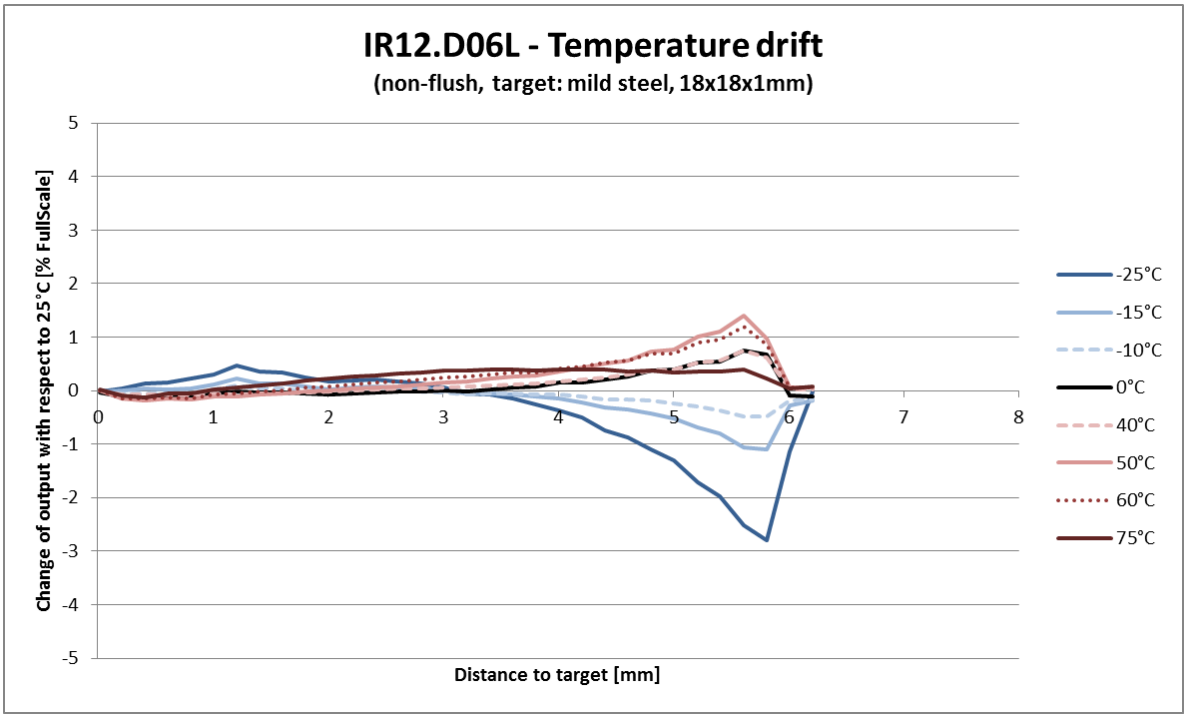


Diagram IR12-D06L sensors: Deviation of the output signal (typical values) at various temperatures and distances relative to the corresponding value at reference temperature (25°C). These sensors show a very small drift, particularly at smaller sensing distances (0...4mm) and between 0…40°C.

4.7 Teach-in procedure

Baumer analog inductive sensors with a linearized output can be adapted to the following situations:

- Compensate tolerances (mechanical tolerances at installation, variation in target geometry and material, deviations from sensor to sensor): typically a 1-point teach of the start or end position is useful in these cases.
- Quick setup of sensors: the distance between the sensor and the target does not need to be set very accurately as variations in distance can be easily compensated using the 1-point teach.
- Measuring symmetrical displacements (vibrations): The 1-point teach can be used to set the center position of the target and thus measure the amplitude relative to the stationary position.
- Get maximal system accuracy: The 2-point teach is most useful as the minimal and maximal distance can be set individually. This allows adjusting the measuring range of a sensor to the distance relevant in a given application and thus defining the slope of the sensor output.
- Set a digital alarm or indicate a valid/invalid position: sensors with an additional digital output can be set to deliver a high output value only if the target is within a defined measuring range.
- Set sensor to a defined state: factory reset

The supported teach levels are described in the dedicated teach manual. It is available for download at www.baumer.com.

5 LED indicator

Baumer analog inductive sensors with teach capability feature a yellow status LED. The flashing frequency of the status LED indicates the selected teach mode. The operating modes are described in detail in the dedicated teach manual.
Analog inductive sensors with an extra digital output have an additional status LED which lights up red whenever the digital output is active.

6 Safety instructions and maintenance

6.1 General safety instructions

Intended use

This product is a precision device and is used for object detection and the preparation and/or provision of measuring values as electrical quantities for a subsequent system. Unless this product is specially labeled, it must not be used for operation in hazardous environments.

Commissioning

Installation, mounting and adjustment of this product may be performed only by a qualified person.

Installation

For mounting, use only the mechanical mountings and mechanical mounting accessories intended for this product. Unused outputs must not be wired. In cable versions with unused wires, these wires must be insulated. Always comply with admissible cable bending radii. Prior to electrical connection of the product, the system must be disconnected from the power supply. In areas where shielded cables are mandatory, they must be used as protection against electromagnetic interferences. If a connector is added by the customer to a shielded cable, an EMC version of the connectors should be used, and the shield must be connected to the connector housing across a large area.

6.2 Maintenance

Inductive sensors do not require any maintenance or cleaning.

7 Error correction and tips

7.1 Error correction

Error	Error correction
Linearity of the output does not meet the expectations	Change the geometry and material of the target to conform to the standard target as much as possible. If this is not feasible, ask Baumer for a customized version.
Slope is not steep enough	Use larger target or ask Baumer for a customized version.
The digital output is switching at different distances if the target is approaching or leaving.	This is due to the hysteresis of the sensor in order to guarantee stable behavior.

8 Change History

2014-11-10	simg	Manual released in version 1.0
2015-05-05	simg	Textual adjustments, new sensor types, linearity, temperature drift, target size, power on drift, 2 point teach analog
2016-03-21	lop	Teach-in procedure excluded, minor textual adjustments, new chapter LED indicator
2016-07-18	lop	New type (Factor 1)

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