Baumer

IO-Link

Instruction Manual

FADK 14I4470/IO
FADK 14I4470/S35A/IO
FADK 14I4470/S14/IO
FADK 14U4470/IO
FADK 14U4470/S35A/IO
FADK 14U4470/S14/IO

Valid as of version 01-02-11

Sensor Solutions
Motion Control
Vision Technologies
Process Instrumentation

Instruction Manual for FADK 14 with IO Link

Contents

1 General Information

1.1 About this Document

These instructions contain information related to commissioning and communications with the Baumer Series 14 photoelectric distance sensor equipped with the IO Link interface. They supplement the installation instructions, already provided with each sensor.

These instructions apply to the following sensor versions (software version 01-02-11):

FADK 14I4470/IO
FADK 14I4470/S14/IO
FADK 14I4470/S35A/IO
FADK 14U4470/IO
FADK 14U4470/S14/IO
FADK 14U4470/S35A/IO

1.2 General Information

Rules for proper usage	This product is a precision measuring device which has been designed for the detection of objects and parts. It generates and provides measured values issued as electrical signals for following systems. Unless this product has not been specifically marked it may not be used in hazardous areas.
Set-up	Installation, mounting and adjustment of this product may only be executed by skilled employees.
Installation	Only mounting devices and accessories specifically provided for this product may be used for installation. Unused outputs may not be connected. Unused strands of hard-wired sensors must be isolated. Do not exceed the maximum permissible bending radius of the cable. Before connecting the product electrically the system must be powered down. Where screened cables are mandatory, they have to be used in order to assure EMI protection. When assembling connectors and screened cables at customer site the screen of the cable must be linked to the connector housing via a large contact area.

2 IO Link Introduction

In order to fully understand the various configuration options, these operating instructions describe the most important aspects of the IO Link interface. More detailed information concerning IO Link, together with all specifications, are available at www.IO-Link.com.

IO Link is a standard interface for sensors and actuators. Devices (sensors, actuators) are connected to an IO Link master via point-to-point connections. Communications between the master and the device are bidirectional, via the device switching line. This interface permits measuring values to be recorded. An option to configure the sensor via the IO Link is also provided. There are two modes of sensor operation: the standard input/output mode (SIO mode) and the IO Link communication mode.

The master switches the sensor to the IO Link communication mode. In this mode, process data (measurement data) are now continuously transferred from the sensor to the master, while requirement data (parameters, commands) are either written to the device or read from it.

2.1 SIO Mode

After start up, the sensor is automatically in the SIO mode. In this mode, the sensor operates as a standard switching or measuring sensor. On the master side, the IO Link port is set as a normal digital input. The sensor can be used like a standard sensor without IO Link. However, various functions can only be controlled with the aid of IO Link.

2.2 IO Link Communication Mode

The sensor is switched to the “communication mode” by means of a so-called “wake up” signal sent by the master. With this action, the master attempts to locate a connected device by means of a defined signal transmitted along the switching line. If the sensor responds, communication parameters are exchanged, after which the cyclic transmission of process data can begin.
The following can be performed in the IO Link communication mode:

- Process data can be received;
- Parameters (SPDUs) can be read from the sensor;
- Parameters (SPDUs) can be written to the sensor;
- Commands can be transmitted to the sensor (e.g., switching point teaching, resets to factory settings, etc.).

The process data contain cyclic data such as measuring value, switch status or quality information which are transferred to the higher level controller.
The master can exit the IO Link communication mode by using a “fall back”, after which the sensor once again operates in the SIO mode until it receives the next “wake up”.

The sensor’s behavior in the SIO mode can be adjusted in the IO Link communication mode. This allows the sensor to be easily adapted to the requirements of corresponding parameters, and to then continue operating as a “normal” sensor, without the use of IO Link. Alternately, the sensor can also operate continuously in the IO Link communication mode in order to fully utilize the entire functional scope provided by the process data.

2.3 IODD (IO Link Device Description)

The IODD describes the IO Link device, and can be downloaded at www.baumer.com. It comprises a set of XML and PNG files. An engineering or diagnostic tool reads a sensor's IODD in order to determine the following:

- Identification (manufacturer, designation, part number, etc.);
- Communication characteristics (communication speed, frame type, etc.);
- Parameters and commands;
- Process data;
- Diagnostic data (events).

The IODD determines who is permitted to review and modify which sensor data. How the data are presented and how they are manipulated are defined by the sensor manufacturer and are therefore independent of the sensor itself.

3 Sensor in the SIO Mode

In the SIO mode, the sensor operates in accordance with its factory settings or according to the settings defined by the user via IO Link. The functional scope in the SIO mode is sensor specific.

4 Sensor in the IO Link Communication Mode

4.1 Process Data

With the sensor in the IO Link communication mode, data are periodically exchanged between the IO Link master and the device. These data comprise process data and possibly commands and parameters for the sensor. Process data transfer the current measuring value and status bits such as the switch status, quality information, etc. to the master. The master does not need to explicitly request these process data.

4.1.1 Process Data Structure

Figure 1 illustrates the structure of process data. The following provides a brief description of the individual information.

measuring value Bit4...Bit15	Bit3	Bit2	Bit1	Bit0

Figure 1: Process data

4.1.1.1 Significance of the Measuring Value

The measuring value (Bit4…Bit15) has a range between 0…4095. The measuring value reflects the sensor's current measuring range. If the object being measured lies at the start of the measurement value range (e.g., 50mm), a measuring value of 0 is output. If the object being measured lies at the end of the measurement value range (e.g., 400mm) a measuring value of 4095 is output.

4.1.1.2 Significance of the Status Information

Bit 0: Alarm

The alarm bit indicates whether an object lies within the measurement value range.
Bit0 = 0 → An object lies within the specified measuring range.
Bit0 = 1 → There is no object within the specified measuring range.

Bit 1: Switch bit

In the IO Link communication mode, the switch bit performs the function of a switching output.
Bit1 = 0 → There is no object within the the switching range.
Bit1 = 1 → An object lies within the switching range.

Bit 2: Quality

This bit provides information about the amount of light reflected by the object being measured (soiled lens indicator).
Bit2 = 0 → The amount of reflected light exceeds the threshold (adequate signal strength).
Bit2 = 1 → The amount of reflected light lies below the threshold (weak signal strength).

Bit3: Not used

4.2 Parameters and Commands

Parameters and commands are either written to the device or read from it using SPDU (Service Protocol Data Unit) indices. The read and write function is provided by the IO Link master. The user can write a value to an index, or can have a value read from it.

4.2.1 Product Information

Some parameters contain product information such as the manufacturer's name, the product name and number, together with a user-specific sensor designation (refer to Table **Fehler! Verweisquelle konnte nicht gefunden werden.**, Table of General Information SPDUs).

4.2.2 Parameters

For a description of parameters, refer to Table 6.2, Table of Parameter SPDUs.

4.2.3 Commands

Commands are written to SPDU Index 0x02 (system commands). Refer to Table 6.3 Table of System Commands.

4.2.4 Saving Modifications

If parameters have been modified by either directly writing to them or by a command (this also includes resetting to factory settings), the modifications must be permanently saved by means of ***Save parameters***. Failure to do this will result in the modifications being lost when the sensor is restarted. The sensor will then use the most recently saved entries.

5 Explanation of the Sensor Configuration

Parameters and commands can be used to configure the sensor functionalities. The following sections provide a detailed description of the various configuration options.

5.1 Teaching a User-Specific Measuring Range

5.1.1 Parameter

Measuring range work: This parameter covers the currently used beginning and end values for the measuring range. The beginning and end values can either be entered directly into the parameter (numerical teaching), or they can be automatically set via the interim register to teach an object The parameter comprises two 16 bit components: ***Measuring range limit A*** and ***Measuring range limit B***.

- Unit: 0.1mm
- Factory setting: 50 ... 400mm

Measuring range interim: This parameter serves as a supplemental register to teach the measuring range for an object.

- Unit: 0.1mm

5.1.2 Commands

Teach-in measuring range limit A: Command used to teach measuring range limit A. The taught value is transferred to the interim register, ***Measuring range interim***.

Teach-in measuring range limit B: Command used to teach measuring range limit B. The taught value is transferred to the interim register, ***Measuring range interim***.

Transfer measuring range: The measuring range learned in the interim register, ***Measuring range interim***, is transferred to the ***Measuring range work*** work register and is set to active.

5.1.3 Description

There are two methods which the user can employ to adjust the measuring range of the FADK 14:

- Numerical teaching: The beginning and end values of the measuring range are written directly to the ***Measuring range work*** parameter;
- Teaching an object: the beginning and end values of the measuring range are learned for an object by applying the corresponding measuring commands. If the object lies outside the original measuring range, the minimum or maximum measuring distance are learned.

The measuring value between measuring value limits A and B is output as a relative value between 0 and 4095. Measuring value limits A and B are output as absolute distances from the leading sensor edge in 0.1 millimeter increments. Figure 2 illustrates possible characteristic measuring value curves.

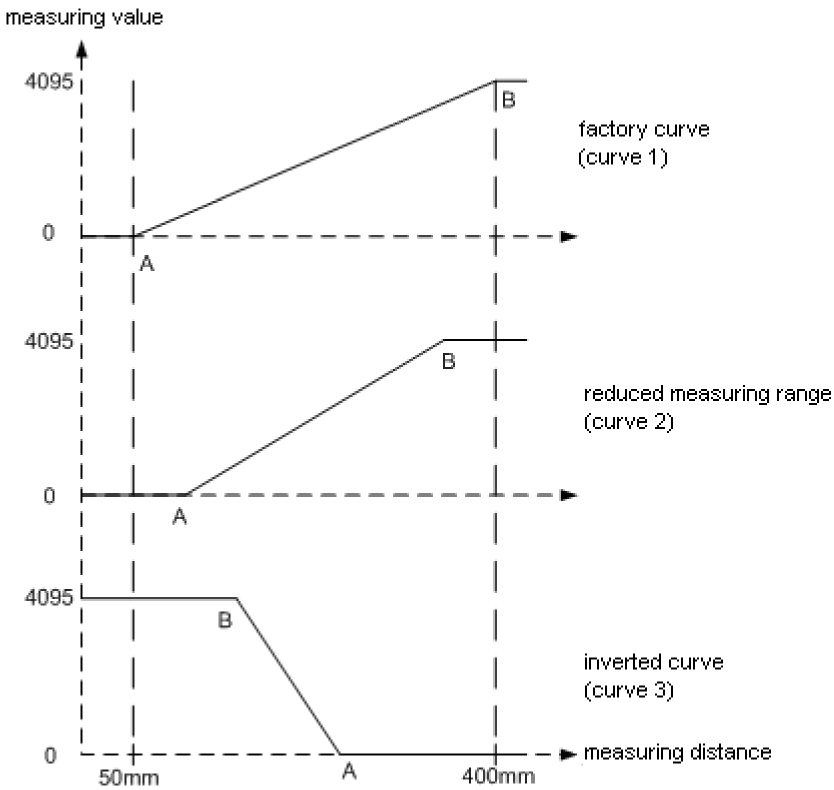

Figure 2: Possible characteristic measuring value curves

5.1.3.1 Example of Numerical Teaching:

1) The measuring range is to be set between 150mm (A) and 300mm (B) (characteristic curve 2).

Point A, absolute value in 0.1 mm: 1500 → 05DC hex (= Measuring range limit A)
Point B, absolute value in 0.1 mm: 3000 → 0BB8 hex (= Measuring range limit B)

Parameter to be written:
***Measuring range work*:** **05DC0BB8 hex**
→ ***Save parameters*** to permanently store the values!

2) An inverted measuring range is to be set between 200mm (B) and 400mm (A) (characteristic curve 3).

Point A, absolute value in 0.1 mm: 4000 → 0FA0 hex (= Measuring range limit A)
Point B, absolute value in 0.1 mm: 2000 → 07D0 hex (= Measuring range limit B)

Parameter to be written:
***Measuring range work*:** **0FA007D0 hex**
→ ***Save parameters*** to permanently store the values!

5.1.3.2 Example of Teaching an Object

The measuring range is to be taught for an object (characteristic curve 2).

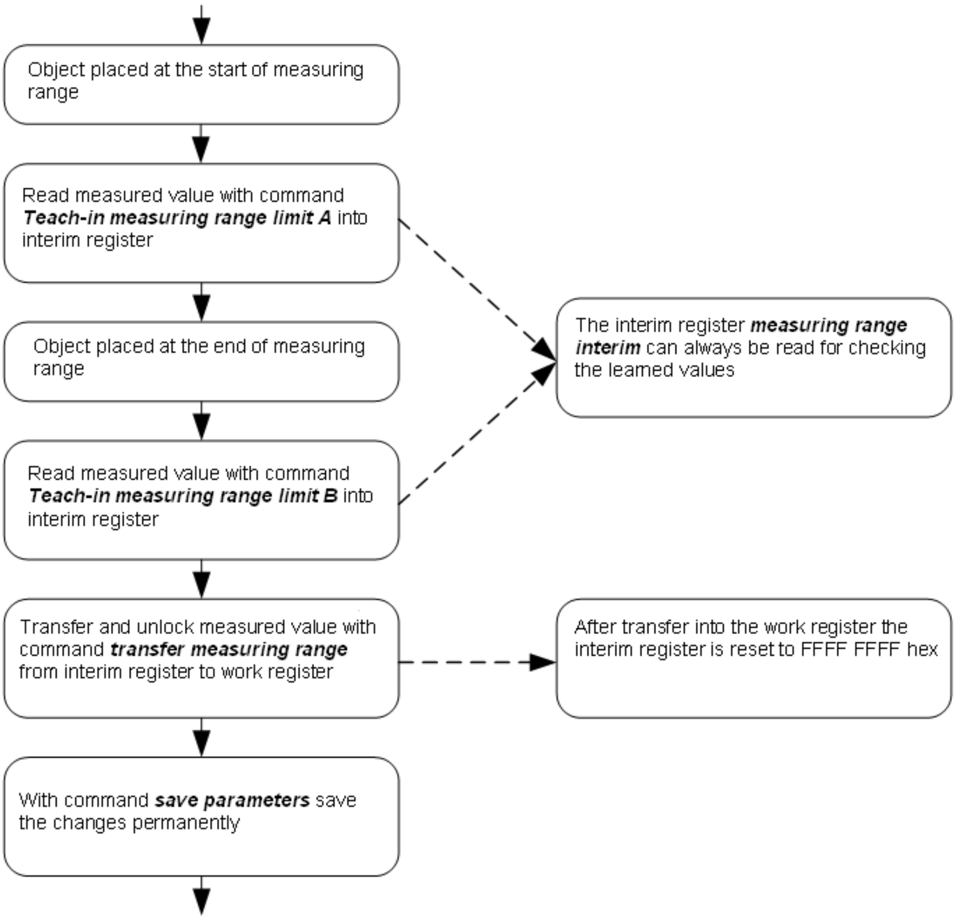

Figure 3: Teaching characteristic measuring value curves

For an inverted characteristic curve (characteristic curve 3), the distance between the sensor and ***Measuring range limit A*** must exceed that to ***Measuring range limit B***.

5.1.4 Error Handling

The taught measuring values lie closer together than is permitted by the learnable measuring range (20mm):

- Error message: ***Interfering parameter*** (refer to: Table **Fehler! Verweisquelle konnte nicht gefunden werden.**, Fault codes);
- Interim register is set to FFFF FFFF hex;
- The most recent valid values remain active.

The learned measuring value lies outside the original measuring range (measuring range on the specification sheet):

- Numerical teaching: Unable to write to ***Measuring range work***; error message: ***Parameter value out of range.*** The most recent valid values remain active.

5.2 Teaching a User-Specific Switching Window

5.2.1 Parameter

Switching points work: This parameter comprises the currently employed beginning and end points of the switching window. The beginning and end point of the desired switching window can either be directly defined in the parameter (numerical teaching), or it can be automatically set via the interim register when an object is being taught. The parameter comprises two 16 bit components: ***Switching point A*** and ***Switching point B***.

- Unit: 0.1mm
- Factory setting: Switching point A = 50mm; switching point B = 400mm

Switching points interim: This parameter serves as a supplemental register to teach the switching points for an object.

- Unit: 0.1mm

5.2.2 Commands

Teach-in switching point A: Command to teach switching point A. The taught value is transferred to the interim register, ***Switching points interim***.

Teach-in switching point B: Command to teach switching point B. The taught value is transferred to the interim register, ***Switching points interim***.

Transfer switching points: The switching points learned in the interim register, ***Switching points interim***, are transferred to the ***Switching points work*** work register and and set to active.

5.2.3 Description

There are two methods which the user can employ to adjust the switching window of the FADK 14:

- Numerical teaching: The beginning and end points of the switching window are written directly to the ***Switching points work*** parameter;
- Teaching an object: The beginning and end points of the switching window are learned for an object by applying the corresponding measuring commands. If the object lies outside the original measuring range, the minimum or maximum measuring distance are learned.

Switching points A and B define a switching window which, in turn, determines the state of the switch bits. Switching points A and B are output as absolute distances from the leading sensor edge in 0.1 millimeter increments.

Figure 4 illustrates all possible characteristic switching curves.

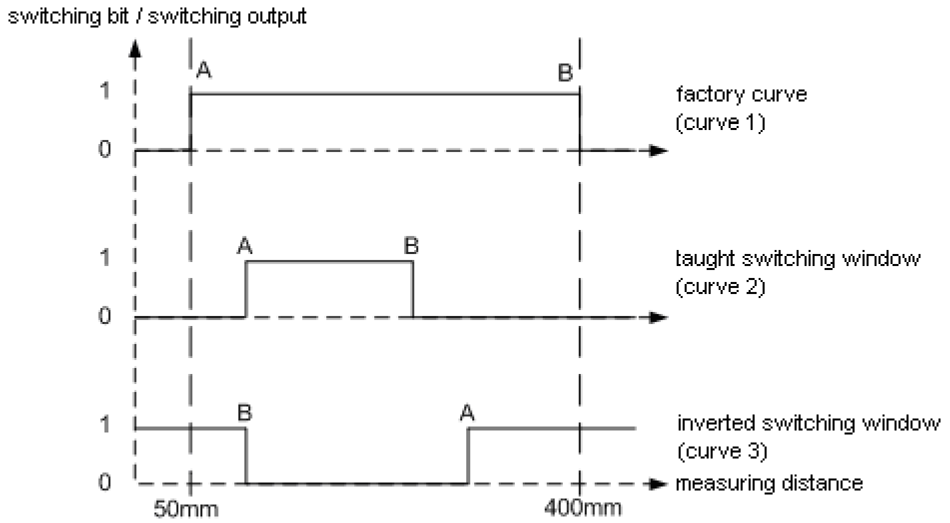

Figure 4: Possible characteristic switching curves

5.2.3.1 Example of Numerical Teaching:

1) A switching window is to be set between 150mm (A) and 300mm (B) (characteristic curve 2).

Point A, absolute value in 0.1 mm: 1500 → 05DC hex (**= *Switching point A***)
Point B, absolute value in 0.1 mm: 3000 → 0BB8 hex (**= *Switching point B***)

Parameter to be written:
***Switching points work*:** **05DC0BB8 hex**
→ ***Save parameters*** to permanently store the values!

2) An inverted switching window is to be set between 200mm (B) and 400mm (A) (characteristic curve 3).

Point A, absolute value in 0.1 mm: 4000 → 0FA0 hex (**= *Switching point A***)
Point B, absolute value in 0.1 mm: 2000 → 07D0 hex (**= *Switching point B***)

Parameter to be written:
***Switching points work*:** **0FA007D0 hex**
→ ***Save parameters*** to permanently store the values!

5.2.3.2 Example of Teaching an Object

The switching window is to be taught for an object (characteristic curve 2).

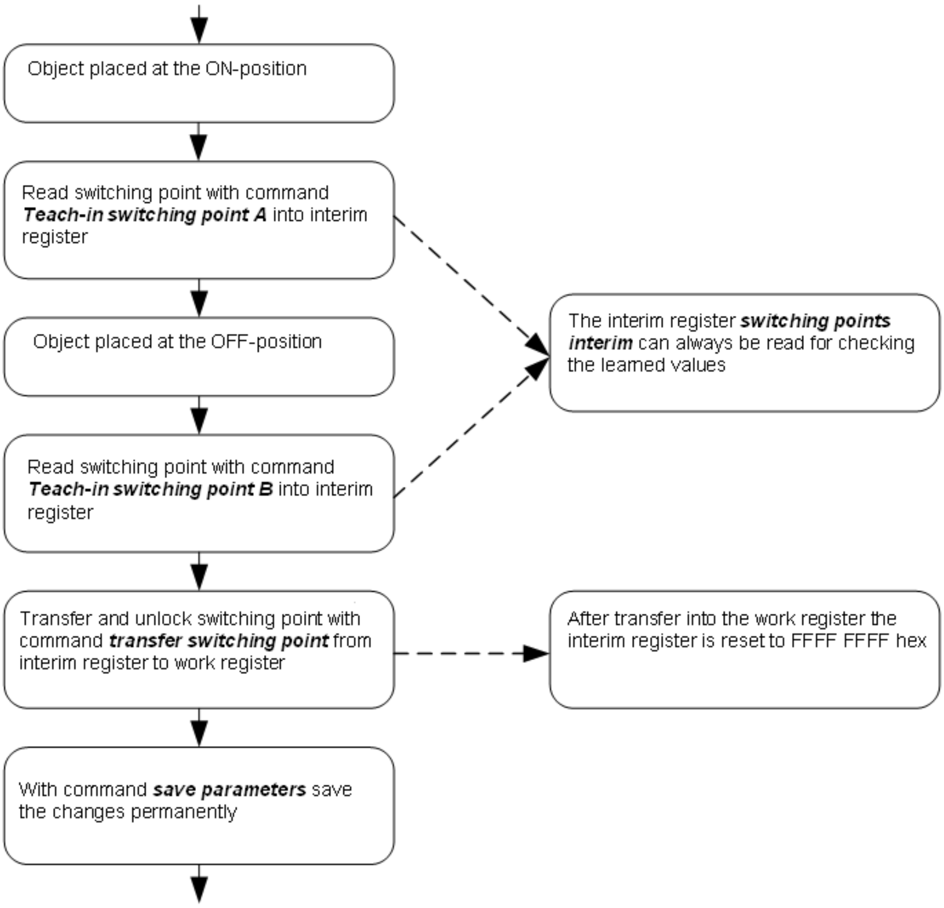

Figure 5: Teaching a switching window

For an inverted switching window (characteristic curve 3), the distance between the sensor and ***Switching point A*** must exceed that to ***Switching point B***.

5.2.4 Hysteresis

In the approach direction to the switching window, the sensor switches at the precisely the learned switching points. If the switching window is then exited, a hysteresis value is then added (refer to Figure 6).

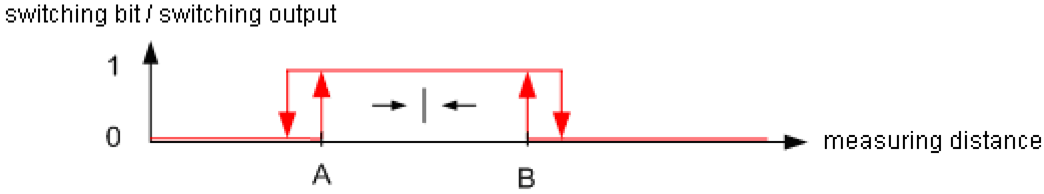

Figure 6: Switching window hysteresis

5.2.5 Error Handling

The learned switching points lie closer together than permitted in the minimum teachable switching window (10mm):

- Error message: ***Interfering parameter*** (refer to: Table **Fehler! Verweisquelle konnte nicht gefunden werden.**, Fault codes);
- Interim register is set to FFFF FFFF hex;
- The most recent valid values remain active.

The learned switching points lie outside the original measuring range (measuring range on the specification sheet):

- Numerical teaching: Unable to write to ***Switching points work,*** error message: ***Parameter value out of range.*** The most recent valid values remain active.

5.3 Soiled Lens Indicator

5.3.1 Parameter

Nominal value

Quality parameter:	Limit value for assessing the receiving signal quality. If the received amount of light falls below this adjustable limit, the process data quality bit is set. - Value range: 1-8 - Factory setting: 7
Quality parameter:	Actual reception quality.

5.3.2 Description

The sensor's illumination controller allows a determination of whether adequate signal reserves still exist, in order to provide reliable measurements. This signal reserve is indicated quantitatively by the ***Quality parameter***. Should the ***Quality parameter*** drop below the value specified in the ***Nominal value quality parameter***, this is displayed in the quality bit of the process data.

Application example:
When setting up an application, reading the ***Quality parameter*** on a regular basis can help determine what its lowest value is. The threshold of the ***Nominal value quality parameter*** can then be defined 1-2 steps lower. If, during actual operation, the ***Quality parameter*** drops below this threshold value for whatever reason, a signal is output. At this point, the application continues to operate normally, the sensor should, however, be inspected as soon as feasible. Some reasons why the ***Quality parameter*** is activated include the following:

- Sensor dirty → Sensor must be cleaned;
- Sensor incorrectly adjusted → Sensor must be readjusted;
- Some factor in the application may have changed, e.g., an alteration to the object's surface features → Sensor (***Nominal value quality parameter***) needs to be readjusted.

This function helps prevent the failure of the sensor by permitting appropriate countermeasures to be taken.

→ **Important:** The sensor will still continue to provide problem-free operation, even at a ***Quality parameter*** of only 1. As high as possible a value does not necessarily need to be set!

5.4 Average Value Formation

5.4.1 Parameter

Average: Number of measurements for which an average is formed.
- Value range: 0, 2, 4, 8, 16
- Factory setting: 0 (no average value formation)

5.4.2 Description

Forming an average of an adjustable number of measuring values helps to reduce measurement noise, and thus increase the sensor's reproducibility and resolution. This reduces the response speed, but the measuring speed remains unaltered.

Floating average algorithm (average value sliding in one direction)

x-order average value: Y_n = (Yn + Yn-1 + Yn-2 +...+ Yn-x)/x

5.5 Switching Output Function

5.5.1 Parameter

Output function switching output: The function carried out on the switching output in the SIO-Mode can be defined.
- Value range: 0, 1, 2
- Factory setting: 0 (Alarm)

5.5.2 Description

Process data status bits (alarm, switch bit, quality) can be applied to the sensor's switching output. This allows, for example, a soiled lens indicator to be utilized in the SIO mode. The factory setting at the switching output indicates when the object lies outside the measurement range.

6 Overview of SPDUs

6.1 Table of General Information SPDUs

SPDU name	SPDU index	Number of Bytes	Format	Range of values	R/W	Comments
General information on sensors						
Vendor Name	0X10	18	String	ASCII	R	“Baumer Electric AG“ for all sensors
Product Name	0X12	22	String	ASCII	R	Corresponds with Baumer article description
Product ID	0X13	8	String	ASCII	R	Corresponds with Baumer article number
Serial Number	0X15	4	String	ASCII	R	Baumer P-Code
Firmware Revision	0X17	8	String	ASCII	R	Baumer Firmware Revision
Application Specific Name	0X18	8	-	-	R/W	8 Byte at customer disposal

6.2 Table of Parameter SPDUs

SPDU name	SPDU index	Number of Bytes	Format	Range of values	R/W	Comments
Measuring range and switching points						
Switching points work	0X40	4	Switching point A (HB, LB) Switching point B (HB, LB)	500…4000	R/W	Distance information on switching points
Switching points interim	0X41	4	Switching point A (HB, LB) Switching point B (HB, LB)	500…4000, 65535	R	Distance information on switching points
Measuring range work	0X42	4	Measuring range limit A (HB, LB) Measuring range limit B (HB, LB)	500…4000	R/W	Distance information on measuring range limits
Measuring range interim	0X43	4	Measuring range limit A (HB, LB) Measuring range limit B (HB, LB)	500…4000, 65535	R	Distance information on measuring range limits
Sensor functions						
Average	0X50	1	-	0,1,2,4,8, 16	R/W	Number of measuring cycles across which an average is formed. Average value = 0 or 1: Average is switched off.
Output function switching output	0X62	1	0 = ON, if there is no valid signal within MB 1 = Switching output defined by switching points 2 = ON if signal falls below excess gain signal threshold	0,1,2	R/W	Indicates what function is available on the output.
Nominal value quality parameter	0X65	1		1..8	R/W	Provided the internal quality parameter drops below this threshold, the switching output is set.
Quality parameter	0X66	1		1..8 or 255	R	

6.3 Table of System Commands

Name of Command	SPDU Index	CMD Value	Comments
Restore factory setting	0X02	0X82	Restores all original factory settings of the sensor
Teach-in switching point A	0X02	0XA0	Teach-in of switching point A. The measured distance is written into the interim switching points register.
Teach-in switching point B	0X02	0XA1	Teach-in of switching point B. The measured distance is written into the interim switching points register.
Transfer switching points	0X02	0XA2	Transfer of the switching points from the interim register to the working register.
Teach-in measuring range limit A	0X02	0XA3	Teach-in of measuring range limit A. The measured distance is written into the measuring range interim register
Teach-in measuring range limit B	0X02	0XA4	Teach-in of measuring range limit B. The measured distance is written into the measuring range interim register.
Transfer measuring range	0X02	0XA5	Transfer of the measuring range from the interim register to the working register
Save parameters	0X02	0XE0	Save all parameters in Flash memory

6.4 Table of Fault Codes

Error Case	Error Code 1	Error Code 2	Description of Error Codes
Communication error (Checksum, …)	0x10	0x00	Communication error, No details
Length of written SPDU is wrong	0x10	0x00	Communication error, No details
Reading an unimplemented SPDU	0x80	0x11	Device error, Index not available
Writing to an unimplemented SPDU	0x80	0x11	Device error, Index not available
Reading Index 2	0x80	0x23	Device error, Access denied
Writing to a read only SPDU	0x80	0x23	Device error, Access denied
Writing an unimplemented System Command	0x80	0x23	Device error, Access denied
Distance between two taught points too small	0x80	0x40	Device error, Interfering parameter
Written parameter out of defined range	0x80	0x30	Device error, Parameter value out of range

6.5 Table of Factory Settings

SPDU name	SPDU index	Default value
Application Specific Name	0X18	empty
Switching points work	0X40	Switching point A: 50mm Switching point B: 400mm
Measuring range work	0X42	Measuring range limit A: 50mm Measuring range limit B: 400mm
Average	0X50	0 (no average value formation)
Output function switching output	0X62	0 (Alarm)
Nominal value quality parameter	0X65	7

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