BTL C1 Rod BN/ZN SSI
(B/ZNCx00-xxxx-C15DUxxx-000S32)

BTL BNC _ 00 - _ _ _ _ - C15DU _ _ _ - _ _ _ _ _ _
BTL ZNC _ 00 - _ _ _ _ - C15DU _ _ _ - _ _ _ _ _ _

english

Contents

1 About this guide

1.1 Validity

This guide provides all the information required for the safe use of the BTL magnetostrictive linear position sensor (measurement system) with SSI interface.

It applies to the following models (see *Type code*):

- **BTL BNC _ 00 - _ _ _ _ - C15DU _ _ _ - _ _ _ _ _ _**
- **BTL ZNC _ 00 - _ _ _ _ - C15DU _ _ _ - _ _ _ _ _ _**

Read this guide and the other applicable documents completely before installing and operating the product.

Original User's guide

This guide was created in English. Other language versions are translations of this guide.

1.2 Other applicable documents

Additional information about this product can be found at www.balluff.com on the product page, e.g. in the following documents:

- Data sheet
- Declaration of Conformity
- Disposal

1.3 Symbols and conventions

Individual actions are indicated by a preceding triangle.

▸ Instruction 1

Action sequences are numbered consecutively:

1. Instruction 1
2. Instruction 2

i Note

Note, tip
This symbol indicates general notes.

1.4 Explanation of the warnings

Always observe the warnings in this guide and the measures described to avoid hazards.

The warnings used here contain various signal words and are structured as follows:

SIGNAL WORD

Type and source of the hazard
Consequences if not complied with
- Measures to avoid hazards

The individual signal words mean:

NOTICE

Identifies a danger that could **damage or destroy the product**.

CAUTION

The general warning symbol together with the signal word CAUTION indicates a hazard which can lead to **slight or moderate injuries**.

WARNING

The general warning symbol together with the signal word WARNING indicates a hazard which can lead to **death or serious injuries**.

DANGER

The general warning symbol in conjunction with the signal word DANGER identifies a hazard which, if not avoided, will certainly result in **death or serious injury**.

1.5 Abbreviations

AdSS
Adjustable Switching Sensor

BET
Balluff Engineering Tool

FMM
Flexible Magnet Mode

IODD
IO-Device-Description

ISDU
IO-Link-Parameter (Index Service Data Unit)

LSB
Least Significant Bit

MSB
Most Significant Bit

PD
Process Data

PDV
Process Data Variable

2 Safety notes

2.1 Intended use

The BTL magnetostrictive linear position sensor, together with a machine controller (e.g. PLC), comprises a position measuring system. It is intended to be installed into a machine or system and used in the industrial sector.

Proper function according to the specifications in the technical data is only assured when the product is used solely as described in the user's guide and the respective documents as well as in compliance with the technical specifications and requirements and only with suitable original Balluff accessories.

Otherwise, there is deemed to be unintended use. Unintended use is not permitted and will result in the loss of warranty and liability claims against the manufacturer.

2.2 Reasonably foreseeable misuse

The product is not intended for the following applications and areas and may not be used there:

- In safety-oriented applications in which personal safety depends on the device function
- In explosive atmospheres
- In food applications

2.3 General safety notes

Activities such as **installation, connection** and **commissioning** may only be carried out by qualified personnel.

Qualified personnel are persons whose technical training, knowledge and experience as well as knowledge of the relevant regulations allow them to assess the work assigned to them, recognize possible hazards and take appropriate safety measures.

The **operator** is responsible for ensuring that local safety regulations are observed.

In particular, the operator must take steps to ensure that a defect in the product will not result in hazards to persons or equipment.

The product must not be opened, modified or changed. If defects and unresolvable faults occur in the product, take it out of service and secure against unauthorized use.

2.4 Cybersecurity

The product must be used in a secure environment. The operator or manufacturer of the machine is responsible for ensuring the machine is cybersecure. This also includes a cybersecurity risk analysis.It is important to plan and implement security measures based on this risk analysis. The operator or manufacturer must ensure that all persons working with the device have received cybersecurity training.

Cybersecure Environment:

To ensure cybersecurity, you must protect components, networks, and systems from unauthorized access and ensure data integrity.

Recommended Measures:

- Take organizational and technical measures for network-capable devices and software.
- Implement an information security management system (ISMS) to manage all information security measures.

Cybersecurity Resources:

- BSI Recommendations for ICS Operators
- CISA Best Practices for Industrial Control Systems
- NIST SP 800-82 Guide to Industrial Control Systems (ICS) Security

We recommend using a network secured according to the state of the art. The device are intended for use at **Purdue Level 0 "Field Level / Sensors"**.

Note on Purdue Level 0: Purdue Level 0 refers to the lowest level of the Purdue reference architecture for industrial automation systems. This level includes the physical sensors and actuators directly connected to the production environment. Devices at this level are responsible for real-time data acquisition and processing. Access to the devices from outside should only be possible for known and trusted devices and authorized users.

The sensor and its interfaces must be protected against unauthorized physical access by appropriate measures, such as machine access control or physical barriers.

The sensor has an IO-Link interface for customer parametrization purposes only. It should only be operated on an IO-Link network module that is sufficiently protected against unauthorized access. Use the device only on an IO-Link network module that is sufficiently protected against access and operated in a secure network. Ensure that only authorized users have access to the IO-Link network module and the secure network.

According to IO-Link Standard V 1.1.4, the sensor does not have authentication mechanisms. Changing the settings/parameters of the sensor is possible for all actors who have access to the IO-Link interface.

According to IO-Link Standard V 1.1.4, the sensor does not have mechanisms to protect against physical manipulation or reading of memory contents in the event of physical access. The sensor and its interfaces must be protected against physical access by appropriate measures, such as access monitoring to the machine and barriers.

According to IO-Link Standard V 1.1.4, the sensor does not have mechanisms to protect data integrity. Data is transmitted unencrypted from the device via the IO-Link protocol to the IO-Link network module. Eavesdropping, influencing, or interfering is possible if the network is not sufficiently protected.

According to the IO-Link Standard, this IO-Link device does not have an independent logging mechanism. However, the device has mechanisms for reporting events (events) that may also be suitable for analyzing cybersecurity events. We recommend using the device on an IO-Link network module with event logging, where the event log can be read out from the IO-Link network module via a suitable protocol.

The sensor includes a configuration interface intended solely for manufacturer-level configuration. It shares the same physical connector as IO-Link but uses a different physical layer. The interface operates with a proprietary protocol and may only be accessed by personnel authorized by the manufacturer.

Use the device only in IO-Link networks that are adequately protected against unauthorized access. No devices other than those provided by the manufacturer may be connected to this interface.

3 Scope of delivery, transport and storage

3.1 Scope of delivery

- Sensor
- Short instructions

3.2 Transport

▶ Transport product to location of use in original packaging.

3.3 Storage conditions

▶ Store product in original packaging.

▶ Observe ambient conditions (see *Ambient condition*).

4 Product information

This section provides information about the product features and specifications.

4.1 Product description

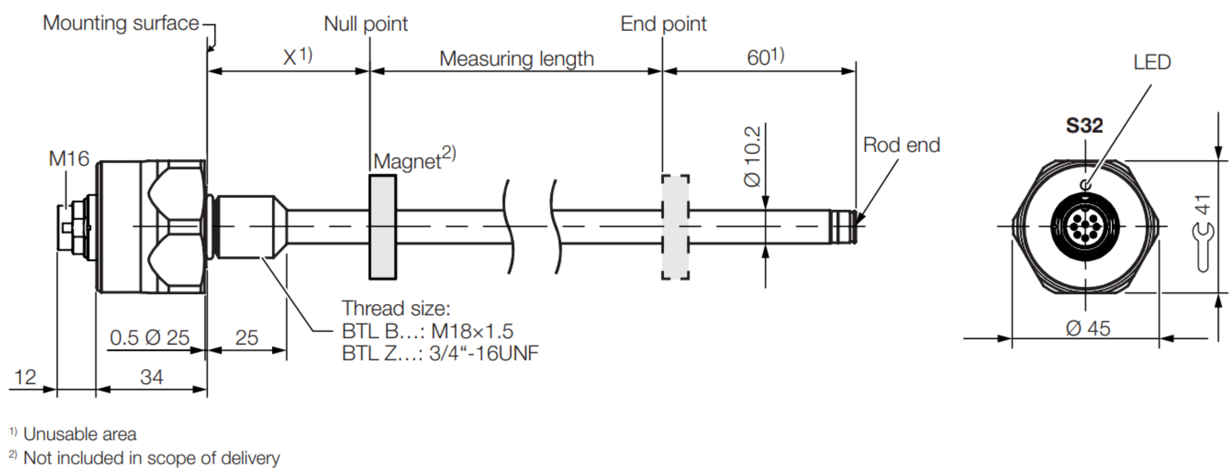


Fig. 1: Dimensions, design and function

Type	X	Rod end
BTL_NC**A**...	30 - 1 mm	with thread M4/4.5 deep
BTL_NC**E**...	2" - 0.04"	with thread M4/4.5 deep

4.1.1 Construction

Electrical connection: The electrical connection is made via a plug connection (see *Type code*).

Housing: Housing containing the processing electronics.

Fastening: We recommend assembling the following BTLs on the mounting thread:

- BTL B...: M18×1.5
- BTL Z...: 3/4"-16UNF

There is an additional thread at the end of the rod to support large measuring lengths.

Position magnet: Defines the position to be measured on the waveguide. Position magnets are available in various models and must be ordered separately (see *Accessories*).

Measuring length: Defines the travel/length range available. Sensors with measuring lengths from 25 mm to 5000 mm are available.

4.1.2 Function

To determine the position of a plant component, a position magnet is connected to the component. Together they are moved along a waveguide located inside the BTL.

An internally generated INIT pulse interacts with the magnetic field of the position magnet to generate a torsional wave in the waveguide which propagates at ultrasonic velocity. The component of the torsional wave which arrives at the end of the waveguide is absorbed in the damping zone to prevent reflection. The component of the torsional wave which arrives at the beginning of the waveguide is converted by a coil into an electrical signal. The position of the position magnet and thus at the same time that of the plant component is determined from the running time of the shaft.

Up to 2 position magnets can be used for FMM (Flexible Magnet Mode).

The following functions can be selected for the output values:

- Position
- Velocity
- Position difference

The product supports following interfaces:

- The primary interface SSI is intended for the transmission of operating data.
- The IO-Link interface is used exclusively for product configuration and maintenance.

To avoid interference with SSI communication, the SSI and IO-Link interface must not be used simultaneously!

The full range of functions can be configured using the "Balluff Engineering Tool" (BET) PC software.

> **Note**
>
> To configure the device via IO-Link, an IO-Link master must be connected.

4.1.3 Display elements

The product support the following display elements:

- The status LED displays its operating status. See *LED interface* for details.

4.1.4 Part label

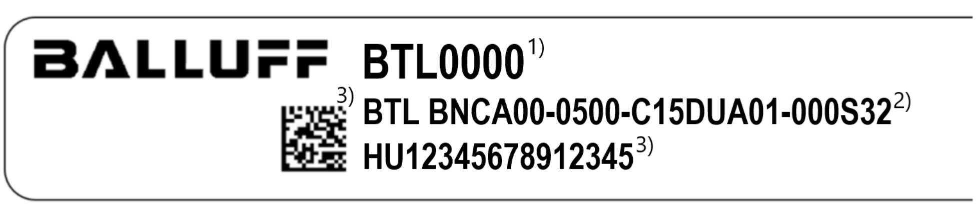


Fig. 2: Part label (excerpt, example)

Element	Description
1)	Order code
2)	Type
3)	Serial number

4.1.5 Type code

Example	BTL	BNCA00	-	0500	-	C15DUA01	-	000S32
Definition	BTL	***a***NC***b***00	-	***cccc***	-	C15***defgh***	-	000S32

Table 1: Type code variant details

Code	Parameter	Meaning
BTL	Sensor type	Magnetostrictive Linear Position Sensor
a	Rod version, fastening	• B = Rod with metric mounting thread M18x1.5 • Z = Rod with inch mounting thread 3/4” - 16UNF
b	Mechanical null point	• A = Null point at 30 mm; rod end with thread (only for BTL B…) • E = Null point at 50.8 mm; rod end with thread
cccc	Measuring length	Metric specification in mm; measuring length (0025…5000)
d	Interface	D = Digital
e	Output type	U = Output SSI and additional IO-Link configuration interface
f	Operating mode	• A = Asynchronous, counting from null point • B = Asynchronous, counting from flange

continues on next page

Table 1 – continued from previous page

Code	Parameter	Meaning
g	Data format	• 0 = 24-bit, binary, rising • 1 = 24-bit, Gray, rising • 2 = 24-bit, binary, falling • 3 = 24-bit, Gray, falling • 6 = 25-bit, binary, rising • 7 = 25-bit, Gray, rising • 8 = 25-bit, binary, falling • 9 = 25-bit, Gray, falling • A = 26-bit, binary, rising • B = 26-bit, Gray, rising • C = 26-bit, binary, falling • D = 26-bit, Gray, falling
h	Resolution	• A = 0.1 µm • 0 = 0.5 µm • 1 = 1 µm • 2 = 2 µm • 3 = 5 µm • 4 = 10 µm • 5 = 20 µm • 6 = 40 µm • 7 = 50 µm • 8 = 100 µm
000S32	Electrical connection	8-pin, M16 plug per IEC 130-9

4.2 Technical data

The specifications are typical values at 24 V DC, room temperature and a measuring length of 500 mm in conjunction with the BTL-P-1013-4R, BTL-P-1013-4S, BTL-P-1012-4R or BTL-P-1014-2R position magnet.

The product is immediately ready for operation, full accuracy is achieved after the warm-up phase.

> **Note**
>
> Further data can be found at www.balluff.com on the product page.

4.2.1 Ambient condition

> **Note**
>
> For UL: Type 1 (UL61010-1), indoor use only. Use in enclosed spaces and up to an altitude of 2000 m above sea level.

Parameter	Specification
Ambient temperature	−40…+85 °C
Storage temperature	−40…+100 °C
Relative humidity	≤ 90%, non-condensing
Operating pressure	≤ 450 bar
Short term pressure	750 bar (10 × 1 min)
Typ. temperature coefficient[1]	≤ 30 ppm/K
Shock rating as per EN 60068-2-27[2],[3]	100 g/6 ms
Continuous shock per EN 60068-2-27[2],[3]	50 g/2 ms
Vibration per EN 60068-2-6[2],[3]	12 g, 10…2000 Hz
Protection per IEC 60529 (when threaded together)[4]	IP67, IP69K

4.2.2 Detection range/Measuring range

Table 2: Detection range/Measuring range

Parameter	Specification
Measuring length	25…5000 mm
Repeat accuracy	≤ ±10 µm
Length-dependent measuring frequency	
Measuring length ≤ 70 mm	8000 Hz
Measuring length > 70… ≤ 170 mm	5000 Hz
Measuring length > 170… ≤ 240 mm	4000 Hz
Measuring length > 240… ≤ 590 mm	2000 Hz
Measuring length > 590… ≤ 1270 mm	1000 Hz
Measuring length > 1270… ≤ 2650 mm	500 Hz
Measuring length > 2650… ≤ 5000 mm	250 Hz
Linearity deviation[5]	
with measuring length ≤ 500 mm	±30 µm
with measuring length > 500 mm	±50 µm
Detectable speed	≤ 10 m/s
Velocity resolution	0.1 mm/s

[1] Measuring length 500 mm, position magnet in the middle of the measuring range
[2] Individual specifications as per Balluff standard
[3] Resonant frequencies excluded
[4] IP protection class not evaluated by UL
[5] Configuration for one position magnet

4.2.3 Electrical data

Parameter	Specification
Operating voltage Ub[6]	10…30 V DC
Typical current draw (at 24 V DC)	≤ 60 mA
Typical power consumption	≤ 1,5 W
Maximal power consumption[7]	≤ 2,8 W
Overvoltage protection	Ub up to 36 V DC
Voltage-proof up to (GND – Housing)	500 V DC

4.2.4 Electrical connection

Parameter	Specification
Short circuit protection	Signal output to GND and to 30 V DC
Protected against polarity reversal	Ub up to 30 V DC

4.2.5 Interfaces

Note

To avoid interference with SSI communication, the SSI and IO-Link interface must not be used simultaneously!

SSI interface

Parameter	Specification
Number of bits	Configurable
Coding	Binary or Gray
Characteristic	Rising or falling
SSI data	Configurable
SSI clock frequency f_{CLK}	10 kHz…1 MHz
Short-circuit protection	Signal lines Data+/–, Clk+/– to +36 V or GND

[6] For UL: The BTL must be externally connected via a limited-energy circuit as defined in UL 61010-1, a lo-power source as defined in UL 60950-1 or a class 2 power supply as defined in UL 1310 or UL 1585.

[7] In the worst-case scenario, with a measurement frequency of 8000 Hz, an ambient temperature of 85 °C, and active communication.

Configuration interface

Parameter	Specification
Interface	IO-Link
Transfer protocol	1.1
Transmission rate	COM3 (230.4 kBaud)
Output value	None

4.2.6 Materials

Parameter	Specification
Housing material	Stainless steel
Rod material	Stainless steel

4.2.7 Mechanical features

Parameter	Specification
Rod diameter	10.2 mm
Weight (depends on length)	Approx. 1 kg/m
Rod wall thickness	2 mm
Housing mounting via threads	
BTL B…	M18×1.5
BTL Z…	3/4“-16UNF

4.2.8 Connector version

Parameter	Specification
Min. cable temperature	−40…+85 °C

4.2.9 Connection to the evaluation unit

The maximum SSI clock frequency f_{CLK}, max is dependent on the cable length[8]:

[8] For longer length: required cable cross-section ≥ 0.6 mm^2 or ≤ AWG19.

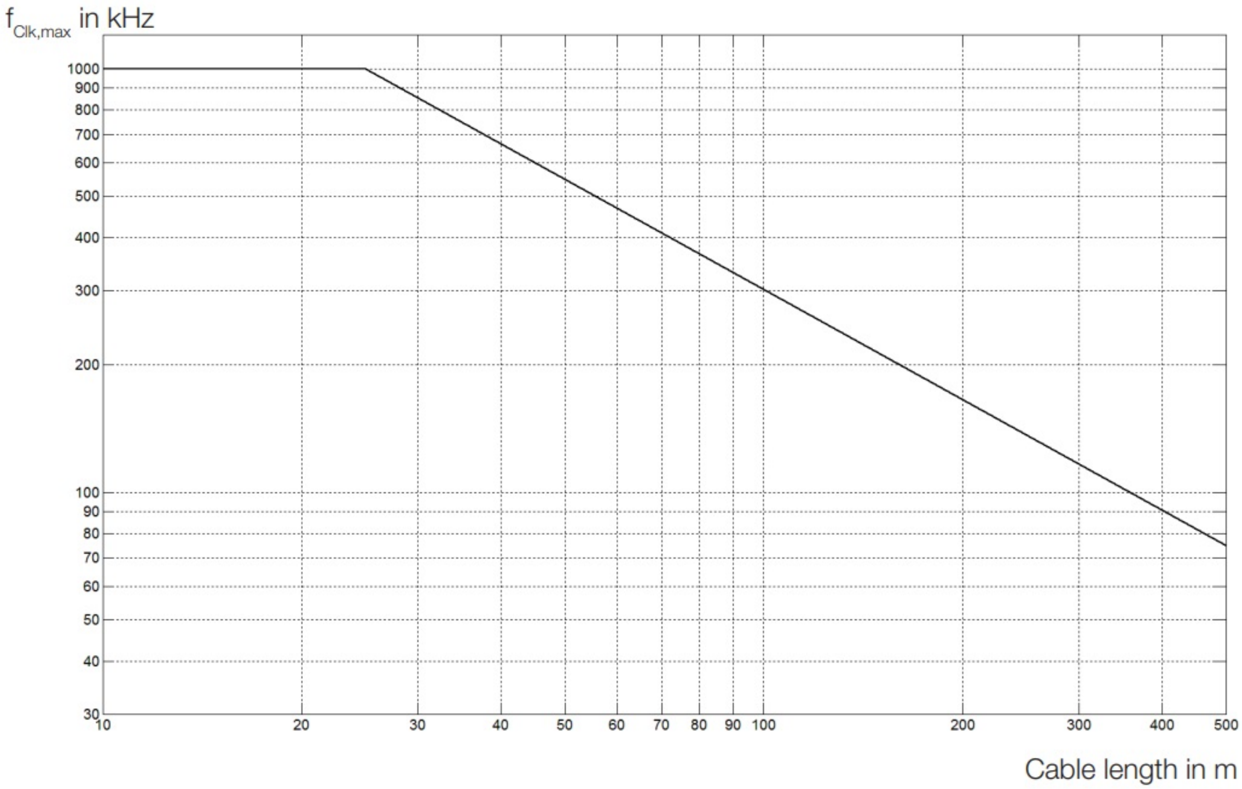


Fig. 3: Maximum SSI clock frequency depending on the cable length

4.2.10 Approvals and markings

Marking	Meaning
	The monitoring sensors BTL Basic Rod Series are restricted for use in industrial machinery applications as defined in the Electrical Standard for Industrial Machinery, NFPA 79.
	The CE Mark verifies that our products meet the requirements of the current EU Directive.

ℹ Note

Additional information on directives, approvals and standards can be found at www.balluff.com on the product page.

4.3 Accessories

Accessories are not included in the scope of delivery and must be ordered separately.

Note

Recommended accessories can be found at www.balluff.com on the product page.

4.3.1 Position magnet

BTL-P-1013-4R

Order code BAM013L

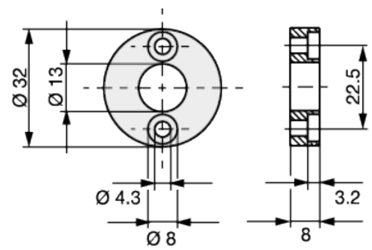


Fig. 4: Installation dimensions of BTL-P-1013-4R position magnet

BTL-P-1013-4S

Order code BAM013P

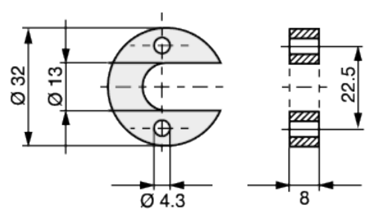


Fig. 5: Installation dimensions of BTL-P-1013-4S position magnet

BTL-P-1012-4R

Order code BAM013J

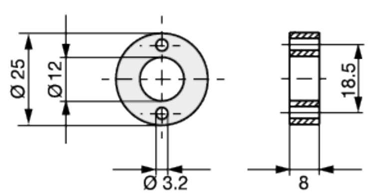


Fig. 6: Installation dimensions of BTL-P-1012-4R position magnet

BTL-P-1014-2R

Order code BAM013R

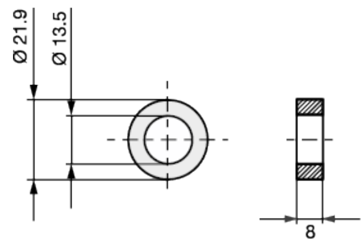


Fig. 7: Installation dimensions of BTL-P-1014-2R position magnet

BTL-P-1013-4R, BTL-P-1013-4S, BTL-P-1012-4R, BTL-P-1014-2R:

Weight
< 15 g

Housing
Aluminum

Included in the scope of delivery for the BTL-P-1013-4R, BTL-P-1013-4S, BTL-P-1012-4R:

Spacer
8 mm, material: polyoxymethylene (POM)

4.3.2 Mounting nut

BTL-A-FK01-E-M18X1,5

Order code: BAM0118

Mounting nut
M18x1.5

BTL-A-FK01-E-3/4“-16UNF

Order code: BAM0117

Mounting nut
3/4”-16U

5 Interfaces and communication

The product supports following interfaces:

- The primary interface SSI is intended for the transmission of operating data. See *Synchronous Serial Interface (SSI)* for details.
- The IO-Link interface is used exclusively for product configuration and maintenance. See *IO-Link interface reference* for details.

Note

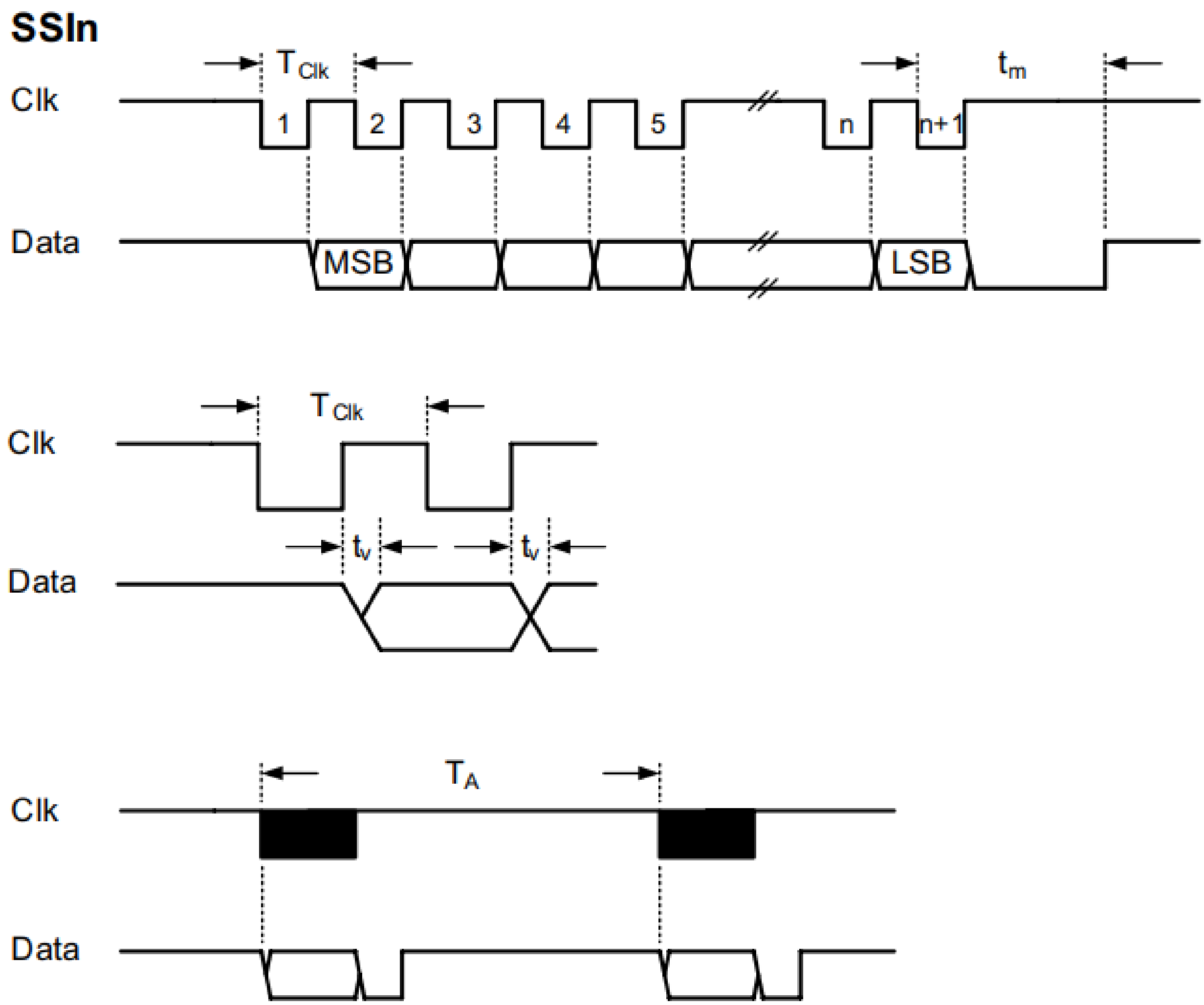
To avoid interference with SSI communication, the SSI and IO-Link interface must not be used simultaneously!

5.1 Synchronous Serial Interface (SSI)

SSI stands for Synchronous Serial Interface and describes a digital synchronous interface with a differential clock line and a differential data line.

With the first falling clock edge, the data word to be output is buffered in the BTL to ensure data consistency. Data output takes place with the first rising clock edge, i.e. the BTL supplies a bit to the data line for each rising clock edge. In doing so, the line capacities and delays of drivers t_v when querying the data bits must be taken into account in the controller.

The max. clock frequency f_{Clk} is dependent on the cable length (see *Maximum SSI clock frequency depending on the cable length*). The t_m time, also called monoflop time, is started with the last falling edge and is output as the low level with the last rising edge. The data line remains at low until the t_m time has elapsed. Afterwards, the BTL is ready again to receive the next clock package.



T_{Clk}	=	$1/f_{Clk}$	SSI clock period, SSI clock frequency
T_A	=	$1/f_A$	Sampling period, sampling rate
n			Number of bits to be transmitted (requires n+1 clock impulses)
t_m	=	$2 \cdot T_{Clk}$	Time until the SSI interface is ready again
t_v	=	150 ns	Transmission delay times (measured with a 1 m cable)

The BTL works in asynchronous operation. If the minimum sampling time is undercut, the BTL outputs the same position value several times. The external sampling rate is then greater than the internal rate. In addition, T_A must be long enough so that the next clock package does not occur in the t_m range of the previous package.

5.1.1 Data format

The BTL with SSI interface has the following factory settings:

- Number of bits: 24, 25 or 26
- Binary or Gray coded
- Rising or falling

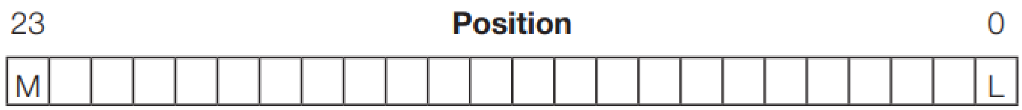


Fig. 1: Example 24-bit SSI data frame with position data M = MSB (Most Significant Bit) L = LSB (Least Significant Bit)

The content of the information to be transmitted (e.g. position or velocity) is configurable. The MSB is always transmitted first.

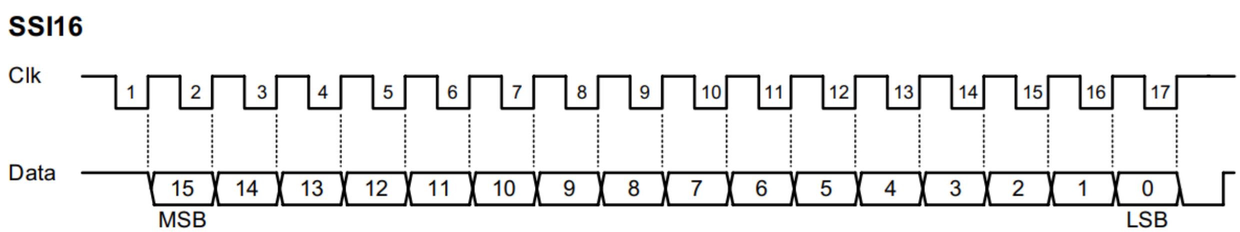


Fig. 2: Example of a complete data transmission (number of bits = 16)

Depending on configuration, position or velocity data may be signed. Negative values are output in two's complement by default. For positive speeds, the position magnet moves away from the connection side; for negative speeds it moves toward the connection side. The controller must then be set to process signed data.

Depending the configuration, the device can output additional data following the main process data (e.g., 24-bit position and 8-bit temperature).

Example with 24 bit position data:

Additional data enable	Main data	Additional data	Data bits (in total)
Disabled (default)	Position (24 bit)	-	24
Enabled	Position (24 bit)	Temperature (8 bit)	24 + 8 = 32

5.1.2 Advanced settings

Besides factory settings following interface related parameters can be modified (see *Comissioning*):

- Number of bits
- Monoflop time t_m
- Coding (binary/Gray)

- Additional error and parity bit (even or odd)
- Multiple transmission mode
- Output characteristic
- Error value
- Representation of negative values (two's complement or sign bit mode)
- Data resolution
- Enable additional data output

Note

Error and parity bits are stuffed into the SSI data frame to the highest bit positions (MSB) by not extending the configured number of bits. Parity bit is always the MSB (if enabled).

Note

If additional data with Gray coding is enabled, Gray coding is applied separately to both data parts!

5.1.3 Faulty query

Underclocking

If there are too few clock edges, the current data level will be maintained for the time to (t_o = 2 x T_{Clk} timeout times) after the last negative edge from Clk. If, however, another positive edge occurs, the next bit will then be output. Afterwards a T_o event will occur, the data output goes to Low and after time tm has elapsed to High. The high level is maintained until the next clock burst. Time t_m following t_o.

Overclocking

If there are too many clock edges, the data output will switch to low after the correct number of cycles has been completed. The t_m timer is reset for every additional negative edge of Clk and internally the T_m event is set. After time t_m the data again goes to high. A T_o or T_m event is shown in the status field as a communication error. In summary a communication error can have the following causes:

- The bit number set in the BIR does not correspond to the bit number in the controller.
  $n_{BTL} > n_{PLC} \rightarrow T_o$ event
  $n_{BTL} < n_{PLC} \rightarrow T_m$ event
- The SSI clock frequency is too low
  $f_{Clk} < 9.771$ kHz $\rightarrow T_o$ event
- The pause between two clock packages is too short $\rightarrow T_m$ event

Asynchronous operation

During asynchronous operation, the external sampling frequency is independent of the internal sampling frequency of the BTL. Depending on the external query point, the position is more or less current and the position delay tD is not constant. In the worst case, it is equal to the internal sampling period. The BTL always works with the maximum possible internal sampling frequency. Due to the measuring principle, the maximum sampling frequency $f^{A,max}$ is dependent on the nominal length of the BTL. The following graphic shows the behavior of internal and external sampling in asynchronous operation:

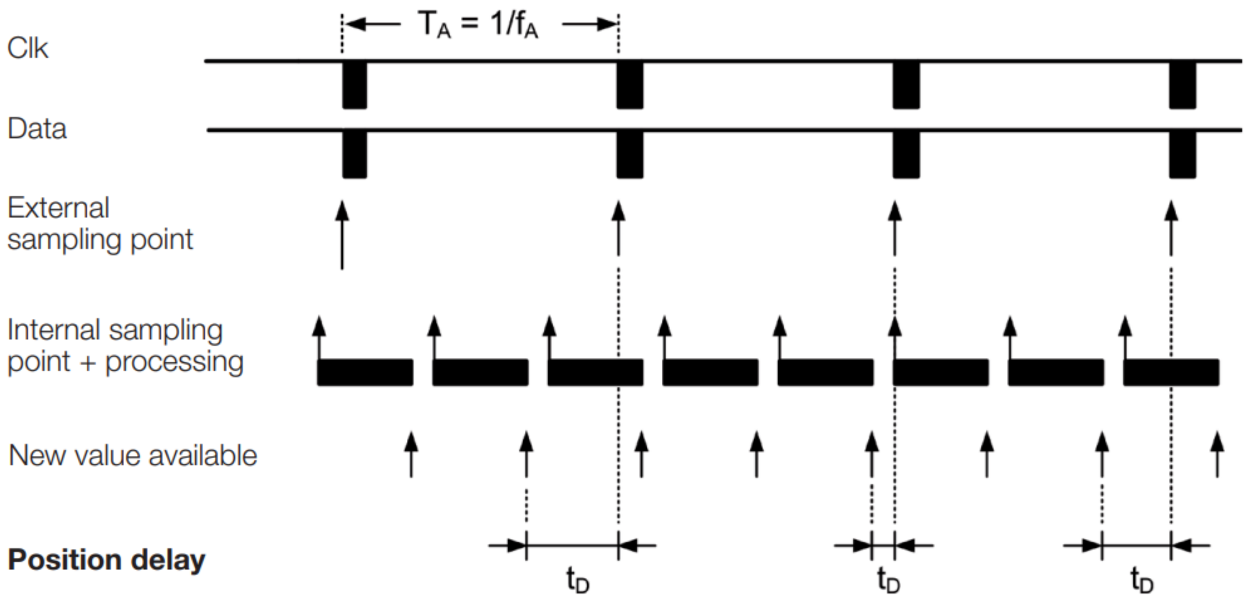


Fig. 3: Behavior in asynchronous operation

Note

The sampling frequency is the reciprocal value of the time between two clock packages and may not be confused with the SSI clock frequency.

Data multiplexer

The device has two special digital inputs labeled *La* and *Lb* (see *Electrical Connection*) which can be used as multiplexer inputs to select various pre-defined data formats for SSI.

Note

Changing the settings on these inputs affects only the output of additional data.

By default these inputs are inactive. For detailed information on the configuration options and on how to enable these inputs, see *SSI output configuration*.

5.2 Display elements

The product support the following display elements:

- The status LED displays its operating status. See *LED interface* for details.

5.2.1 LED interface

This product features an LED interface to display its operating status.

Table 1: LED display

Signal	Meaning
Green	**Normal function**: Position magnet is within the measuring range, no communication.
Green flashing, 1 Hz	**Normal function**: Position magnet is within the measuring range, SSI communication active, BTL in asynchronous mode.
Yellow flashing, 3 Hz	**Warning**: Position magnet is outside the measuring range.
Red flashing, 1 Hz	**Measurement error**: No magnet.

The priority of the LED display is as follows (highest to lowest priority):

- Measurement error
- Warning
- Normal function

6 IO-Link interface reference

This section provides information about the configuration via IO-Link interface.

6.1 IO-Link Basic Knowledge

6.1.1 General

IO-Link integrates conventional and intelligent sensors and actuators in automation systems and is intended as a communication standard below classic field buses. Field- bus-independent transfer uses communication systems that are already available (field buses or Ethernet-based systems).

IO-Link devices, such as sensors and actuators, are connected to the controlling system using a point-to-point connection via a gateway, the IO-Link master. The IO-Link devices are connected using commercially available unshielded standard sensor cables.

Communication is based on a standard UART protocol with a 24-V pulse modulation in half-duplex operation. This allows classic three-conductor physics.

6.1.2 Protocol

With IO-Link communication, permanently defined frames are cyclically exchanged between the IO-Link master and the IO-Link device. In this protocol, both process and on demand data, such as parameters or diagnostic data, is transferred. The size and the type of the frame and the cycle time used result from the combination of master and device features (see *communication properties*).

6.1.3 Cycle Time

The cycle time used (master cycle time) results from the minimum possible cycle time of the IO-Link device (min cycle time, see *communication properties*) and the minimum possible cycle time of the IO-Link master. When selecting the IO-Link master, please note that the larger value determines the cycle time used.

6.1.4 Communication parameters

In order to be able to establish a stable communication connection between master and device, the master requests some important communication parameters from the device at the start of communication. Settings for communication in Preoperate and Operate modes are influenced by the parameters and the device is clearly identified.

6.1.5 Process Data Flow

The data transfer is based on the general profile specification (IO-Link Common Profile 1.0, see *Example of a PDInput data flow* for example).

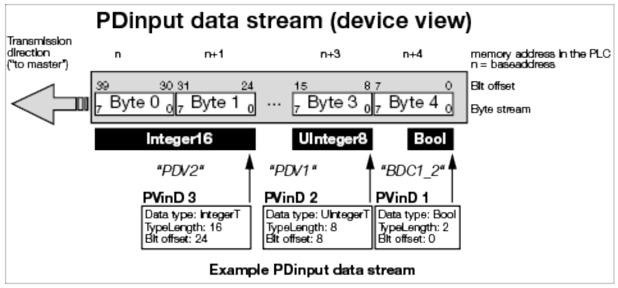


Fig. 1: Example of a PDInput data flow

The highest value byte (MSB, designated as *Byte 0*) is transferred first and can be found in the PLC under the lowest storage address. The lowest value byte (LSB) is transferred last and has the highest byte number (designated in *Example of a PDInput data flow* as *Byte 4*).

For word-based data types (> 8 bit) this means that the byte at the lowest address is the highest value byte, while the highest address contains the lowest value byte.

In the IODD, the description of the data flow is realized using the skew descriptors. This skew starts *at the right* with the lowest value byte.

Process data variables (in *Example of a PDInput data flow*: PDV1, PDV2) are aligned to the byte limits in most cases.

Binary information (BDC) is transferred in the lowest value byte in most cases.

6.1.6 Process data objects

The process data flow is made up of various process data objects, which are not only shown in the process data flow, but are also used for the internal exchange of information between functions. For example, PdObjects can be used to offset random binary information in the function *Logic Blocks* or to display certain information at the digital output. Therefore, a unique object ID is assigned to this individual information, which can be used at different places.

Process data objects are described in the function chapters under *Process Data*.

6.1.7 Device Status

The *Device Status* indicates the current status of the device or of the directly connected peripherals. This functionality is part of the IO-Link specification.

The following states are output by the device:

- *Device is operating properly* (device is functioning error-free): This status indicates that no serious error has occurred in the device and the device can be operated without restrictions.
- *Maintenance-Required*: Although the process data is valid, internal diagnosis functions show that the device or the operational environment of the device should be serviced.
- *Out-of-Specification*: Although the process data is valid, internal diagnosis functions show that the device is operating outside of the specified specification. This can affect both the measurement application itself as well as the environmental conditions.
- *Functional-Check*: Process data is temporarily invalid while a deliberate intervention is performed on the device. For example, parameterization processes or teach-in.
- *Failure*: The device or the connected peripherals have a severe error. The device cannot perform its intended function!

For further information, see *Device Status and Detailed Device Status*.

The creation of the *Device Status* is always based on the output of diagnosis messages. A *Device Status* is output for every diagnosis message (event). Each of these can be found in the event overview list (see Events) or in the description of the functions.

6.1.8 Block Parameterization

Block parameterization refers to a special process in which multiple parameters are parameterized in one process. It is started with a start command and concluded with an end command.

Because the check of the data is not performed until the parameterization is concluded, pieces of data that are dependent on one another can also be set without problem.

6.1.9 Data Storage

Data Storage refers to a special process for being able to store the parameterization data of a device on the master. The master controls the process between uploads (if data is intentionally changed) or downloads (if, e.g., an incorrectly parameterized device is connected). The system comprising master and device thereby ensures that a device can be exchanged without the need for an active re-parameterization.

> **ℹ Note**
>
> The settings regarding *Data Storage* are to be performed on the IO-Link master gateway (refer to the information in the corresponding documentation).

Operation is dependent on the used IO-Link master and is explained in the corresponding description.

> **ℹ Note**
>
> All parameters that are stored for parameter management in the IO-Link master are marked appropriately in *ISDU – Identification Data*.

6.1.10 Reset Commands

The device offers various reset functions. A corresponding command is executed via a *system command*.

The behavior and the values that are reset in a given case can be found in the ISDU overview (see *ISDU – Identification Data*) and in the individual function descriptions.

The *Reset Commands* are described in *Reset Commands*.

6.1.11 Device Functions and Master Gateway

The functions of the device are described in detail in the subsequent sections. Refer to the guide of the IO-Link master for information on the implementation of the process, parameter and diagnostic data via the master gateway.

6.2 Overview of IO-Link

6.2.1 Device Variants

- BTL BNCA00 - _ _ _ _ - C15DU _ _ _ - _ _ _ _ _ _
- BTL ZNCE00 - _ _ _ _ - C15DU _ _ _ - _ _ _ _ _ _

6.2.2 Communication parameters

The most important communication parameters of the different device variants can be found in the following table.

Table 1: Communication properties

Device ID	Baud rate	PDInput	PDOutput	IO-Link protocol version	Minimum cycle time
0x03040C	COM3	1 byte	–	V1.1	1 ms

For more information see the *Communication parameter details*

6.2.3 Supported profiles

This sensor supports the following IO-Link profiles.

Table 2: Supported profile characteristics

Short name, type	ID	Characteristic name
SSP 2.8	0x001C (28)	Adjustable Switching Sensor, multi channel, integer
FWUPD	0x0031 (49)	Firmware Update
I&D	0x4000 (16384)	Identification & Diagnosis
Locator	0x8101 (33025)	Locator or Device Discovery

6.2.4 Process Data In structure

i Note

Important
Process data must not be used during normal operation; it is intended solely for profile compatibility.

The BTL provides one byte of process data, which contains the four available switching signal channel's output value.

Structure of the process data is defined by SSP2.8 (Smart Sensor Profile - Adjustable Switching Sensors).

Table 3: Process data structure

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Reserved	Reserved	Reserved	Reserved	SSC1.4	SSC1.3	SSC1.2	SSC1.1

6.2.5 Details

The following table shows a detailed overview of the communication parameters.

Table 4: Communication properties - details

Property	Value
Transmission rate	COM3 (230.4 kBaud)
Minimum cycle time	1 ms
IO-Link protocol version	*0x11* (Version 1.1)
Process data in length	1 byte
Process data out length	-
Manufacturer ID	*0x378* (888)
Device ID	*0x03040C* (197644)
M-sequence capability	*0x1B* (27)
ISDU support	yes
Preoperate M-sequence type	TYPE_1_2
Operate M-sequence type	TYPE_2_V (2 bytes OD)

6.3 Primary Device Functions

6.3.1 Identification

Description

The identification data is used for the identification and management of the IO-Link devices.

ISDU

Table 5: Identification – ISDU

Name	Index	Sub-index	Access	Length	Data Type	Data Storage	Default
Vendor Name	0x0010 (16)		R	7 bytes	STRING	n/a	"Balluff"
Vendor Text	0x0011 (17)		R	15 bytes	STRING	n/a	"www.balluff.com"
Product Name	0x0012 (18)		R	≤ 64 bytes	STRING	n/a	"BTL BNCA00-xxxx-C15DUxxx-000S32"
Product ID	0x0013 (19)		R	≤ 64 bytes	STRING	n/a	"BTL BNCA00-xxxx-C15DUxxx-000S04"
Product Text	0x0014 (20)		R	≤ 64 bytes	STRING	n/a	Balluff Position Transducer
Serial Number	0x0015 (21)		R	16 bytes	STRING	n/a	
Hardware Revision	0x0016 (22)		R	2 bytes	STRING	n/a	
Firmware Revision	0x0017 (23)		R	≤ 10 bytes	STRING	n/a	
Application Specific Tag	0x0018 (24)		R/W	≤ 32 bytes	STRING	Yes	"***"
Function Tag	0x0019 (25)		R/W	≤ 32 bytes	STRING	Yes	"***"
Location Tag	0x001A (26)		R/W	≤ 32 bytes	STRING	Yes	"***"
Product Type Code	0x0700 (1792)		R	≤ 64 bytes	STRING	n/a	e.g. "BTL BNCA00-0500-C15DUA01-000S32"
Product Order Code	0x0701 (1793)		R	7 bytes	STRING	n/a	e.g. "BTLxxxx"

Application Specific Tag

With the *Application Specific Tag* parameter, a string (maximum 32 bytes) can be written to the device. This value typically describes the application in which the product is used.

Function Tag

With the *Function Tag* parameter, a string (maximum 32 bytes) can be written to the device. This value typically describes the function of the product in the application area.

Location Tag

With the *Location Tag* parameter, a string (maximum 32 bytes) can be written to the device. This value typically describes the location of the product in the application area.

Product Type Code

The Balluff type code is stored permanently in the device.

Product Order Code

The Balluff order code is stored permanently in the device.

6.3.2 Locator

Description

With the *Locator* (previously known as *Device Discovery*) function, an IO-Link device can be found again by starting signaling on the LED of the device by means of a system command.

ISDU

Table 6: Locator Timeout parameter – ISDU

Name	Index	Subindex	Access	Length	Data Type	Data Storage	Default
Locator Timeout	0x00FE (254)	0	R/W	2 bytes	UINT16	Yes	0x0A

Locator Timeout

The *Locator Timeout* parameter sets the duration of the Locator signal that is displayed via LEDs.

The value is specified minutes. The value range from 0 to 30 minutes is allowed. If the parameter is set to 0, the Locator signal is deactivated. The parameter is reset by *Application Reset* and *Factory Reset* (also see *Reset Commands*).

System Commands

Table 7: Device detection – System Commands

Command Value	Device Action
0xAF (175)	*Start Device Discovery* (for backward compatibility)
0x7E (126)	*Start Locator*
0x7F (127)	*Stop Locator*

6.3.3 Magnet mode

Description

The number of position magnets can be set to fixed or flexible.

Fixed number of position magnets

If a fixed number of one or two position magnets is set, the BTL continuously checks the number of detected position magnets.

If this number does not correspond to the set number, the application goes to error mode.

Flexible Magnet Mode (FMM)

In *Flexible Magnet Mode* the number of position magnets is flexible and can also be changed during operation.

ISDU

Table 8: Magnet Mode – ISDU

Name	Index	Subindex	Access	Length	Data Type	Data Storage	Default
Magnet Mode	0x00C9 (201)	0	R/W	1	ENUM (UINT8)	Yes	[1]

Available modes

The following modes are available:

Table 9: Magnet mode – Values

Value	Meaning	Description
0x00 (0)	Flexible Magnet Mode	At least one position magnet is required.
0x01 (1)	1 position magnet	Only one position magnet is detected (the one closer to the connector).
0x02 (2)	2 position magnets	Two position magnets are required.

6.3.4 SSI output configuration

Description

The behavior of the SSI interface can be configured via IO-Link. Normally the SSI supports only one output data but with this product additional data can be enabled that follows directly after the main data.

Some properties of the additional data can be configured independently, though with limited options.

Main data

This is the primary data for the SSI output. This data is transmitted first (the length is determined by the *SSI configuration* parameter *Number of bits*).

The following is available as main data:

- Position of the first position magnet
- Position difference

[1] The default value can be variant dependent. Please check the *typecode*.

Additional data

If the *SSI additional data enable* parameter is set to true, the selected data is inserted after the main data.

The following is available as additional data:

- Position of the second position magnet
- Velocity of the first position magnet (signed)
- Velocity of the first position magnet (absolute)
- Position difference
- Internal temperature
- Movement distance
- Total operating time

ISDU

Table 10: SSI output configuration – ISDU

Name	Index	Subindex	Access	Length	Data Type	Data Storage	Default
SSI data selector	0x0124 (292)	0	R/W	2	ENUM (UINT16)	Yes	0x0000 (0)
SSI configuration	0x0125 (293)	0	R/W	16	RECORD	Yes	
Coding		1	R/W	1	ENUM (UINT8)	No	0x00 (0)
Representation		2	R/W	1	ENUM (UINT8)	No	0x00 (0)
Parity mode		3	R/W	1	ENUM (UINT8)	No	0x00 (0)
Error bit enable		4	R/W	1	BOOL	No	0x00 (0)
Multiple transmission enable		5	R/W	1	BOOL	No	0x00 (0)
Adaptive timeout enable		6	R/W	1	BOOL	No	0x00 (0)
Invert		7	R/W	1	BOOL	No	0x00 (0)
Number of bits		8	R/W	1	UINT8	No	0x18 (24)
Timeout		9	R/W	2	UINT16	No	
Hysteresis		10	R/W	2	UINT16	No	
Error value		11	R/W	4	INT32	No	0x7FFFFFFF (2147483647)

continues on next page

Table 10 – continued from previous page

Name	Index	Subindex	Access	Length	Data Type	Data Storage	Default
SSI resolution	0x0126 (294)	0	R/W	2	ENUM (UINT16)	Yes	0x0002 (2)
SSI offset	0x0127 (295)	0	R/W	4	INT32	Yes	0x00000000 (0)
SSI additional data enable	0x0142 (322)	0	R/W	1	BOOL	Yes	0x00 (0)
SSI additional data selector	0x0143 (323)	0	R/W	2	ENUM (UINT16)	Yes	0x0001 (1)
SSI additional data configuration	0x0144 (324)	0	R/W	8	ENUM (UINT16)	Yes	
Invert		1	R/W	1	BOOL	No	0x00 (0)
Number of bits		2	R/W	1	UINT8	No	0x18 (24)
Hysteresis		3	R/W	2	UINT16	No	
Error value		4	R/W	4	INT32	No	0x7FFFFFFF (2147483647)
SSI additional data resolution	0x0145 (325)	0	R/W	2	ENUM (UINT16)	Yes	0x0002 (2)
SSI additional data offset	0x0146 (326)	0	R/W	4	INT32	Yes	0x00000000 (0)

SSI output data selector

Table 11: SSI output data selector – options

Value	Meaning
0x00 (0)	Position of position magnet 1
0x04 (4)	Position difference

SSI configuration

Coding

This parameter is used to select between binary and Gray coding. It affects both the encoding of the main data and that of the supplementary data, however with Gray coding the two values are coded seperately.

Table 12: SSI configuration – coding

Value	Meaning
0x00 (0)	Binary
0x01 (1)	Gray

Representation

Selects between two's complement and *sign and magnitude* representations. This parameter affeccts both main and additional data's representation.

Table 13: SSI configuration – representation

Value	Meaning
0x00 (0)	Two's complement
0x01 (1)	Sign and magnitude

Parity mode

Controls the parity bit mode for the main data only.

Table 14: SSI configuration – parity mode

Value	Meaning
0x00 (0)	Parity disabled
0x01 (1)	Even parity
0x02 (2)	Odd parity

> **ℹ Note**
>
> Enabling the parity bit **reduces** the number of bits available for the main data.
> For example if the *Number of bits* is set to 24 and the parity bit is enabled (even or odd), the remaining 23 bits are used to represent the actual value.

> **ℹ Note**
>
> When parity is enabled, it is always the MSB.

Error bit enable

If the parameter is set to true, an error bit is inserted before the main data.

> **ℹ Note**
>
> Enabling the error bit **reduces** the number of bits available for the main data.
> For example if the *Number of bits* is set to 24 and the error bit is enabled, the remaining 23 bits are used to represent the actual value.

Multiple transmission enable

Set this parameter to true to enable multiple transmission. For more details see *operation principle*.

Adaptive timeout enable

If adaptive timeout is *disabled*, the monoflop timeout is set to *Timeout*. If adaptive timeout is *enabled*, the monoflop timeout is derived from the SSI clock frequency (twice the clock period).

For details, see *operation principle*.

Invert

This parameter inverts the output characteristic.

> **Note**
>
> Invert is only for position data.

Number of bits

This field specifies that how many bits are used to represent the main data. The *Number of bits* must be between 16 and 32 (inclusive) and can be configured in increments of 1 bit. If the additional data is enabled, the total number of bits must be less than or equal to 48.

> **Note**
>
> The *Number of bits* includes the error and / or parity bit if enabled.
> For example: to have 24 bit position data with error and parity bit, the *Number of bits* parameter must be set to 26.

Timeout

Specifies the SSI monoflop timeout in microseconds (µs). This value must be between 1 and 500 µs (inclusive).

Hysteresis

Specifies the position hysteresis. The unit is micrometer (µm). The value must be between 0 and 10.000 (inclusive).

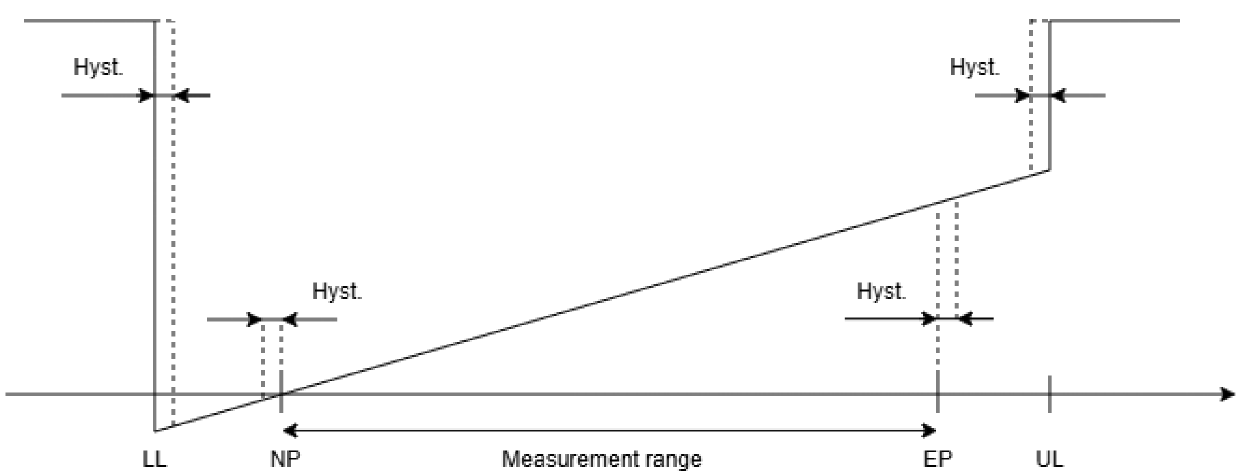


Fig. 2: SSI output characteristic - hysteresis

Error value

This parameter defines the substitution value if there is an error condition or the measurement value is below lower limit (`LL`) or upper limit (`UL`). By default it is the largest 32 bit positive integer.

SSI resolution

Available resoltion modes:

Table 15: SSI configuration – resolution

Value	Resolution
0x00 (0)	100 nm
0x01 (1)	500 nm
0x02 (2)	1 µm
0x03 (3)	2 µm
0x04 (4)	5 µm
0x05 (5)	10 µm
0x06 (6)	20 µm
0x07 (7)	40 µm
0x08 (8)	50 µm
0x09 (9)	100 µm

SSI offset

This parameter is an optional offset value for the main data.

ℹ Note

The offset is used for the following data only:

- Position of the first position magnet
- Position difference

The offset for all the other data is ignored.

SSI additional data enable

Enables the additional data that follows immediately the main data.

SSI additional data selector

Table 16: SSI additional data selector – options

Value	Meaning
0x01 (1)	Postition of the second position magnet
0x02 (2)	Velocity of the first position magnet (signed)
0x03 (3)	Velocity of the first position magnet (absolute)
0x04 (4)	Position difference
0x10 (16)	Internal temperature
0x11 (17)	Movement distance
0x12 (18)	Device operating time
0x80 (128)	Multiplexer data

Note

If *Multiplexer data* option is enabled, the state of the two digital inputs determines which value is set as additional data. **Not all variant supports this mode**.

Note

The unit for *Movement distance* and *Device operating time* depends on the number of bits used for the additional data.

For more information, see *Additional data and multiplexer input* section.

SSI additional data configuration

Invert

This parameter reverses the output characteristic curve.

Note

Invert is only available for position data.

Number of bits

This field specifies how many bits are used to represent the additional data.

Only the following options are available:

Table 17: SSI additional data configuration – number of bits

Value	Meaning
0x08 (8)	8 bit
0x10 (16)	16 bit
0x18 (24)	24 bit

> **Note**
>
> The following values are **not available** in 8 bit mode:
> - Position of the second magnet
> - Velocity of the first position magnet (signed)
> - Velocity of the first position magnet (absolute)
> - Position difference
>
> The following values are **not available** in 24 bit mode:
> - Internal temperature
> - Movement distance
> - Device operating hours
> - Multiplexer data

Hysteresis

This parameter specifies the position or velocity hysteresis. The unit is `µm` (position data) or `0.1 mm/s` (velocity data). The value must be between 0 and 10.000 (inclusive), see *Hysteresis*.

Error value

This parameter defines the substitution value when an error condition occurs. By default, it is the largest 32 bit positive integer.

SSI additional data resolution

This parameter controls the additional data resolution. See *SSI resolution* for available options.

> **Note**
>
> This parameter controls the resolution for the following additional data:
> - Position of the second position magnet
> - Position difference
>
> The resolution for all the other additional data modes is fixed.

SSI additional data offset

This parameter is an optional offset value for the additional data.

> **Note**
>
> The offset is used for the following data only:
> - Position of the second position magnet
> - Position difference
>
> The offset for all the other data is ignored.

Additional data and multiplexer input

In case of *Movement distance* and *Device operating time* the unit depends on the *SSI additional data configuration - Number of bits* field.

Table 18: Movement distance - unit

Number of bits	Unit
0x08 (8)	1000 km
0x10 (16)	km

Table 19: Device operating time - unit

Number of bits	Unit
0x08 (8)	1000 hours
0x10 (16)	24 hours (day)

The unit for *Internal temperature* is °C.

When the additional data selector is set to *Multiplexer input*, the two digital inputs of the BTL selects between the following additional data values:

Table 20: Multiplexer input

La	Lb	Meaning
LOW (0)	LOW (0)	Additional data disabled
LOW (0)	HIGH (1)	Internal temperature
HIGH (1)	LOW (0)	Movement distance
HIGH (1)	HIGH (1)	Device operating time

6.3.5 Operation mode

Description

This feature controls the internal filtering settings of the BTL.

By default, the BTL runs in **balanced mode**, which provides acceptable latency and noise. Suitable for most applications.

High speed mode provides minimal latency but noise levels could be higher.

High precision mode in contrast filters the measurement data extensively, providing minimal noise, however the latency is increased.

This parameter can be configured according to requirements of the specific application.

ISDU

Table 21: Operation mode – ISDU

Name	Index	Subindex	Access	Length	Data Type	Data Storage	Default
Operation mode	0x0129 (81)	0	R/W	1	ENUM (UINT8)	Yes	0x02 (2)

Available modes

The following operation modes are available:

Table 22: Operation mode configuration – available modes

Value	Meaning	Description
0x01 (1)	High speed	Minimal filtering, latency minimized
0x02 (2)	Balanced	Balanced mode (default)
0x03 (3)	High precision	Extensive filtering, latency increased

6.3.6 Synchronous mode configuration

> **i Note**
>
> The *Synchronous* and *Single Shot* modes are not available for *Hardware Revision* `"01"` (see *Available modes*).

Description

Depending on this parameter, the BTL's measurement module can operate in different modes.

Typically, the BTL's measurement unit operates in free-running mode (continuous measurement) and is independent of the SSI request. However, it can be synchronized with the SSI request so that the measurement cycle can be controlled by the SSI master.

ISDU

Table 23: Synchronous mode configuration – ISDU

Name	Index	Subindex	Access	Length	Data Type	Data Storage	Default
Synchronous mode	0x0200 (512)	0	R/W	1	ENUM (UINT8)	Yes	0x00 (0)

Available modes

The following modes are available:

Table 24: Synchronous mode configuration – available modes

Value	Meaning	Description
0x00 (0)	Free-running (asynchronous)	Measurement is running independently from the SSI requests
0x01 (1)	Synchronous	BTL synchronizes itself to the SSI requests
0x02 (2)	Single shot	Measurement directly controlled by the SSI requests

6.4 Secondary Device Functions

6.4.1 Operating Hours Counter

Description

The operating hours counter can record the operating hours of a device accurately to the second. There are a total of three operating hours counters. In addition to an operating hours counter for the operating hours since the start of the device, there is a total operating hours counter and a customer-specific operating hours counter that can be reset. The storage interval is configurable and the operating hours are not stored once one million storage cycles have been reached.

The output of the operating hours can serve as a time control for the service interval as well as for preventative maintenance. Schedules for regular service can be tied to the operating hour values. Moreover, a high value of the total operating hours is indicative of intensive use of a device and possible deterioration of the performance. The risk of failure can be countered preventatively through replacement.

Algorithm

While the counter is incremented every second, the storage interval doubles after each save operation. Starting with a save operation after 1 minute, then after 2 minutes, then after 4 minutes, then after 8 minutes, up to a maximum storage rate of 12 minutes.

Process Data

Table 25: Operating hours counter – Process data

Object ID	Name	Description	Direction
0x001B (27)	Current Operating Hours	Output of the current operating hours counter	Input
0x001C (28)	Total Operating Hours	Output of the total operating hours counter	Input
0x001D (29)	Custom Operating Hours	Output of a user-defined operating hours counter	Input

Also see Process Data Profiles.

ISDU

Table 26: Operating hours counter – ISDU

Name	Index	Subindex	Access	Length	Data Type	Data Storage	Default
Operating Hours Counter	**0x0057 (87)**	**0**	**R**	**12 bytes**		**n/a**	
Current Operating Hours		1	R	4 bytes	UINT32	n/a	–
Total Operating Hours		2	R	4 bytes	UINT32	n/a	–
Custom Operating Hours		3	R	4 bytes	UINT32	n/a	–
Operating Hours Saving Mode	**0x0074 (116)**	**0**	**R/W**	**1 byte**	**UINT8 (ENUM)**	**Yes**	**0**

Note

The maximum counter value that can be saved is 1,000,000 and, with a switch-on and switch-off every 12 minutes (with static counter), this means a service life of over 20 years.
If switched on and off more frequently or in the case of dynamic storage, the maximum storage time is reduced depending on the application.

Current Operating Hours Parameter

This parameter saves the value of the operating hours since the last commissioning in seconds.

Total Operating Hours Parameter

This parameter saves the value of the operating hours since the first commissioning in seconds.

Custom Operating Hours Parameter

This parameter saves the value of the operating hours since the last reset in seconds.

Operating Hours Saving Mode

The current storage behavior can be set.

Table 27: Operating Hours Counter – Operating Hours Saving Mode

Value	Meaning	Description
0x00 (0)	Dynamic	The first save operation is performed 1 minute after switching on; the storage interval than doubles after every save operation. This is limited to a storage interval of 12 minutes. The intervals are 1, 2, 4, 8, 12 minutes.
0x01 (1)	Static	Operating hours counters are stored every 12 minutes.

System Commands

Table 28: Operating hours counter – System Commands

Command Value	Device Action
0x81 (129)	*Application Reset* – Resets *Custom Operating Hours* to the default value.
0x82 (130)	*Restore Factory Settings* – Resets *Custom Operating Hours* and *Operating Hours Saving Mode* to the default value.
0xA5 (165)	*Maintenance Reset* – Resets *Custom Operating Hours* to the default value.

6.4.2 Boot Cycle Counter

Description

After each start, the current Boot Cycle Counter is read from the non-volatile memory, incremented by 1 and rewritten. In addition, a second Boot Cycle Counter is implemented that can be reset.

The output of the current boot cycle can serve as a control for the service interval as well as for preventative maintenance. Schedules for regular maintenance can be tied to the values of the Boot Cycle Counter.

Process Data

Table 29: Boot cycle counters – Process data

Object ID	Name	Description	Direction
0x001E (30)	Boot Cycle Counter	Output of the current Boot Cycle Counter	Input
0x001F (31)	Custom Boot Cycle Counter	Output of the resettable Boot Cycle Counter	Input

Also see Process Data Profiles.

ISDU

Table 30: Boot cycle counter – ISDU

Name	Index	Subindex	Access	Length	Data Type	Data Storage	Default
Boot Cycle Counter	**0x0058 (88)**	**0**	**R**	**8 bytes**		**n/a**	
Boot Cycle Counter		1	R	4 bytes	UINT32	n/a	–
Custom Boot Cycle Counter		2	R	4 bytes	UINT32	n/a	–

> **ℹ Note**
>
> The maximum counter value that can be saved is 1,000,000 and, with a switch-on and switch-off every 12 minutes, this means a service life of over 20 years.

Boot Cycle Counter Parameter

This parameter saves the value of the current boot cycle, which is incremented on each start.

Custom Boot Cycle Counter Parameter

This parameter saves the value of the current, user-defined counter, which is incremented on each start and can be reset via the *Maintenance Reset* system command.

System Commands

Table 31: Boot cycle counter – System Commands

Command Value	Device Action
0x81 (129)	*Application Reset* – Resets the *Custom Boot Cycle Counter* with ISDU-index 0x58 subindex 2 to the default value 0.
0x82 (130)	*Restore Factory Settings* – Resets the *Custom Boot Cycle Counter* with ISDU-index 0x58 subindex 2 to the default value 0.
0xA5 (165)	*Maintenance Reset* – Resets the *Custom Boot Cycle Counter* with ISDU-index 0x58 subindex 2 to the default value 0.

6.4.3 Internal Temperature

Description

The device has internal temperature monitoring. This records the device temperature as well as the maximum and minimum values since production and since the last time the device was restarted.

An upper and a lower threshold value can be defined for the device temperature module. If the threshold is exceeded or if device limit values are exceeded or undercut, the device triggers IO-Link events.

> **Note**
>
> The internal device temperature is measured in the device and is therefore higher than the ambient temperature. The level of this increased temperature depends on the ambient temperature, the ventilation of the device and the device settings.

Process Data

Table 32: Internal temperature – Process data

Object ID	Name	Description	Direction
0x004E (78)	Temperature Status Customer Limits	Temperature status – Warning related to the configured customer limits [Index 0x0053]. Set when out of limits.	Input
0x004F (79)	Temperature Status Device Limits	Temperature status – Warning related to the device limits. Set when out of limits.	Input
0x0050 (80)	Device Temperature	Current device temperature in °C.	Input

ISDU

Table 33: Internal temperature – ISDU (overview)

Name	Index	Subinde	Access	Length	Data Type	Data Storage	Default
Device Temperature	**0x0052 (82)**	**0**	**R**	**10 bytes**		**n/a*	
Device Temperature		1	R	2 bytes	INT16	n/a	–
Minimum Device Temperature Since Reset		2	R	2 bytes	INT16	n/a	–
Maximum Device Temperature Since Reset		3	R	2 bytes	INT16	n/a	–
Lifetime Minimum Device Temperature		4	R	2 bytes	INT16	n/a	–
Lifetime Maximum Device Temperature		5	R	2 bytes	INT16	n/a	–
Device Temperature Alarm Configuration	**0x0053 (83)**	**0**	**R/W**	**4 bytes**		**Yes**	
Lower Alarm Level Device Temperature		1	R/W	2 bytes	INT16	No	−40
Upper Alarm Level Device Temperature		2	R/W	2 bytes	INT16	No	115

Device Temperature

Device Temperature contains information about the device temperature (current value in °C), the minimum or maximum device temperature since the last time the device was switched on/reset (in °C) and minimum or maximum device temperature during the lifetime of the device (in °C).

Device Temperature Alarm Configuration

Setting of the lower threshold value (in °C) for the device temperature warning (0x8D20) and of the upper threshold value (in °C) for the device temperature warning (0x8D10).

Events

Table 34: Internal temperature – Events

Event Code	Event Type	Event – Description – Remedy	Device Status
0x4000 (16384)	Error	*Temperature Fault – Overload* – The device is operated outside of the device-specific temperature limits. Risk of device damage.	4 – Failure
0x4210 (16912)	Warning	*Device Temperature Overrun – Clear Heat Of Source* – Risk of device damage. The device is too hot. Remove heat source, provide the device with heat insulation if necessary.	2 – Out-of-specification
0x4220 (16928)	Warning	*Device Temperature Underrun – Insulate Device* – Risk of device damage. The device is too cold. Insulate the device.	2 – Out-of-specification
0x8D10 (36112)	Warning	*Device Temperature Upper Warning* – The set upper temperature warning threshold has been exceeded.	0 – Device is operating properly.
0x8D20 (36128)	Warning	*Device Temperature Lower Warning* – The device temperature has fallen below the set lower temperature warning threshold.	0 – Device is operating properly.

6.4.4 Signal Delay

Description

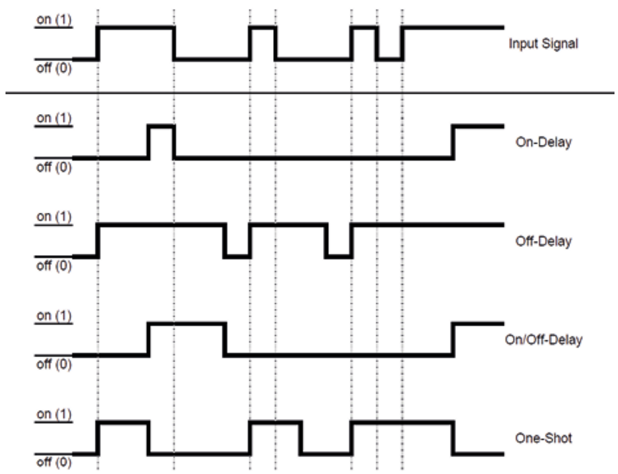
This is a function that is applied to an internal binary signal. This function allows the user to apply time delay functions to the internal binary signal of the device (On-Delay, Off- Delay, One-Shot or On/Off-Delay).

Mathematics/Algorithm

Process Data

Table 35: Signal delay – process data

Object ID	Name	Description	Direction
0x0008 (8)	Signal Delay Channel 1	Output signal *Signal Delay Channel 1*	Input
0x0009 (9)	Signal Delay Channel 2	Output signal *Signal Delay Channel 2*	Input
0x000A (10)	Signal Delay Channel 3	Output signal *Signal Delay Channel 3*	Input
0x000B (11)	Signal Delay Channel 4	Output signal *Signal Delay Channel 4*	Input



ISDU

Table 36: Signal delay – ISDU

Name	Index	Subindex	Access	Length	Data Type	Data Storage	Default
Signal Delay Input	**0x0096 (150)**	**0**	**R/W**	**8 bytes**		**Yes**	
Channel 1		1	R/W	2 bytes	UINT16(ENUM)	No	0
Channel 2		2	R/W	2 bytes	UINT16(ENUM)	No	0
Channel 3		3	R/W	2 bytes	UINT16(ENUM)	No	0
Channel 4		4	R/W	2 bytes	UINT16(ENUM)	No	0
Signal Delay Mode	**0x0097 (151)**	**0**	**R/W**	**4 bytes**		**Yes**	
Channel 1		1	R/W	1 byte	UINT8(ENUM)	No	0
Channel 2		2	R/W	1 byte	UINT8(ENUM)	No	0
Channel 3		3	R/W	1 byte	UINT8(ENUM)	No	0

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Table 36 – continued from previous page

Name	Index	Subindex	Access	Length	Data Type	Data Storage	Default
Channel 4		4	R/W	1 byte	UINT8(ENUM)	No	0
Signal Delay On-Delay	**0x0098 (152)**	**0**	**R/W**	**8 bytes**		**Yes**	
Channel 1		1	R/W	2 bytes	UINT16	No	0
Channel 2		2	R/W	2 bytes	UINT16	No	0
Channel 3		3	R/W	2 bytes	UINT16	No	0
Channel 4		4	R/W	2 bytes	UINT16	No	0
Signal Delay Off-Delay / One-Shot	**0x0099 (153)**	**0**	**R/W**	**8 bytes**		**Yes**	
Channel 1		1	R/W	2 bytes	UINT16	No	0
Channel 2		2	R/W	2 bytes	UINT16	No	0
Channel 3		3	R/W	2 bytes	UINT16	No	0
Channel 4		4	R/W	2 bytes	UINT16	No	0
Signal Delay Status	**0x009A (154)**	**0**	**R**	**4 bytes**		**n/a**	
Channel 1		1	R	1 byte	UINT8(ENUM)	n/a	–
Channel 2		2	R	1 byte	UINT8(ENUM)	n/a	–
Channel 3		3	R	1 byte	UINT8(ENUM)	n/a	–
Channel 4		4	R	1 byte	UINT8(ENUM)	n/a	–

Signal Delay Input Parameter

With *Signal Delay Input*, the internal binary signal source can be selected. *Input* contains a list of the internal binary signals.

Signal Delay Mode Parameter

With *Signal Delay Mode*, the current mode of the signal delay function can be selected.

Table 37: Signal Delay – Signal Delay Mode

Value	Meaning	Description
0x00 (0)	Deactivated	Deactivated
0x01 (1)	Delay	On, Off and On-/Off delay function
0x02 (2)	One-Shot	One-Shot function

Signal Delay On-Delay Parameter

With *Signal Delay On-Delay*, the time for On-Delay can be set. The value represents the time in milliseconds. The value range is between 0x0000 (0) and 0xFFFF (65535). A value of 0x0000 (0) represents no delay. The parameter has no effect in *One-Shot-Modus*.

Signal Delay Off-Delay / One-Shot Parameter

With *Signal Delay Off-Delay / One-Shot*, the time for Off-Delay and One-Shot can be set. The value represents the time in milliseconds. The value range is between 0x0000 (0) and 0xFFFF (65535). A value of 0x0000 (0) represents no delay.

Signal Delay Status Parameter

With *Signal Delay Status*, the current status of each channel can be read.

Table 38: Signal Delay – Signal Delay Status

Value	Meaning	Description
0x00 (0)	Off	Output signal of Signal Delay = 0/FALSE
0x01 (1)	On	Output signal of Signal Delay = 1/TRUE
0x02 (2)	On-Delay	Output signal of Signal Delay = 0/FALSE and On-Delay currently running.
0x03 (3)	Off-Delay	Output signal of Signal Delay = 1/TRUE and OFF-Delay currently running.
0x07 (7)	One-Shot	Output signal of Signal Delay = 1/TRUE and One-Shot function currently running.
0xFF (255)	Deactivated	Feature is deactivated.

System Commands

Table 39: Signal delay – System Commands

Command Value	Device Action
0x81 (129)	*Application Reset* – Resets writable parameters to the default value.
0x82 (130)	*Restore Factory Settings* – Resets writable parameters to the default value.

6.4.5 Stroke monitoring

The stroke monitoring feature contains the following components:

- Distance counter
- Stroke counter
- Deviation monitoring

This feature supports up to 3 independent stroke channels. Each channel can be configured and enabled separately. A stroke channel is determined by the start and end switching point. One switching point can be used in multiple stroke channels.

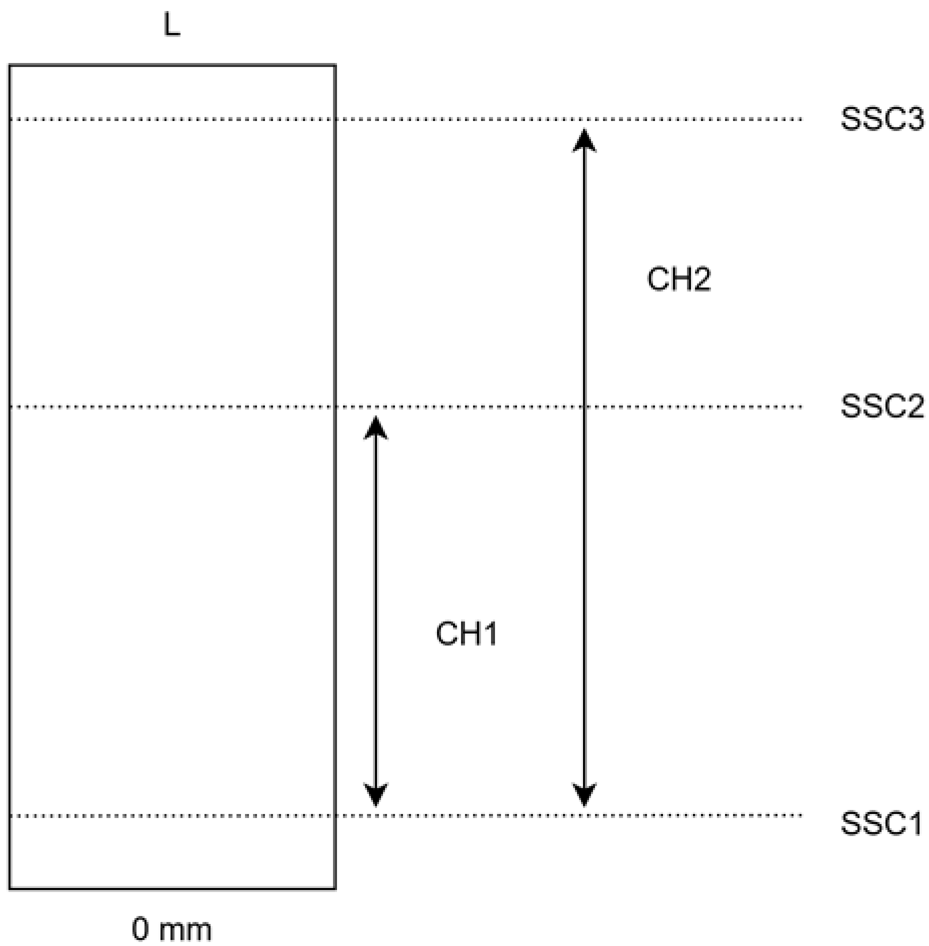

Fig. 3: Stroke monitoring - overview

- `L`: nominal length of the BTL
- `CHx`: stroke channels
- `SSCx`: switching points

Distance counter

Description

The distance counter records the distance taken by the first position magnet (forward and backward as well). The value is determined independently of the configuration of the stroke channels and is specified as an absolute value. The counter is updated periodically.

A jitter window is used to determine the smallest recorded movement, therefore the position magnet movement must be greater than the value of this window. The window size can be adapted to the application.

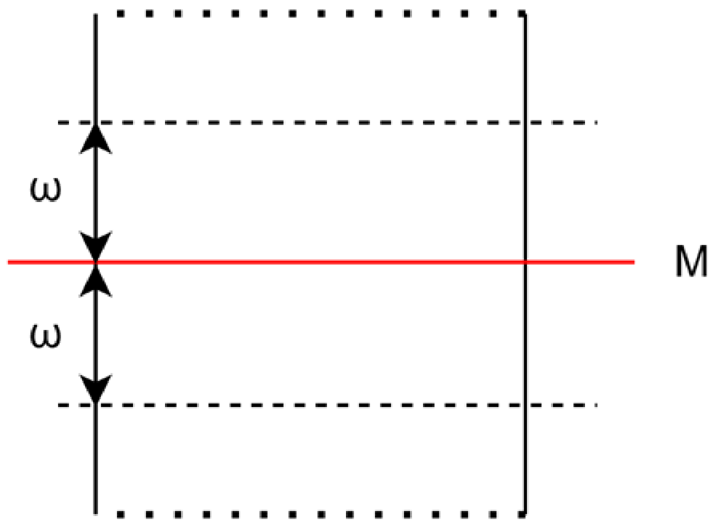

Fig. 4: Stroke monitoring - jitter window

- M: target position (first position magnet)
- ω: jitter window

The following distance counters are available:

Table 40: Distance counter - values

Distance value	Meaning
Actual distance	Value since the last sensor start (or reset)
Since startup	Value since the last boot-up
Since reset	Value since the last reset
Lifetime	Value since the sensor was delivered

All distance counter values are represented in µm.

Note

The *Actual distance* can be reset by the *Reset distance* system command, while the *Since reset* counter is reset by a *Maintenance reset*.
It is not possible to reset *Lifetime distance*.

Note

The *Lifetime* distance counter can be read out via *SSI additional data* (*Movement distance*).

Stroke counter

Description

The stroke counter counts the strokes performed for each activated stroke channel depending on the selected mode. The following counters are available for each channel:

Table 41: Stroke counter - values

Stroke counter	Meaning
Actual value	Value since the last sensor start
Since reset	Value since the last maintenance reset
Lifetime	Value since the sensor was delivered

> **Note**
>
> Only completed strokes are counted. Depending on the *CHx stroke mode* parameter the meaning of a *complete stroke* can vary, please refer to the *stroke mode* description.

Stroke deviation

Description

The stroke deviation feature constantly monitores the position deviation from the switching points assigned to a given channel. If the target position is within the *CHx sensing window*, the current deviation value is determined.

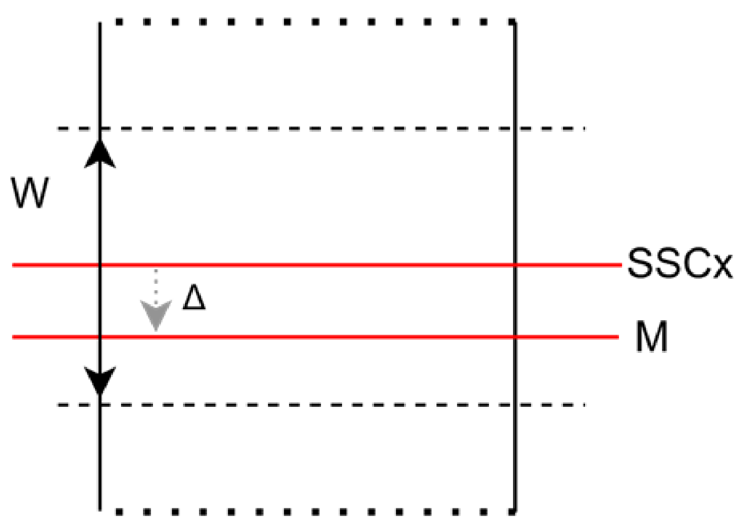

Fig. 5: Stroke monitoring - sensing window

- `SSCx`: switching point
- `M`: target position (first position magnet)
- `W`: sensing window

- ∆: deviation

Table 42: Stroke deviation - values

Deviation value	Meaning
Actual deviation	If position is in the sensing window, then the current deviation from the switching point. Otherwise the last minimum deviation.
Since startup	Relative deviation since the last boot-up
Since reset	Relative deviation since the last reset
Lifetime	Value since the sensor was delivered

For a given channel the *Actual deviation* value is in µm and it is a signed value. The other deviation values are statistical (relative) values expressed in percentage, refering to the channel's stroke length in µm.

Note

Because the statistical deviation values are referring to the channel's stroke length for longer stroke lengths these values will be effectively zero. These values mostly usefull for applications requiring short stroke lengths.

ISDU

Stroke monitoring configuration

Table 43: Stroke monitoring – configuration ISDU

Name	Index	Subindex	Access	Length	Data Type	Data Storage	Default
Stroke monitoring config.	0xA9 (169)	0	R/W	2	RECORD	Yes	
CH1 SSC start		1	R/W	1	ENUM (UINT8)	No	0x00 (0)
CH1 SSC end		2	R/W	1	ENUM (UINT8)	No	0x00 (0)
CH1 sensing window		3	R/W	4	UINT32	No	0x00 (0)
CH1 stroke mode		4	R/W	1	ENUM (UINT8)	No	0x00 (0)
CH1 enable		5	R/W	1	BOOL	No	0x00 (0)
CH2 SSC start		6	R/W	1	ENUM (UINT8)	No	0x00 (0)
CH2 SSC end		7	R/W	1	ENUM (UINT8)	No	0x00 (0)

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Table 43 – continued from previous page

Name	Index	Subindex	Access	Length	Data Type	Data Storage	Default
CH2 sensing window		8	R/W	4	UINT32	No	0x00 (0)
CH2 stroke mode		9	R/W	1	ENUM (UINT8)	No	0x00 (0)
CH2 enable		10	R/W	1	BOOL	No	0x00 (0)
CH3 SSC start		11	R/W	1	ENUM (UINT8)	No	0x00 (0)
CH3 SSC end		12	R/W	1	ENUM (UINT8)	No	0x00 (0)
CH3 sensing window		13	R/W	4	UINT32	No	0x00 (0)
CH3 stroke mode		14	R/W	1	ENUM (UINT8)	No	0x00 (0)
CH3 enable		15	R/W	1	BOOL	No	0x00 (0)
Global enable		16	R/W	1	BOOL	No	0x00 (0)
Data storage cycle		17	R/W	2	UINT16	No	0x00 (0)
Jitter window		18	R/W	2	UINT16	No	0x00 (0)

CHx start

Switching signal channel index which marks the stroke channel’s start position. Multiple stroke channels can use the same switching signal channel.

Table 44: Stroke monitoring - SSC indices

SSC	Value
SSC1.1	0x00 (0)
SSC1.2	0x01 (1)
SSC1.3	0x02 (2)
SSC1.4	0x03 (3)

CHx end

Switching signal channel index which marks the stroke channel’s end position. Multiple stroke channels can use the same switching signal channel.

Table 45: Stroke monitoring - SSC indices

SSC	Value
SSC1.1	0x00 (0)
SSC1.2	0x01 (1)
SSC1.3	0x02 (2)
SSC1.4	0x03 (3)

CHx sensing window

The sensing window marks a symmetrical interval around a channel's switching point, where the stroke deviation is determined. The window size must be between 100 µm and 100.000 µm (10 cm), including the limits.

CHx stroke mode

Defines the stroke mode for the given channel. The available stroke modes are the following:

Table 46: Channel stroke mode – options

Value	Meaning
0x00 (0)	Single way
0x01 (1)	Single way - reverse
0x02 (2)	Double way
0x03 (3)	Double way - reverse

CHx enable

Enables or disables a specific stroke channel.

Global enable

Enables or disables the stroke monitoring feature in general.

Data storage cycle

The counter values are periodically stored into non-volatile memory of the sensor. This cycle can be configured here. The cycle time must be between 60 and 3600 seconds, including the limits. The parameter is in seconds.

Jitter window

A jitter window is used to determine the smallest recorded movement. Shorter movements than the jitter window size are not recorded. The parameter is in µm and must be between 10 µm adnd 50.000 µm, including the limits.

> **Note**
>
> Setting the *Jitter window* to the minimum can have the risk that increased noise in the position can be recorded as movement.

Distance counter

Table 47: Stroke monitoring – distance counter ISDU

Name	Index	Subindex	Access	Length	Data Type	Data Storage	Default
Distance counter	0xAA (170)	0	R	32	RECORD	n/a	
Actual distance		1	R	8	UINT64	n/a	-
Since startup		2	R	8	UINT64	n/a	-
Since reset		3	R	8	UINT64	n/a	-
Lifetime		4	R	8	UINT64	n/a	-

Actual distance

Distance travelled by the first position magnet since the sensor is powered or since the last *Distance reset* command. The value is in µm.

Since startup

Distance travelled by the first position magnet since the sensor is powered. The value is in µm.

Since reset

Distance travelled by the first position magnet since the last *Maintenance reset* is executed. The value is in µm.

Lifetime

Total distance travelled by the first position magnet since delivery. This value cannot be reset. The value is in µm.

Stroke counter

Table 48: Stroke monitoring – stroke counter ISDU

Name	Index	Subindex	Access	Length	Data Type	Data Storage	Default
Stroke counter	0xAB (171)	0	R	72	RECORD	n/a	
CH1 actual		1	R	8	UINT64	n/a	-
CH1 since reset		2	R	8	UINT64	n/a	-
CH1 lifetime		3	R	8	UINT64	n/a	-
CH2 actual		4	R	8	UINT64	n/a	-
CH2 since reset		5	R	8	UINT64	n/a	-
CH2 lifetime		6	R	8	UINT64	n/a	-
CH3 actual		7	R	8	UINT64	n/a	-
CH3 since reset		8	R	8	UINT64	n/a	-
CH3 lifetime		9	R	8	UINT64	n/a	-

CHx actual

Shows the current stroke count since the sensor startup.

CHx since reset

Shows the stroke count since the last *Maintenance reset*.

CHx lifetime

Shows the total number of strokes on a given channel since the sensor was shipped. This value cannot be reset.

Stroke deviation

Table 49: Stroke monitoring – stroke deviation ISDU

Name	Index	Subindex	Access	Length	Data Type	Data Storage	Default
Stroke counter	0xAB (171)	0	R	48	RECORD	n/a	
CH1 actual		1	R	4	INT32	n/a	-
CH1 startup relative		2	R	4	INT32	n/a	-
CH1 reset relative		3	R	4	INT32	n/a	-
CH1 lifetime relative		4	R	4	INT32	n/a	-
CH2 actual		5	R	4	INT32	n/a	-
CH2 startup relative		6	R	4	INT32	n/a	-
CH2 reset relative		7	R	4	INT32	n/a	-
CH2 lifetime relative		8	R	4	INT32	n/a	-
CH3 actual		9	R	4	INT32	n/a	-
CH3 startup relative		10	R	4	INT32	n/a	-
CH3 reset relative		11	R	4	INT32	n/a	-
CH3 lifetime relative		12	R	4	INT32	n/a	-

CHx actual

If the target is currently in the sensing window around the switching point, then it shows the current deviation in µm. If the target is outside of the sensing window, then it shows the minimum recorded deviation in µm.

CHx startup relative

Shows the stroke deviation of a given channel since the sensor startup in percentage of the channel's stroke length.

CHx reset relative

Shows the stroke deviation of a given channel since the last *Maintenance reset* in percentage of the channel's stroke length.

CHx lifetime relative

Shows the stroke deviation of a given channel since it was shipped in percentage of the channel's stroke length. This value cannot be reset.

6.4.6 Switching signal channel

The sensor implements SSP 2.8 profile according to the IO-Link specification. In this profile there are four switching channels are available:

- SSC1.1
- SSC1.2
- SSC1.3
- SSC1.4

Note

The implemented profile requires a Process Data In byte, so that these switching signals are available in the process data. For details see *Process Data In structure*.
However it is **not recommended to use those signals for any purpose** as this sensor is primarily an SSI sensor. These signals are mainly used in the *Stroke monitoring* function.

Description

Evaluation logic

The sensor performs measurement value acquisition as a continous signal that is avaluated for switching signal generation. The measurement value is only evaluated if it is within this valid measurement range. If the measurement value is outside of this range, the switching channel output goes into **inactive** state.

Note

The switching channel output signal (*high* or *low*) depends on the channel configuration.

In case of BTL the measurement signal is always the **position of the first position magnet**.

Switching points are defined by means of setpoints that can be determined using teach process. Alternatively, the setpoints can also be set directly via ISDUs, but under observation of the same requirements and rules as define for the teach process.

The setpoint setting can also be used to deactivate the switching point evaluation.

Table 50: Setpoints - substitution value

Value	Meaning
0x7FFFFFFC (2,147,483,644)	Setpoint not taught, disabled

Overview of switching signal channels

Switchpoint logic

With switching logic High Active, the switching output switches to high if the current measurement value is greater than the set (taught) setpoint.

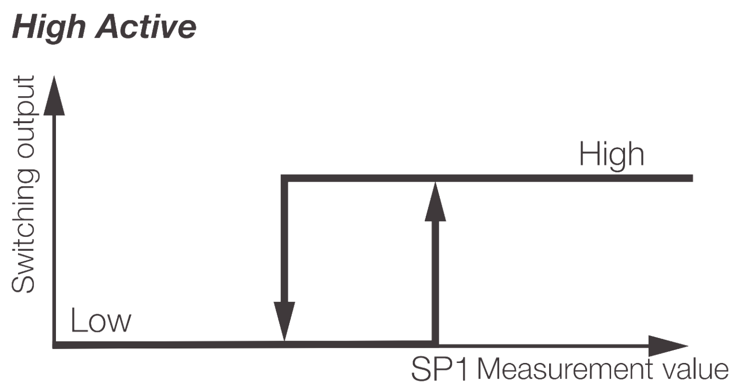

Fig. 6: SSC logic - high active

With Low Active this logic is inverted.

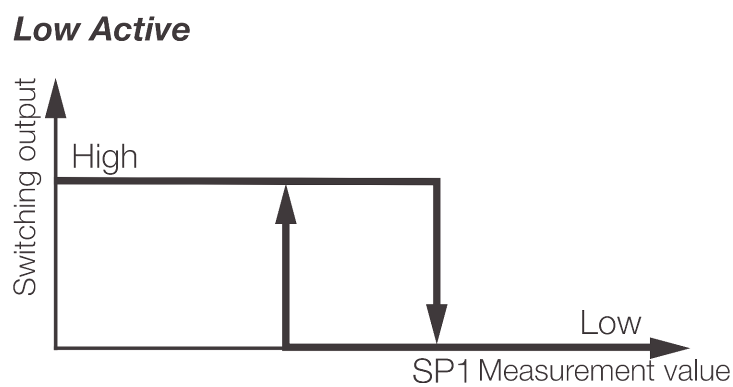

Fig. 7: SSC logic - low active

Switchpoint mode

Single point mode

In single point mode, only one switching point (setpoint) is defined.

Switching behavior:

- Measurement value ≥ switching point: output active
- Measurement value ≤ switching point minus a defined hysteresis: output inactive

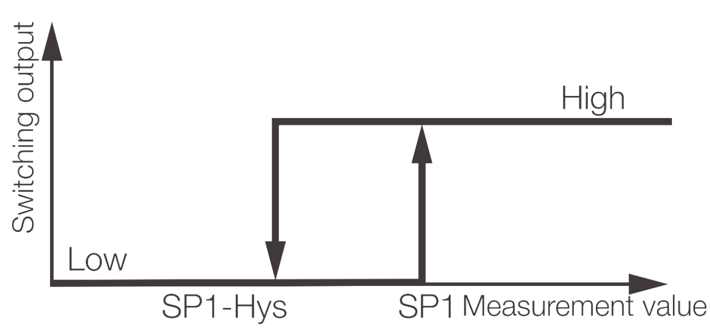

Fig. 8: SSC mode - single point mode

Two point mode

In two point mode, two switching points (setpoint) are defined.

Switching behavior:

- Measurement value ≥ switching point 1: output active
- Measurement value ≤ switching point 2 output inactive

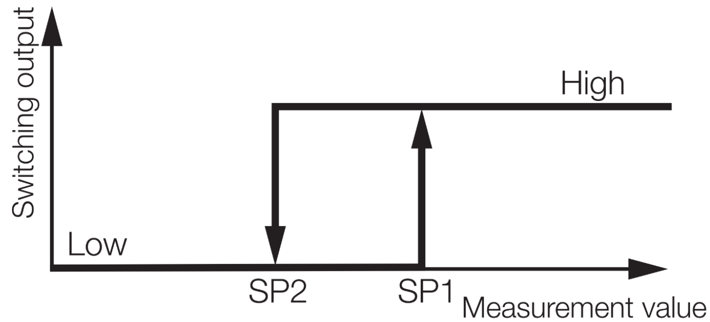

Fig. 9: SSC mode - two point mode

Window mode

In window mode, two switching points (setpoints) are defined.

Switching behavior:

- If the output is inactive and the measurement value is greater than or equal to switching point 2 + 50% of the set hysteresis or the measurement value is less than or equal to switching point 1 – 50% of the set hysteresis, the output switches to active.
- If the output is active and the measurement value is less than or equal to switching point 2 – 50% of the set hysteresis or the measurement value is greater than or equal to switching point 1 + 50% of the set hysteresis, the output switches to inactive.

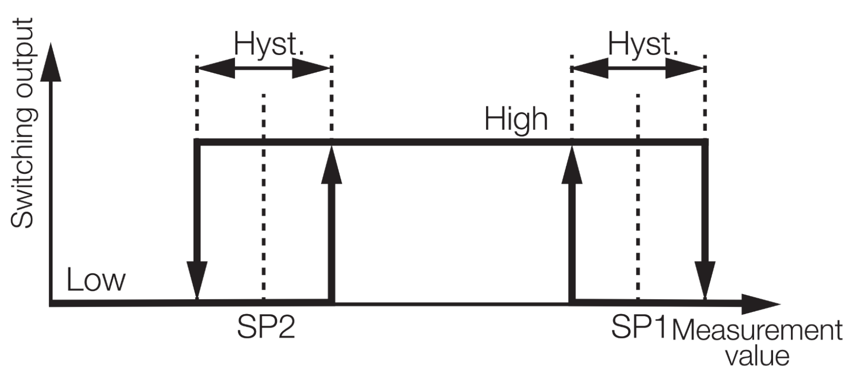

Fig. 10: SSC mode - window mode

Teaching

Single value teach

With Single-Value Teach, the switching point (setpoint) is defined via a teach point. Moreover, this is a static process, i.e., the measurement value is constant during the teach phase. The teach process is performed independently for each switching point in two point mode.

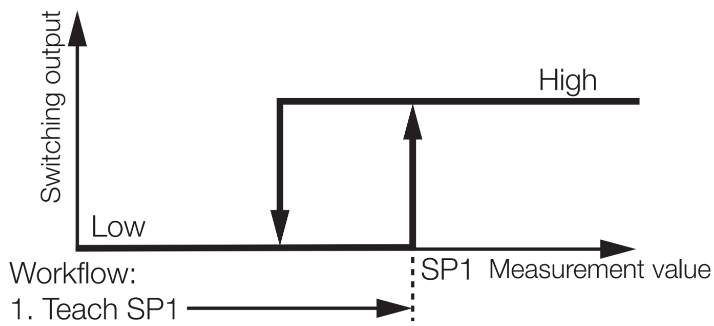

Fig. 11: Single value teach in single point mode

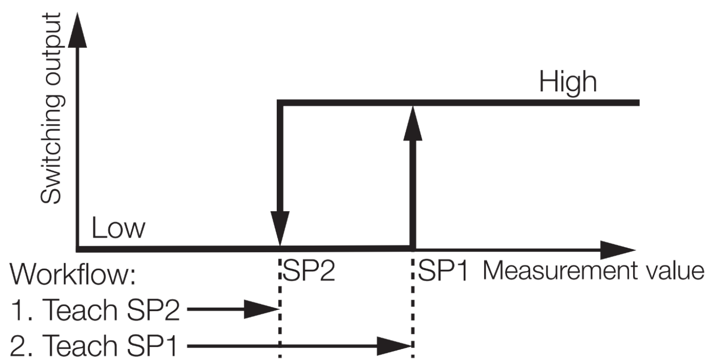

Fig. 12: Single value teach in two point mode

ISDU

Table 51: Switching signal channel – configuration ISDU

Name	Index	Subindex	Access	Length	Data Type	Data Storage	Default
Teach-in select	0x003A (58)	0	R/W	1	UINT8	No	0x00 (0)
Teach-in result	0x003B (59)	0	R	1	UINT8	n/a	–
SSC 1.1 parameter	0x003C (60)	0	R/W	8	RECORD	Yes	–

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Table 51 – continued from previous page

Name	Index	Subindex	Access	Length	Data Type	Data Storage	Default
Setpoint 1		1	R/W	4	INT32	No	0x7FFFFFFC (2147483644)
Setpoint 2		2	R/W	4	INT32	No	0x7FFFFFFC (2147483644)
SSC 1.1 configuration	0x003D (61)	0	R/W	4	RECORD	Yes	–
Switchpoint logic		1	R/W	1	UINT8	No	0x00 (0)
Switchpoint mode		2	R/W	1	UINT8	No	0x00 (0)
Hysteresis		3	R/W	2	INT16	No	0x01F4 (500)
SSC 1.2 parameter	0x003E (62)	0	R/W	8	RECORD	Yes	–
Setpoint 1		1	R/W	4	INT32	No	0x7FFFFFFC (2147483644)
Setpoint 2		2	R/W	4	INT32	No	0x7FFFFFFC (2147483644)
SSC 1.2 configuration	0x003F (63)	0	R/W	4	RECORD	Yes	–
Switchpoint logic		1	R/W	1	UINT8	No	0x00 (0)
Switchpoint mode		2	R/W	1	UINT8	No	0x00 (0)
Hysteresis		3	R/W	2	INT16	No	0x01F4 (500)
SSC 1.3 parameter	0x4000 (16384)	0	R/W	8	RECORD	Yes	–
Setpoint 1		1	R/W	4	INT32	No	0x7FFFFFFC (2147483644)
Setpoint 2		2	R/W	4	INT32	No	0x7FFFFFFC (2147483644)
SSC 1.3 configuration	0x4001 (16385)	0	R/W	4	RECORD	Yes	–
Switchpoint logic		1	R/W	1	UINT8	No	0x00 (0)
Switchpoint mode		2	R/W	1	UINT8	No	0x00 (0)

continues on next page

Table 51 – continued from previous page

Name	Index	Subindex	Access	Length	Data Type	Data Storage	Default
Hysteresis		3	R/W	2	INT16	No	0x01F4 (500)
SSC 1.4 parameter	0x4002 (16386)	0	R/W	8	RECORD	Yes	–
Setpoint 1		1	R/W	4	INT32	No	0x7FFFFFFC (2147483644)
Setpoint 2		2	R/W	4	INT32	No	0x7FFFFFFC (2147483644)
SSC 1.4 configuration	0x4003 (16387)	0	R/W	4	RECORD	Yes	–
Switchpoint logic		1	R/W	1	UINT8	No	0x00 (0)
Switchpoint mode		2	R/W	1	UINT8	No	0x00 (0)
Hysteresis		3	R/W	2	INT16	No	0x01F4 (500)

Teach-in select

With the help of this parameter, the switching channel that is to be taught is selected.

Table 52: Teach-in select - available values

SSC	Value
Default (SSC 1.1)	0x00 (0)
SSC 1.1	0x01 (1)
SSC 1.2	0x02 (2)
SSC 1.3	0x03 (3)
SSC 1.4	0x04 (4)

Teach-in result

Outputs the current status of the currently active or of the last teach-in process.

Table 53: Teach-in result - state

Value	Meaning
0x00 (0)	*IDLE* - No currently active teach process
0x01 (1)	*SP1 SUCCESS* - Last process for SP1 was successful
0x02 (2)	*SP1 SUCCESS* - Last process for SP1 was successful
0x03 (3)	*SP12 SUCCESS* - Last process for SP1 was successful
0x04 (4)	*WAIT FOR COMMAND* - Wait for next command
0x05 (5)	*BUSY* - Process active
0x06 (6)	Reserved
0x07 (7)	*ERROR* - Last process was not successful

SSC 1.x configuration

Switchpoint logic

This parameter controls the logical output value of a switching signal channel.

Table 54: Switchpoint logic - options

Logic	Value
High active	0x00 (0)
Low active	0x01 (1)

Switchpoint mode

Table 55: Switchpoint mode - options

Logic	Value
Deactivated	0x00 (0)
Single point	0x01 (1)
Window	0x02 (2)
Two point	0x03 (3)

Hysteresis

Switchpoint hysteresis in µm. The actual usage of this value is depends on the *Switchpoint mode*.

SSC 1.x parameter

This ISDU contains two setpoints which defines the switching characteristic according to the channel's mode. *Setpoint 2* is not relevant if the channel mode is *Disabled* or *Single point*.

6.4.7 Storage Usage Monitoring

Description

All variable data is stored in a permanent memory on the device. The data is stored in various segments for different access and usage purposes.

Because the number of write cycles in the permanent memory is limited, the number in each segment is monitored by a counter.

All data segments are protected with a CRC32 checksum.

Events

Table 56: Storage usage monitoring – Events

Event Code	Event Type	Event – Description – Remedy	Device Status
0x8D22 (36130)	Warning	Warning limit for write cycles reached – maintenance monitoring no longer guaranteed – for information purposes only.	0 – Device is operating properly.
0x8D23 (36131)	Error	Write cycle limit reached – saving no longer ensured – replacement recommended.	1 – Maintenance-Required

6.5 System functions

6.5.1 Device Status and Detailed Device Status

Description

The *Device Status* feature provides information about the current device status.

Each *Device Status* is combined with a corresponding diagnostic message (*Events* see Events).

It also gives the user the possibility to actively read out currently pending events of the device.

Process Data

Table 57: Device status and detailed device status – Process Data

Object ID	Name	Description	Direction
0x002F (47)	System Error	This bit is set (TRUE) if there is an error in the device. This information is linked to the device status (4-Failure), which can be triggered by different device functions or diagnostic messages. The bit is reset as soon as the error status is no longer displayed (FALSE).	Input

Also see Process Data Profiles.

ISDU

Table 58: Device status and detailed device status – ISDU

Name	Index	Subindex	Access	Length	Data Type	Data Storage	Default
Device Status	0x0024 (36)	0	R	1 byte	UINT8	n/a	–
Detailed Device Status	0x0025 (37)	0	R	30 bytes	UINT8[ ]	n/a	0x00 0x00 0x00

Device Status

The parameters are accessed via subindex 0. The output values are to be interpreted as follows:

Table 59: Device Status

Value	Status	Description
0	Device is operating properly	Device working correctly.
1	Maintenance Required	Although the process data is valid, internal diagnoses show that the device will soon lose its ability to function properly. Maintenance is necessary.
2	Out-of-Specification	Although the process data is valid, internal diagnoses show that the device is operating outside of its specified measurement range or environmental conditions. The installation must be checked for unintentional malfunctions.
3	Functional check	Process data is temporarily invalid due to intentional changes to the device, e.g., parameterization or teaching-in.
4	Failure	Process data is invalid due to a malfunction of the device or its peripheral devices. The device is not able to perform its intended function. Re-configuration (resetting to factory settings) can help. Otherwise, Balluff service must be contacted or the device replaced.

Detailed Device Status

Detailed Device Status indicates the currently pending diagnosis messages (error, warning). For an event overview, see Events.

It can be used to perform a more detailed error analysis or to find the corresponding error source in the event of an unexpected device status.

The length of the list varies dynamically depending on the number of entries. Each entry in the list consists of the *EventQualifier* and the *EventCode* and has a data length of 3 bytes. The total list can be queried via subindex 0, individual entires with the corresponding subindex. Each of the entries in the lists can only be called while the event is pending.

Table 60: Detailed Device Status

Subindex	Object name	Data Type
1	Error_Warning_1	3 bytes
2	Error_Warning_2	3 bytes
3	Error_Warning_3	3 bytes
4	Error_Warning_4	3 bytes
…		
n	Error_Warning_n	3 bytes

Remarks:

- All bytes 0x00 (0): no error/warning
- Byte 1: EventQualifier
- Byte 2, 3: EventCode

6.5.2 Diagnosis Suppression

Description

Diagnosis suppression is used to suppress diagnosis messages from the device. There are two possibilities here:

- Diagnosis suppression level that permits a general suppression of messages of a certain level (message, warning, error).
- Event-code suppression of up to 5 events as a list or via a teach-in.

ISDU

Table 61: Diagnosis suppression – ISDU

Name	Index	Subindex	Access	Length	Data Type	Data Storage	Default
Diagnosis Level Configuration	0x0070 (112)	0	R/W	1 byte	UINT8(ENUM)	Yes	0
Event Code Suppression	0x0071 (113)	0	R/W	10 bytes		Yes	
Event Code Suppression		1…5	R/W	2 bytes	UINT16	No	0
Event Code Suppression Teach-in	0x0072 (114)	0	W	2 bytes	UINT16	n/a	–
Event Code Suppression Delete	0x0073 (115)	0	W	2 bytes	UINT16	n/a	–

Diagnosis Level Configuration Parameter

This parameter offers the possibility to select an output level for events.

This index is part of the data management and is stored in non-volatile memory.

Table 62: Diagnosis suppression – Diagnosis level configuration

Value	Diagnosis Level	Descriptions
0	All events	All diagnosis messages are reported (default setting).
1	Warnings and errors	All warnings and errors are reported – messages are suppressed.
2	Error	Only events of type error are reported.
3	No events	All diagnosis messages from the device are suppressed.

Events

For an event overview, see Events.

Event Code Suppression Parameter

This parameter indicates the currently suppressed event messages. The user can access the individual messages via subindex 0 or a specific subindex. This index is part of the data storage and is stored in non-volatile memory.

Value 0x0000 (0) is the default value and is interpreted as FREE.

Each event message is structured as follows:

Table 63: Diagnosis suppression – Event Message Suppression

Byte1 (MSB)	Byte0 (LSB)
Event Code High Byte	Event Code Low Byte

Event Code Suppression Teach-in/Delete

To add an event to the list of suppressed events, the event code is inserted in subindex 0 in *Event Code Suppression Teach-In*. It is added to the next free place in the table.

If the event code is deleted with *Event Code Suppression Delete*, it is removed from the list.

6.5.3 Reset Commands

Description

The device supports various reset commands for resetting the set parameters to default values. Each of these commands is accessed by means of *System Commands*.

This function is defined in the IO-Link specification and is implemented according to Version 1.1.4.

ISDU

Table 64: Reset Commands – ISDU

Name	Index	Subindex	Access	Length	Data Type	Data Storage	Default
System Commands	0x0002 (2)	0	W	1 byte	UINT8	n/a	–

System Commands

Table 65: Reset Commands – System Commands

Command Value	Device Action
0x80 (128)	*Device Reset* – Device Reset means a warm start of the device. During this process, the microcontrollers are restarted and all initializations performed again without any change made to the parameter values.
0x81 (129)	*Application Reset* – This reset is performed using IO-Link specification V1.1.4. • Resets all parameters and device settings to default values (with the exception of the identification and tagging parameters) • No reset of the configuration of the device variant • Set DS-Upload request (accept the data in the memory) • No communication stop or restart
0x82 (130)	*Restore Factory Settings* – This reset is performed using IO-Link specification V1.1.4. • Reset all parameters and device settings to default settings (including identification and tagging parameters) • Reset the configuration of the device variants to the default variant • No DS-upload-request • No communication stop or restart
0xA5 (165)	*Maintenance Reset* – Resets all resettable maintenance and service life parameters for the user so that the next maintenance cycle can begin.

6.5.4 LED Meaning and Configuration

Description

Only the signal with the highest priority is displayed. The signals are listed in descending priority.

Balluff Standard

Table 66: LED meaning and configuration – Balluff Standard

Name	Signal	Meaning
Device Discovery	Blue flashing, 3 Hz	The Device Discovery can be activated via a system command to find the device again.
Short Circuit Pin 2 / Pin 4	Red flashing, 3 Hz	Short circuit at pin 2 or pin 4
Measurement Error	Red flashing, 1 Hz	This signal occurs if a measurement error occurs. The measurement value is unknown due to an error or outside of the measuring range.
Failure	Static red	General error
Teach-in	Static red	The device is currently in teach-in mode.
Maintenance Required	Blue, static	Maintenance must be performed.
Overload	Orange, flashing, 3 Hz	Overload on pin 2 / pin 4 has been detected.
Out of Specification	Yellow flashing, 3 Hz	The device is operated outside of specifications. A reliable measurement signal can no longer be ensured.
Communication	Green alternating with LED off at ratio of 10:1, 1 s period	IO-Link communication is active. The device is ready.
Ready	Static green	The device is ready.

Namur Standard

Table 67: LED meaning and configuration – Namur Standard

Name	Signal	Meaning
Device Discovery	Blue flashing, 3 Hz	The Device Discovery can be activated via a system command to find the device again.
Short Circuit Pin 2 / Pin 4	Red flashing, 3 Hz	Short circuit at pin 2 or pin 4
Measurement Error	Red flashing, 1 Hz	This signal occurs if a measurement error occurs. The measurement value is unknown due to an error or outside of the measuring range.
Failure	Static red	General error
Teach-in	Static red	The device is currently in teach-in mode.
Maintenance Required	Blue, static	Maintenance must be performed.
Overload	Orange, flashing, 3 Hz	Overload on pin 2 / pin 4 has been detected.
Out of Specification	Yellow flashing, 3 Hz	The device is operated outside of specifications. A reliable measurement signal can no longer be ensured.
Communication	Green alternating with LED off at ratio of 10:1, 1 s period	IO-Link communication is active. The device is ready.
Ready Diagnosis On	Static green	The device is ready. Diagnosis functions are on.
Ready Diagnosis Off	Static white	The device is ready. Diagnosis functions are switched off.

ISDU

Table 68: LED meaning and configuration – ISDU

Name	Index	Subindex	Access	Length	Data Type	Data Storage	Default
LED Standard Selection	0x00FD (253)	0	R/W	1 byte	UINT8(ENUM)	Yes	0

LED Standard Selection

It is possible to select between two different signaling standards with the help of a parameter. The parameter defines which signaling standard is to be used:

Table 69: LED meaning and configuration – LED Standard Selection

Value	Standard
0	BALLUFF
1	NAMUR

The parameter is reset by the commands *Application Reset* and *Factory Reset* (also see Reset Commands).

6.5.5 Profile Characteristic

Description

Profile Characteristic is a readable parameter that provides information about which IO-Link profiles are supported. It is used mainly to allow profile function modules of the control unit to detect which profile or functions on the device are available.

This parameter is defined in the IO-Link specification.

ISDU

Table 70: Profile Characteristic – ISDU

Name	Index	Subindex	Access	Length	Data Type	Data Storage	Default
Profile Characteristic	0x000D (13)	0	R	6 bytes (Smart Sensor Profile Ed. 2), 8 bytes (Smart Sensor Profile Legacy), 6 bytes (Smart Sensor Profile Legacy, without PDIn)	UINT16	n/a	–

The parameter can be read via subindex 0 and consists of multiple profile indices and function classes (each 16-bit values).

If a profile ID is specified, this means that all included function classes are supported. If only sub-functions are supported, these are output explicitly as an individual function class.

This device supports the following profiles:

Table 71: Profile Characteristic – supported profiles

Profile ID	Name / Description
0x0001	Smart Sensor Profile Legacy
0x000B	Digital Measuring Sensor
0x0030	BLOB
0x0031	Firmware Update
0x4000	Common Profile

The following function classes are supported:

Table 72: Profile Characteristic – supported function classes

Function Class ID	Name / Description
0x8000	Device Identification
0x8002	Process Data Mapping
0x8003	Device Diagnosis
0x8004	Teach Commands
0x800B	Measurement High Resolution
0x8100	Extended Identification

All individual functions are described in this guide.

For more exact descriptions of the profiles, refer to the corresponding profile specifications (see www.io-link.com).

6.5.6 Parameter Manager

Description

The parameter manager is responsible for the saving of parameters in the permanent memory of the device. On startup, all stored parameters are read from permanent memory; if parameters are changed, the data is stored within the permanent memory by the parameter manager.

All data is protected with a CRC32 checksum. In the event of damaged memory, the parameter manager outputs the *Parameters not consistent* event.

Events

Table 73: Parameter manager – Events

Event Code	Event Type	Event – Description – Remedy	Device Status
0x8D24 (36132)	Warning	Parameter write error – for information purposes only.	0 – Device is operating properly.
0x8D25 (36133)	Error	Parameters not consistent – basic settings are used, service required. Parameterization processes and resets can no longer be performed.	4 – Failure

7 Installation

7.1 Preparing for installation

Installation information

Two mounting options are provided:

- Mounting in a hole with internal thread (mounting hole).
- Mounting in a through-hole (without internal thread) using a mounting nut (see *Accessories*).

Installation guidelines

Installation in non-magnetizable material

We recommend using non-magnetizable material to mount the BTL and position magnet.

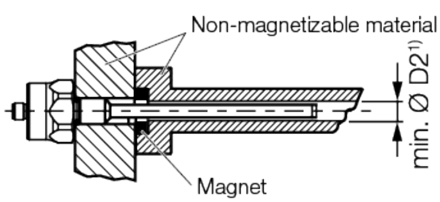
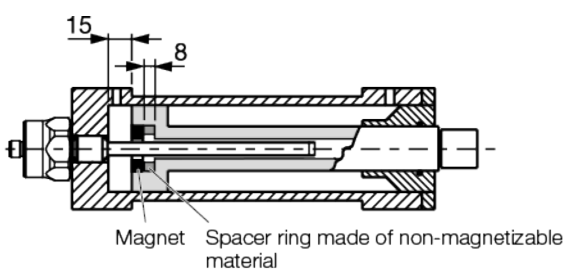


Fig. 1: Installation in non-magnetizable material

1) min. Ø D2 = Minimum bore diameter (see *Bore diameter*)

Installation in magnetizable material

If using magnetizable material, the BTL must be protected against magnetic interference through suitable measures (e.g. spacer ring made of non-magnetizable material, a suitable distance from strong external magnetic fields).



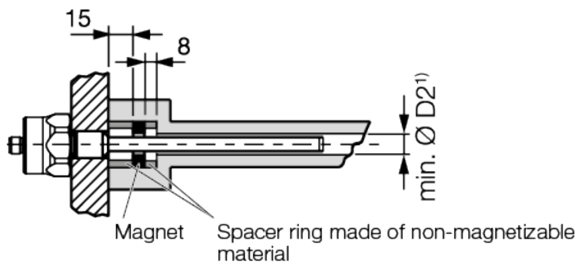


Fig. 2: Installation in magnetizable material

[1] min. Ø D2 = Minimum bore diameter (see *Bore diameter*)

Installation instructions

Hydraulic cylinder

If installed in a hydraulic cylinder, the position magnet should not make contact with the rod. Minimum bore diameter in the support piston:

Table 1: Bore diameter

Rod diameter	Bore diameter D2
10,2 mm	At least 13 mm

Mounting hole

Depending on the version, the BTL comes with an M18×1.5 thread (according to ISO) or a 3/4"-16UNF thread (according to SAE) to secure it. Accordingly, the mounting must be made before assembly.

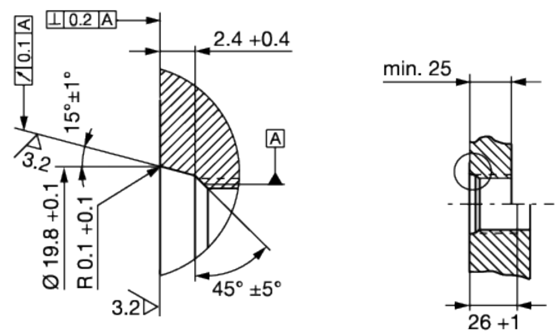


Fig. 3: Mounting hole M18×1.5 according to ISO 6149 O-Ring 15.4×2.1

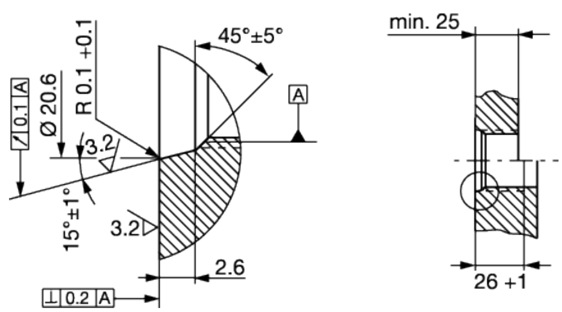


Fig. 4: Mounting hole 3/4"-16UNF according to SAE J475 O-Ring 15.3×2.4

Horizontal mounting
For horizontal mounting with measuring lengths > 500 mm, support the rod and, if necessary, screw it on at the end (with threaded rod end).

Position magnet
Various position magnets are available for the BTL (see *Accessories*).

Installation recommendation for hydraulic cylinders
If installing horizontally in a hydraulic cylinder (measuring lengths > 500 mm), we recommend affixing a slide element to protect the rod end from wear.

> **Note**
>
> Dimensioning of the detailed solutions is the responsibility of the cylinder manufacturer.

The slide element material must be suitable for the appropriate load case, medium used, and application temperatures. E.g. Torlon, Teflon or bronze are all possible materials.

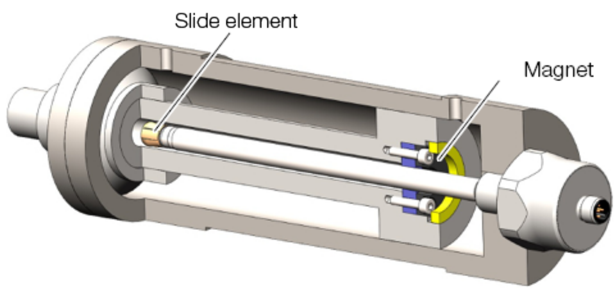


Fig. 5: Example 1, BTL is installed with slide element

The slide element can be screwed on or bonded.

- Secure the screws so they cannot be loosened or lost.
- Select a suitable adhesive.

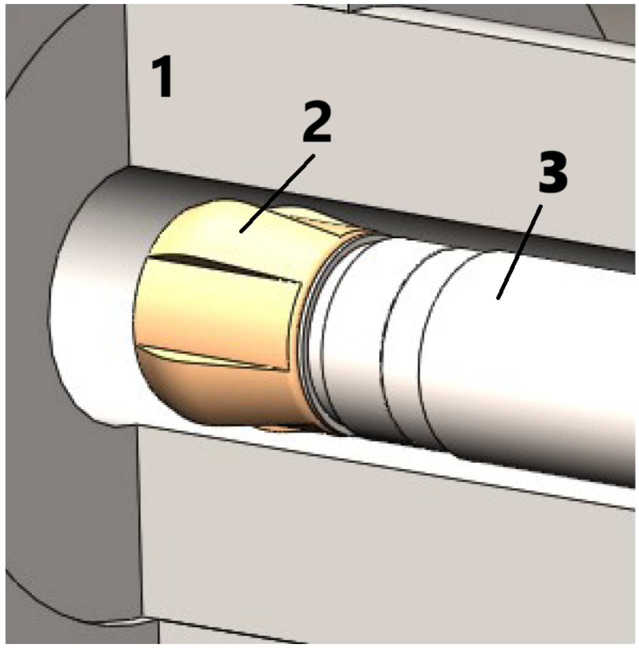


Fig. 6: Detailed side view of slide element

Table 2: Side view slide element descriptions

Position	Description
1	Slide element
2	Piston rod
3	Rod

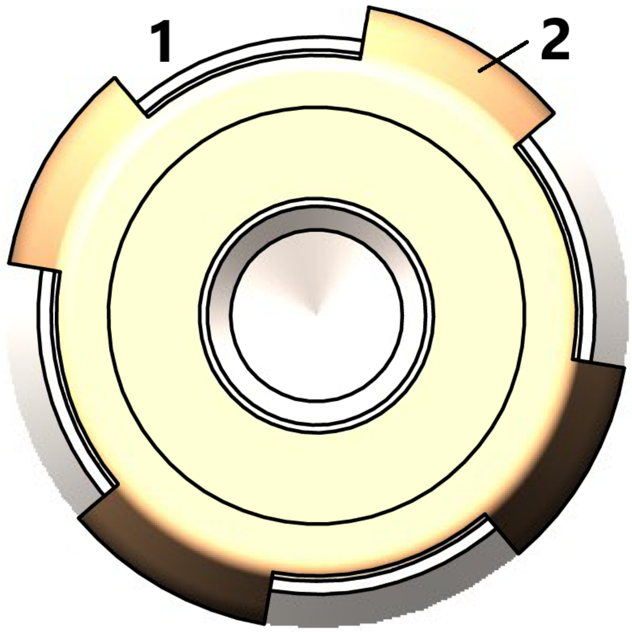


Fig. 7: Detailed top view of slide element

Table 3: Top view slide element descriptions

Position	Description
1	Flow gap
2	Slide surface

There must be a gap between the slide element and piston bore that is sufficiently large for the hydraulic oil to flow through.

Options for fixing the position magnet:

- Screws
- Threaded ring
- Press fitting
- Notches (center punching)

ℹ Note

If installed in a hydraulic cylinder, the position should not make contact with the rod.

The hole in the spacer ring must ensure optimum guidance of the rod by the slide element.

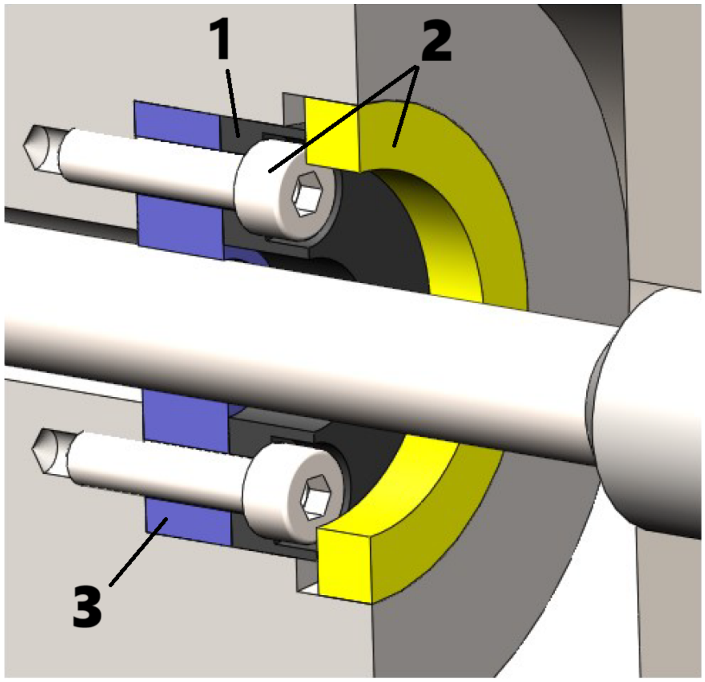


Fig. 8: Fixing of position magnet

Table 4: Fixing of position magnet element descriptions

Position	Description
1	Position magnet
2	Fixing of position magnet
3	Spacer ring

7.2 Installation

> **ℹ Note**
>
> For dimensions, see *structure diagram*.

> **ℹ Note**
>
> Suitable nuts for the mounting thread are available as accessories (see *Accessories*).

> ***NOTICE***
>
> **Interference in function**
> Improper installation can compromise the function of the BTL and result in increased wear.
> - Ensure that the contact surface of the BTL is in full contact with the mounting surface.
> - Seal the hole perfectly (O-ring/flat seal).

7.2.1 Mounting in a hole with internal thread (mounting hole)

1. Make a mounting hole with thread (possibly with countersink for the O-ring) acc. to *Mounting hole figure 1* or *Mounting hole figure 2*.
2. Screw the BTL with mounting thread into the mounting hole (max. torque 75 Nm).

7.2.2 Mounting in a through-hole

i Note

Mounting in a through-hole is only permitted under ambient atmospheric pressure.

1. Guide the BTL through the hole.
2. Screw the mounting nut (max. torque 75 Nm, see *Accessories*) onto the mounting thread on the rod side.

7.2.3 Further steps

- Install the position magnet (accessory).

When using multiple position magnets a minimum separation of 65 mm must be maintained between them.

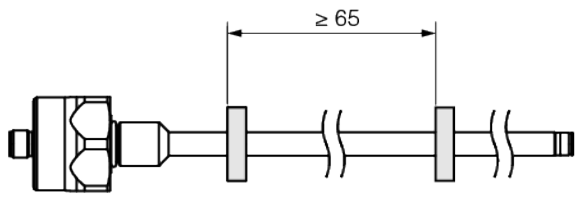


Fig. 9: Minimum spacing when using multiple position magnets

- From measuring length of 500 mm: Support the rod and if necessary screw on at the end.

7.3 Electrical Connection

The electrical connection is made via a plug connection (see *Pin assignment S32*).

i Note

See the information about *Shielding and cable routing*.

7.3.1 S32 connector

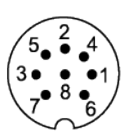


Fig. 10: Pin assignment of S32 (view from above on BTL)

Table 5: Pin assignment S32

Pin	Signal
1	CLK+
2	DATA+
3	CLK–
4	C/Q[1] / CFG[2] / La[4]
5	DATA–
6	GND[3]
7	Vin (10…30 V DC)
8	Lb[4]

7.4 Shielding and cable routing

> **i Note**
>
> **Defined ground!**
> The BTL and the control cabinet must be at the same ground potential.

7.4.1 Shielding

Observe the following instructions to ensure electromagnetic compatibility (EMC):

- Connect BTL and controller using a shielded cable. Shielding: Braided copper shield with minimum 85% coverage.
- Shield is internally connected to connector housing.

7.4.2 Magnetic fields

The position measuring system is a magnetostrictive system. Ensure that there is sufficient distance between the BTL and the transducer/holding cylinder and strong, external magnetic fields.

7.4.3 Cable routing

All cables between BTL, control and power supply must be routed tension-free. To prevent electromagnetic interference, ensure sufficient distance from high-current cables and cables carrying high-frequency voltage signals (e.g. from frequency converters).

> **i Note**
>
> Only approved cables with a minimum cross-sectional area of AWG 24 may be used. All connected cables must have a temperature resistance of at least 85 °C. Use copper conductor only.

[1] Only for configuration via IO-Link
[2] Proprietary interface, only for configuration by the manufacturer
[4] Digital inputs for SSI data multiplexer function. Connect to GND on the controller side if not used, but not to the shield.
[3] Reference potential for supply voltage and EMC-GND

7.4.4 Cable length

For SSI operation the maximum cable length is 500 m[5]. For IO-Link operation the maximum cable length is 20 m.

> **Note**
>
> For notes on cable length, see *Maximum SSI clock frequency depending on the cable length*.

[5] Prerequisite: Construction, shielding and routing preclude the effect of any external noise fields. Required cable cross-section ≥ 0.6 mm^2 and ≤ AWG19.

8 Comissioning

8.1 Balluff Engineering Tool (BET)

NOTICE

Interference in function
Configuration with the BET while the system is running may result in malfunctions.

- ▸ Stop the system before performing the configuration.

With the PC software BET the BTL can be quickly and easily configured on the PC.

i Note

The PC software can be found online at www.balluff.com on the product page.

8.2 Connect units

The units must be connected for configuration with the BET, see *connection with connector*.

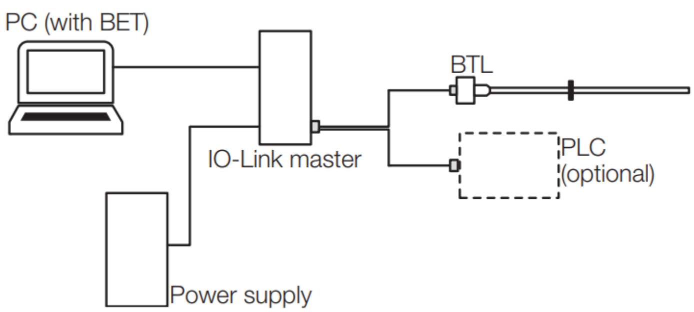


Fig. 1: Connection of units with BTL

To connect the units with a connector:

1. Connect BTL to the master via the adapter cable (accessory).
2. Optional: Also connect outputs to the control (PLC) via the adapter cable.
3. Connect PC (with BET) to the master.

8.3 Configuration options

⚠ DANGER

Uncontrolled system movement
When starting up, if the position measuring system is part of a closed loop system whose parameters have not yet been set, the system may perform uncontrolled movements. This could result in personal injury and equipment damage.

- ▶ The system must be taken out of operation before configuration.
- ▶ The position sensors may only be connected to the master box for configuration.
- ▶ The master box must be removed after configuration.

8.3.1 Prerequisites

- BTL connected to IO-Link master and PC.
- Software correctly installed.
- BTL connected to the power supply.
- Position magnet on BTL.

8.3.2 Position magnet and outputs

Possible factory default of number of position magnets:

- One position magnet
- Flexible Magnet Mode (FMM)

The number of position magnets can be set to fixed or flexible.

- **Fixed setting, one position magnet:** With the setting of one position magnet, a second position magnet is ignored.
- **Flexible Magnet Mode (FMM):** With Flexible Magnet Mode the number of position magnets is flexible so that it can also be changed during operation.

i Note

Condition with two magnets
The distance between two position magnets must be at least ≥ 65 mm.

8.3.3 Functions of the outputs

- **Position**
- **Position difference:** Distance between two position magnets. The selection is only possible if Flexible Magnet Mode (FMM) is selected for the number of position magnets.
- **Speed:** Speed of the position magnet. The sign displays the movement direction. Movement from null point to end point is displayed with a positive sign. Movement from end point to null point is displayed with a negative sign. The maximum measurable speed range is −10…+10 m/s.

8.3.4 Status of the outputs

- Status of the output is readable.

8.3.5 Freely configurable curve

- Zero and end points can be taught-in (Teach-In).
- The characteristic curve can be inverted.
- The limits can be adjusted to the measuring range.
- The error value can be set according to the limits.

> **Note**
>
> The distance between null point and end point must be at least 10 mm.

8.3.6 Extended settings

- Change interface related parameters, e.g. SSI number of bits, etc.

9 Startup and operation

9.1 Startup

DANGER

Uncontrolled system movement
When starting up, if the sensor is part of a closed loop system whose parameters have not yet been set, the system may perform uncontrolled movements. This could result in personal injury and equipment damage.

- ► Persons must keep away from the system's hazardous zones.
- ► Startup must be performed only by trained technical personnel.
- ► Observe the safety instructions of the equipment or system manufacturer.

1. Check connections for tightness and correct polarity. Replace damaged connections.
2. Turn on the system.
3. Check measured values and adjustable parameters and readjust the BTL if necessary. Check the values over the entire measuring range.

Note

Check for the correct values, especially after replacing the BTL or after repair by the manufacturer.

9.2 Operating notes

- To change settings, see *Comissioning*.
- Regularly check function of the BTL and all associated components.
- Take the BTL out of operation whenever there is a malfunction.
- Secure the system against unauthorized use.
- Check fasteners and retighten if needed.

9.3 Maintenance

The product is maintenance-free.

10 Decomissioning

10.1 Disposal

▶ Observe the national regulations for disposal.

> **i Note**
>
> Additional information can be found at www.balluff.com on the product page.

11 Repair and disposal

11.1 Repair

Repairs to the product may only be performed by Balluff.

If the product is defective, contact our Service Center.

Headquarters and Technical Service Hubs

www.balluff.com/go/contact

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