BALLUFF

BIS M-4_ _-045-_0_-07-S4
BIS M-4_ _-072-_0_-07-S4

Technical Description, Operating Manual

english

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1 User Instructions

1.1 Conformity and User Safety

This product was developed and manufactured in accordance with applicable European standards and directives.

Declaration of Conformity

This product was developed and manufactured in accordance with applicable European standards and directives.

Note
You can request a Declaration of Conformity separately.
For additional safety instructions, refer to chapter "Safety" on page 8.

UL listing
Control No. 3TLJ
File No. E227256

IC:
This device complies with Industry Canada license-exempt RSS standard(s).
Operation is subject to the following two conditions:

1. this device may not cause interference, and
2. this device must accept any interference, including interference that may cause undesired operation of the device.

FCC:
This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

1. this device may not cause harmful interference, and
2. this device must accept any interference received, including interference that may cause undesired operation.

CAUTION TO USERS
Changes or modifications not expressly approved by the party responsible for compliance could void the user`s authority to operate the equipment.

1.2 Scope of Delivery

Included in the scope of delivery:
– BIS M-4_ _ IO-Link device

1 User Instructions

1.3 About This Manual

This manual describes the read/write device of the BIS M-4_ _ identification system with IO-Link interface and includes commissioning instructions for immediate operation.
This manual does not describe:
– The startup, function and safe operation of the host device (PC, PLC, IO-Link master).
– The installation and function of accessories and expansion devices.

1.4 Structure of the Manual

The manual is organized so that the sections build on each other.
Chapter 2: Basic Safety Information.
Chapter 3: The key steps for installing the identification system.
Chapter 4: Introduction to the material.
Chapter 5: Technical data for the read/write device.
Chapter 6: Basics on the IO-Link communications standard.
Chapter 7: User-defined settings for the read/write device.
Chapter 8: Integration into a fieldbus system using Profibus as an example.
Chapter 9: Processor and host system interaction.

1.5 Typographical Conventions

The following conventions are used in this manual.

Enumerations

Enumerations are shown as a list with an en-dash.
– Entry 1.
– Entry 2.

Actions

Action instructions are indicated by a preceding triangle. The result of an action is indicated by an arrow.

► Action instruction 1.
⇒ Action result.
► Action instruction 2.

Syntax

Numbers:
– Decimal numbers are shown without additional indicators (e.g. 123),
– Hexadecimal numbers are shown with the additional indicator $_{hex}$ (e.g. 00_{hex}).

Parameters:
Parameters are shown in italics (e.g. *CRC_16*).

Directory paths:
References to paths where data is stored or to be saved are shown in small caps (e.g. PROJECT:\DATA TYPES\USER-DEFINED).

Cross-references

Cross-references indicate where additional information on the topic can be found (see "Technical Data" starting on page 24).

1 User Instructions

1.6 Symbols

Note!
This symbol indicates a safety instruction that absolutely must be followed.

Note, tip
This symbol indicates general notes.

1.7 Abbreviations

BIS	Balluff Identification System
CRC	Cyclic Redundancy Code
DPP	Direct Parameter Page
EMC	Electromagnetic Compatibility
LSB	Least Significant Bit
MSB	Most Significant Bit
PC	Personal Computer
SIO	Standard IO
SPDU	Service Protocol Data Unit
PLC	Programmable Logic Controller
TCP	Transmission Control Protocol

2 Safety

2.1 Intended use

The BIS M-4xx_ _ read/write device, together with other components of the BIS M, form the identification system.
They may only be used for this purpose in an industrial environment corresponding to Class A of the EMC law.
This description applies for the read/write devices of the BIS M-4_ _ series with IO-Link interface

2.2 General Safety Notes

Installation and Startup
Installation and startup are to be performed by trained technical personnel only. Any damage resulting from unauthorized manipulation or improper use voids the manufacturer's guarantee and warranty.
When connecting the read/write device to an external controller, pay attention to the choice and polarity of the connection as well as the power supply.
The read/write device must only be powered using approved power supplies (see "Technical Data" starting on page 24).

⚠ **Caution!**
This is a Class A device. This device may cause RF disturbances in residential areas; in such a case the operator may be required to take appropriate countermeasures.

Operation and testing
The operator is responsible for ensuring that locally applicable safety regulations are observed.
In the event of defects and non-correctable faults in the identification system, take the system out of service and secure it to prevent unauthorized use.

2.3 Meaning of Warning Notes

⚠ **Caution!**
The pictogram used with the word "Caution" warns of a situation that could harm someone's health or damage equipment. Failure to observe these warning notes may result in injury or damage to equipment.
► Always observe the described measures for preventing this danger.

3 Getting Started

3.1 Mechanical Connection

BIS M-400-...-001

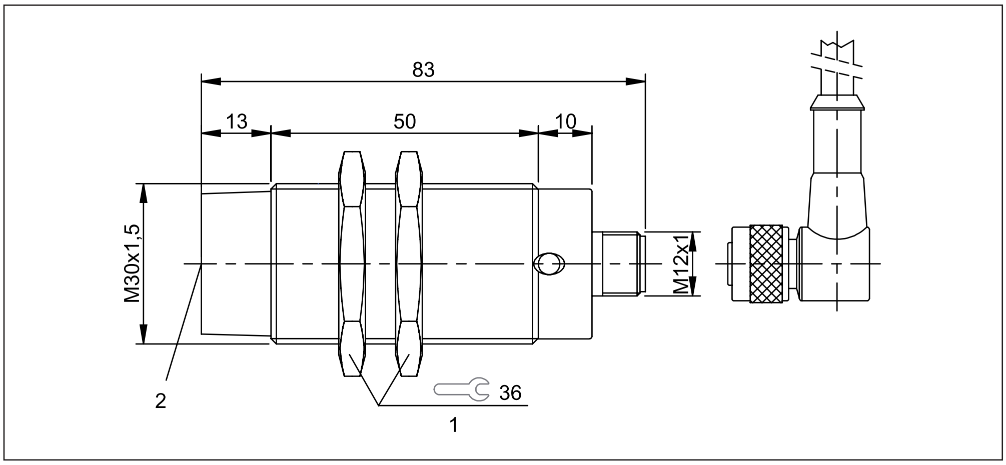


Figure 1: BIS M-400-045-001-07-S4 / BIS M-400-072-001-07-S4 read/write device, values in mm

1 Maximum tightening torque 40 Nm **2** Sensing surface

BIS M-400-...-002

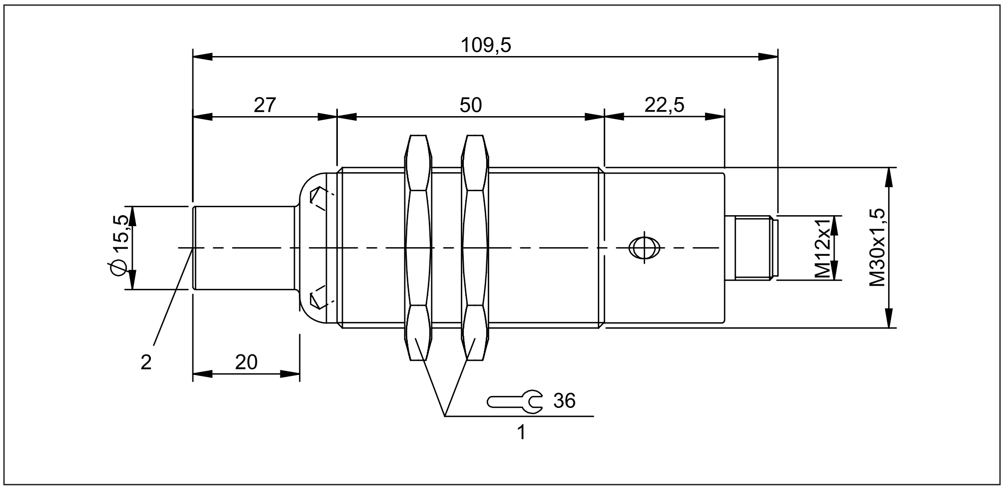


Figure 2: BIS M-400-045-002-07-S4 / BIS M-400-072-002-07-S4 read/write device, values in mm

1 Maximum tightening torque 40 Nm **2** Sensing surface

3 Getting started

BIS M-400-...-401

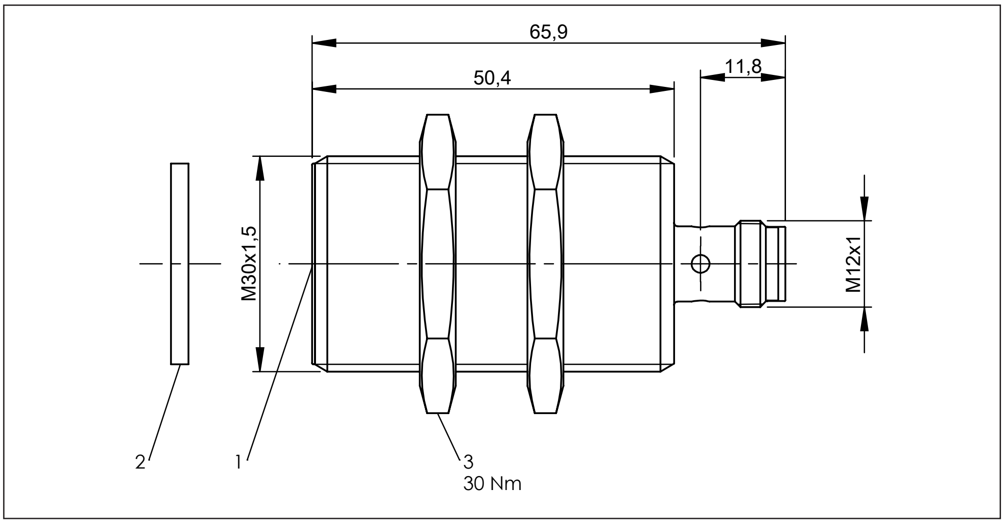


Figure 3: BIS M-400-0_ _-401-07-S4 read/write device, values in mm

1 Sensing surface
2 Data carrier
3 Tightening torque

BIS M-401-...-001

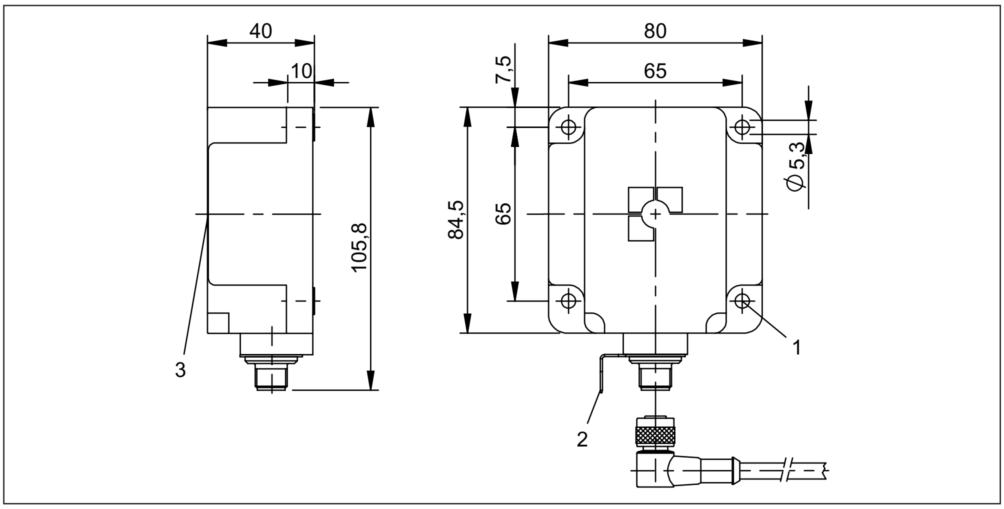


Figure 4: BIS M-401-045-001-07-S4 / BIS M-401-072-001-07-S4 read/write device, values in mm

1 Maximum tightening torque 3 Nm
2 Grounding strap
3 Sensing surface

3 Getting started

BIS M-402-...-002

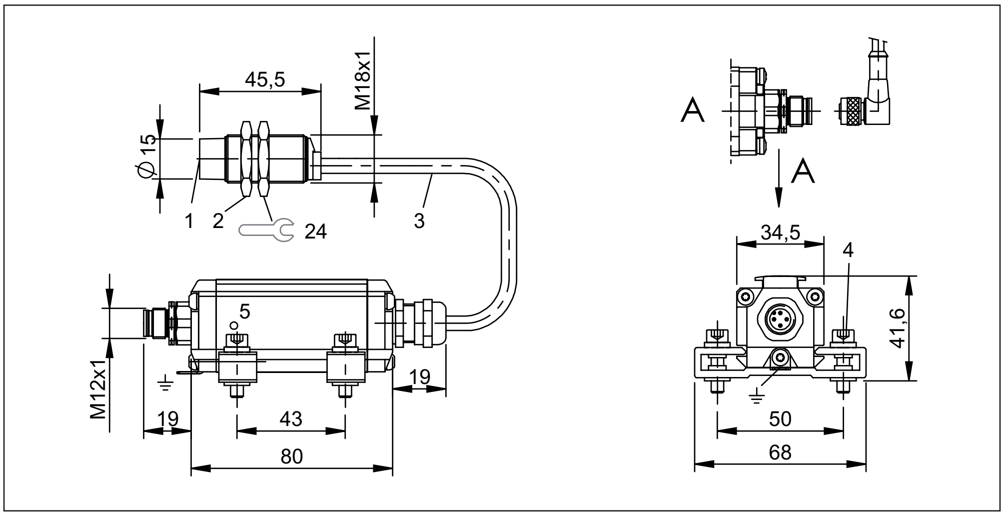


Figure 5: BIS M-402-045-002-07-S4 / BIS M-402-072-002-07-S4 read/write device, values in mm

1 Sensing surface
2 Maximum tightening torque 25 Nm
3 Cable length 0.5 m
4 Maximum tightening torque 2 Nm

BIS M-402-...-003

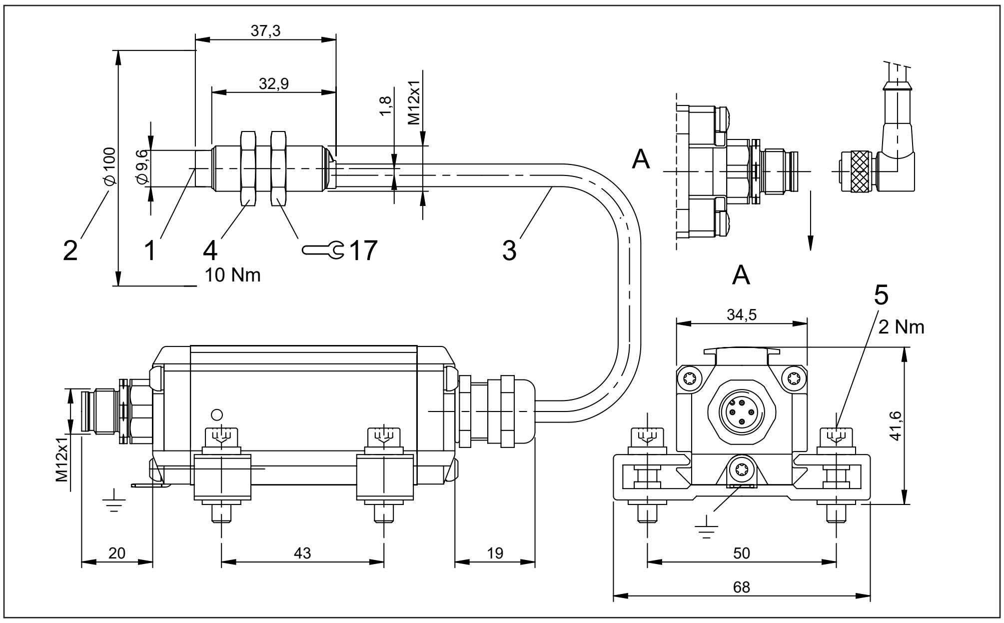


Figure 6: BIS M-402-045-003-07-S4 / BIS M-402-072-003-07-S4 read/write device, values in mm

1 Sensing surface
2 Clear zone
3 Cable length 0.5 m
4 Maximum tightening torque 10 Nm
5 Maximum tightening torque 2 Nm

3 Getting started

BIS M-402-...-004

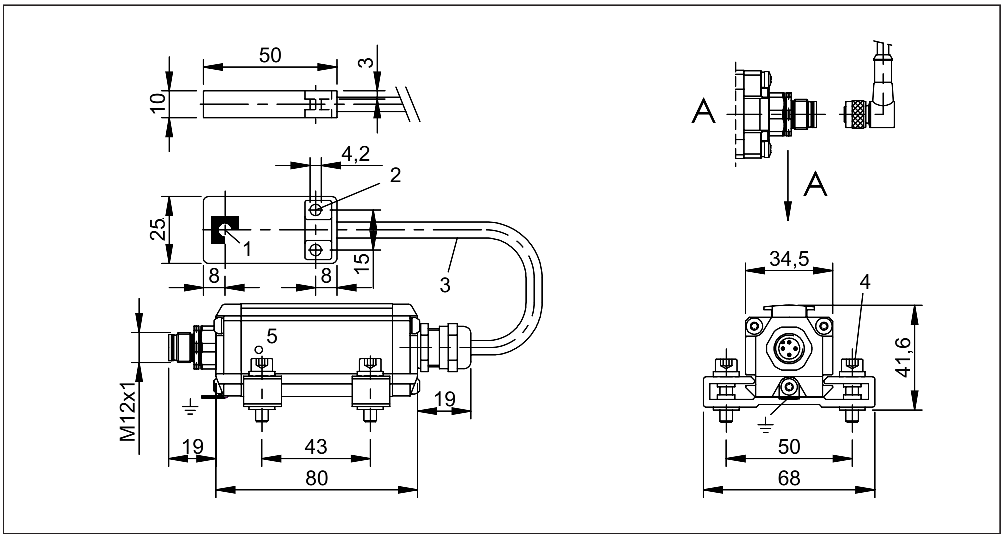


Figure 7: BIS M-402-045-004-07-S4 / BIS M-402-072-004-07-S4 read/write device, values in mm

1 Sensing surface
2 Maximum tightening torque 1 Nm
3 Cable length 0.5 m
4 Maximum tightening torque 2 Nm

BIS M-402-...-007

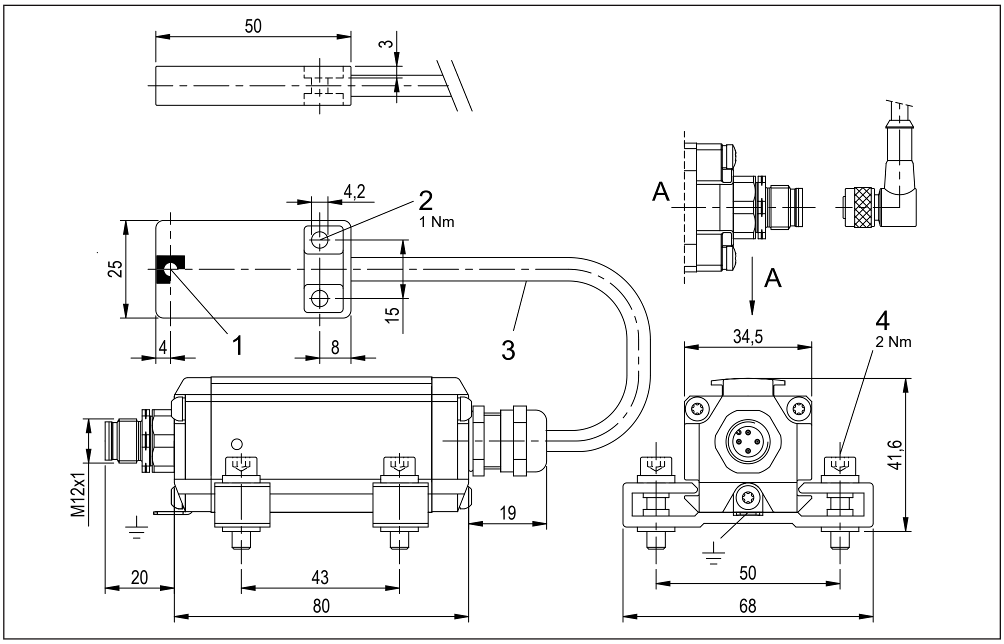


Figure 8: BIS M-402-045-007-07-S4 / BIS M-402-072-007-07-S4 read/write device, values in mm

1 Sensing surface
2 Maximum tightening torque 1 Nm
3 Cable length 0.5 m
4 Maximum tightening torque 2 Nm

3 Getting started

BIS M-404-...-401

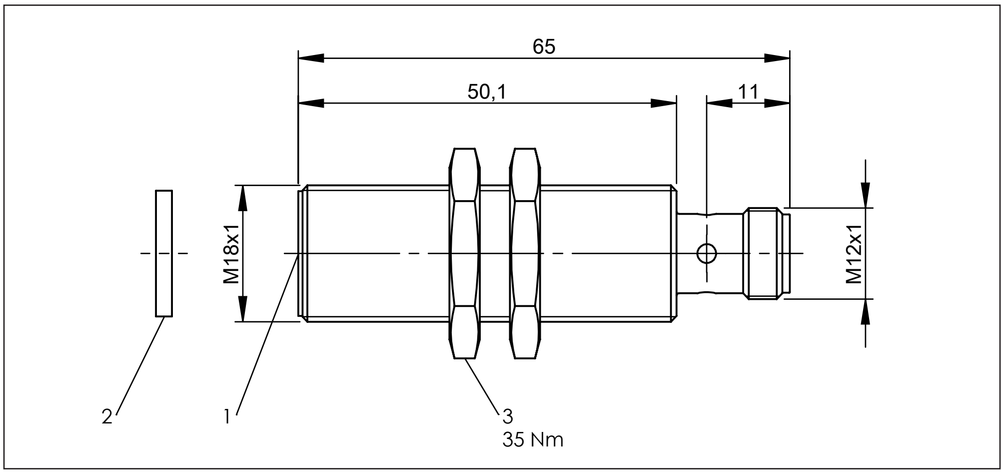


Figure 9: BIS M-404-0_ _-401-07-S4 read/write device, values in mm

1	Sensing surface	**2**	Data carrier
3	Tightening torque		

BIS M-405-...-001/
BIS M-405-...-008

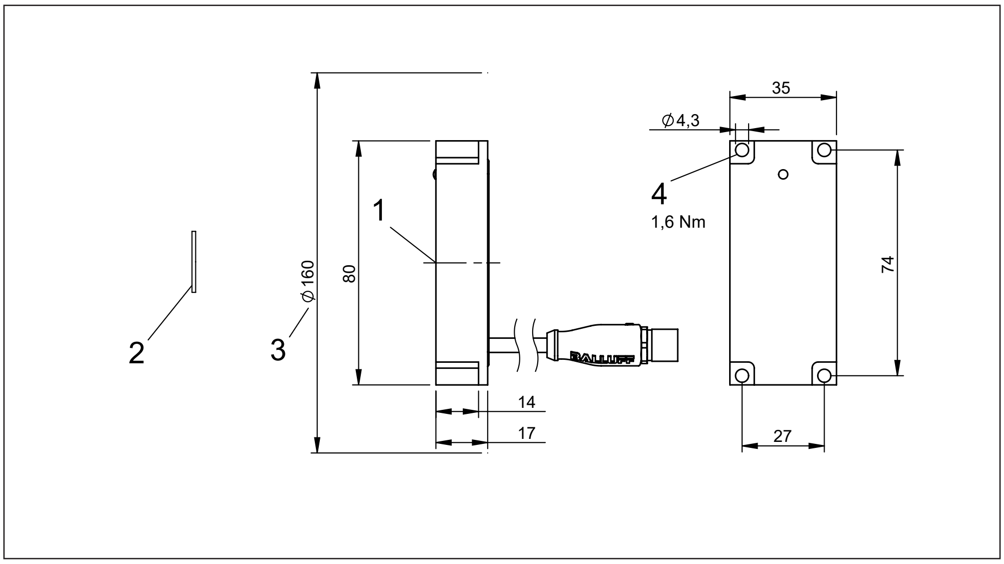


Figure 10: BIS M-405-0_ _-00_-07-S4 / BIS M-405-0_ _-00_-07-S4 read/write device, values in mm

1	Sensing surface	**2**	Data carrier
3	Clear zone	**4**	Maximum tightening torque 1,6 Nm

3 Getting started

BIS M-406-...-001

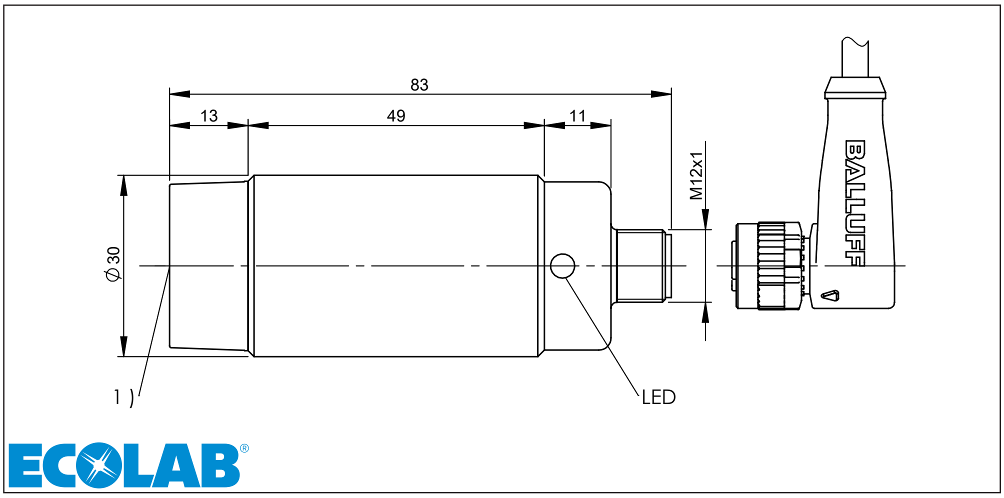


Figure 11: BIS M-406-045-001-07-S4 / BIS M-406-072-001-07-S4 read/write device, values in mm

1 Sensing surface

BIS M-408-...-001

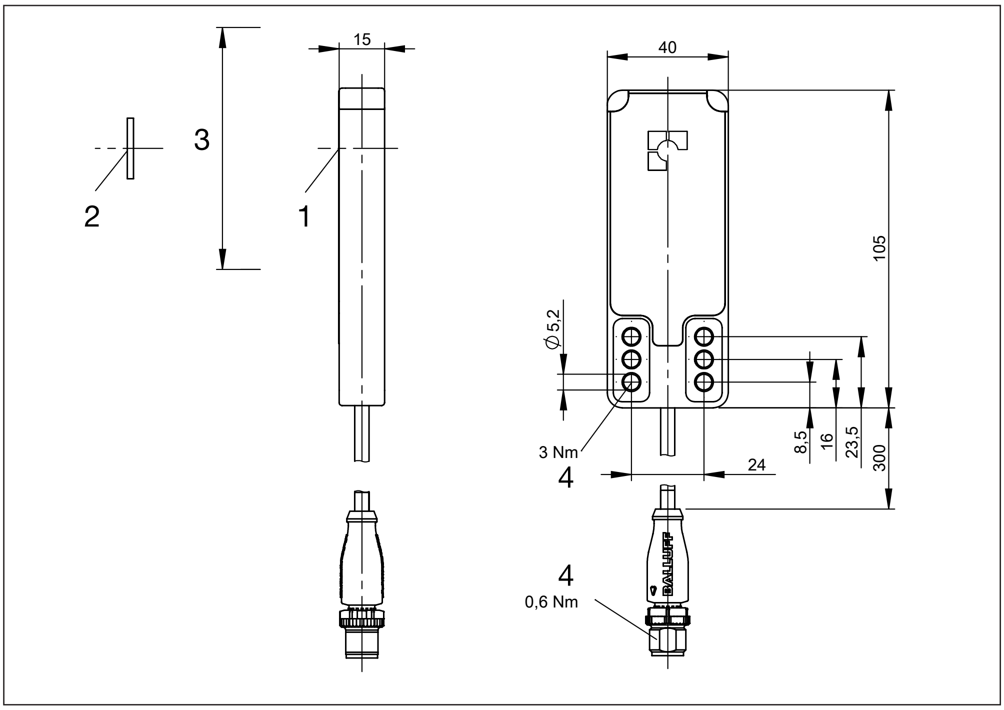


Figure 12: BIS M-408-045-004-07-S4 / BIS M-408-072-004-07-S4 read/write device, values in mm

1 Sensing surface
2 Data carrier
3 Clear zone (dependent on data carrier)
4 Tightening torque

3 Getting started

BIS M-414-...-401

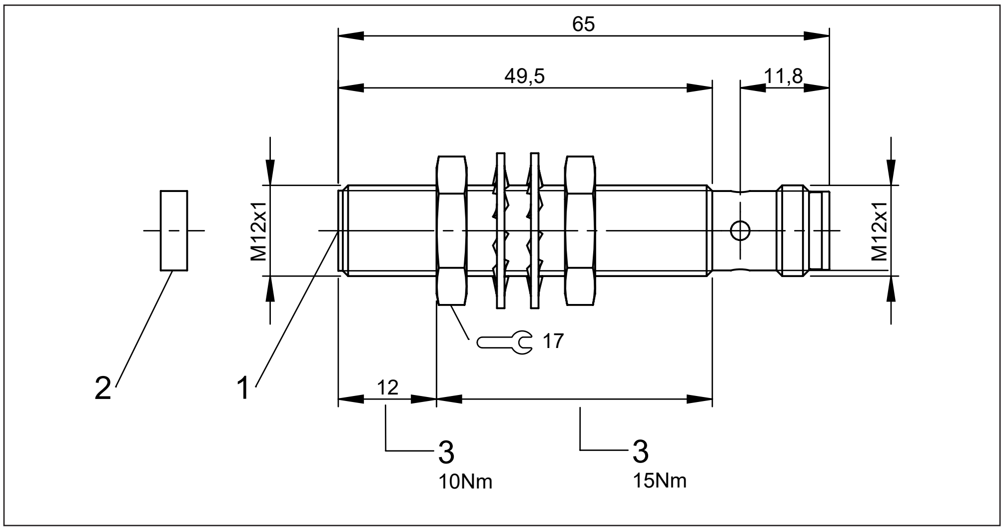


Figure 13: BIS M-414-045-401-07-S4 read/write device, values in mm

1	Sensing surface	**2**	Data carrier
3	Tightening torque		

BIS M-451-...-001

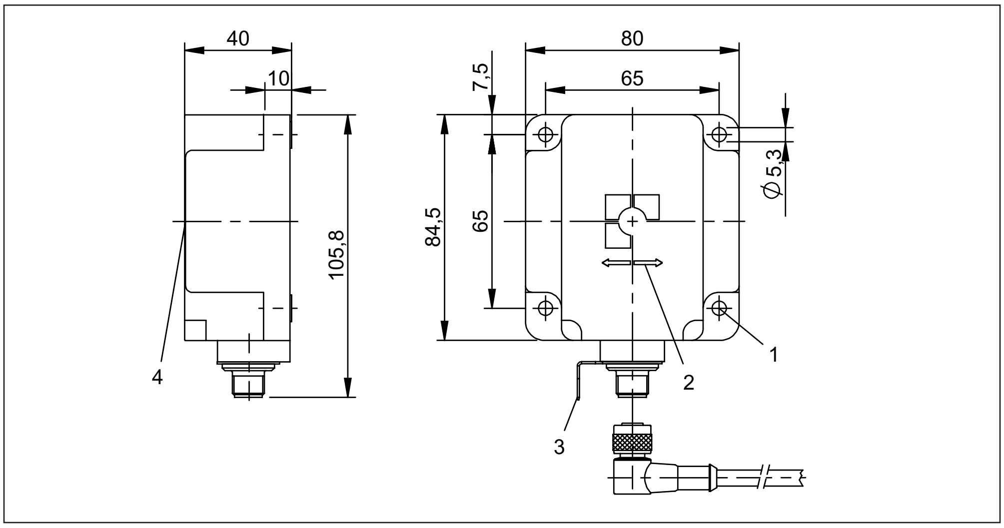


Figure 14: BIS M-451-045-001-07-S4 / BIS M-451-072-001-07-S4 read/write device, values in mm

1	Maximum tightening torque 3 Nm	**2**	Read/write axis
3	Grounding strap	**4**	Sensing surface

3 Getting started

BIS M-458-...-001

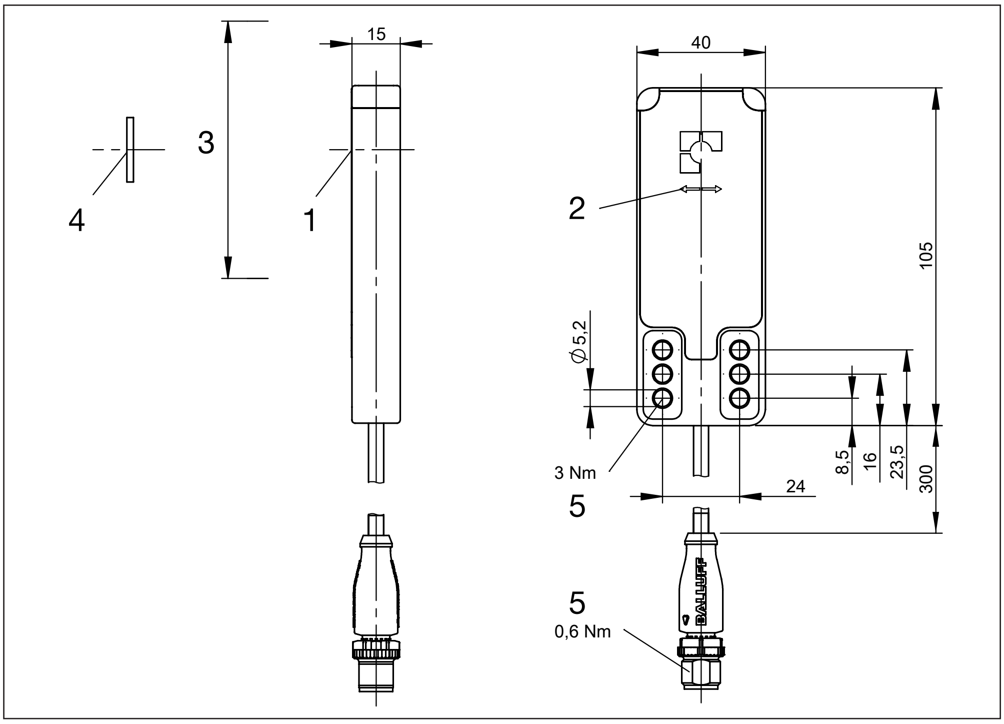


Figure 15: BIS M-458-045-001-07-S4 / BIS M-458-072-001-07-S4 read/write device, values in mm

- **1** Sensing surface
- **2** Read/write axis
- **3** Clear zone (dependent on data carrier)
- **4** Data carrier
- **5** Tightening torque

3 Getting started

Distance between the data carriers

Data carrier	Distance BIS M-...						
	101-... 106-... 107-... 108-... 110-... 111-... 115-... 128-...	**102-... 112-... 134-... 135-...**	**105-... 122-...**	**120-...**	**140-... 142-... 143-... 144-...**	**150-... 151-... 152-... 154-...**	**153-...**	**191-...**
BIS M-400-...	> 10 cm	> 15 cm	> 10 cm	–	> 10 cm	–	–	–
BIS M-401-...	> 20 cm	> 20 cm	–	> 25 cm	> 20 cm	–	–	–
BIS M-402-...	> 10 cm	–	> 10 cm	–	> 10 cm	–	–	–
BIS M-404-.../ BIS M-414-...	> 10 cm	–	> 10 cm	–	> 10 cm	–	–	–
BIS M-406-...	> 10 cm	> 15 cm	> 10 cm	–	> 10 cm	–	–	–
BIS M-405-.../ BIS M-408-...	> 10 cm	> 20 cm	> 10 cm	–	> 10 cm	–	–	–
BIS M-451-...	–	–	–	–	–	> 25 cm	> 30 cm	–
BIS M-458-...	–	–	–	–	–	> 20 cm	> 20 cm	> 10 cm

Distance between the read/write devices

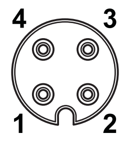
Read/Write Device	Minimum distance
BIS M-400-_ _ _ -001-...	150 mm
BIS M-400-_ _ _ -401-...	100 mm
BIS M-401-...	200 mm
BIS M-402-...	100 mm
BIS M-404-…/ BIS M-414-…	50 mm
BIS M-405-.../ BIS M-406-...	150 mm
BIS M-408-...	80 mm
BIS M-451-...	300 mm
BIS M-458-...	80 mm

Note
When installing two BIS M-4_ _-... on metal, there is normally no mutual interference. Unfavorable use of a metal frame can result in problems when reading a data carrier. In this case, the read distance is reduced to 80% of the maximum value. In critical applications, a pre-test is recommended.

3 Getting started

3.2 Electrical Connection

IO-Link port (M12, A-coded, female)



PIN	Function
1	+24 V
2*	Balluff service interface
3	GND
4	C/Q

* Do not connect PIN 2!

Caution!
Connecting Pin 2 to an external voltage can damage the interface.
► Do not connect PIN 2!

► Connect data line to IO-Link master.
(See Balluff IO-Link catalog for connection cables and accessories)
In areas with electromagnetic noise, shielded cables are recommended.

Note
For all variants, the ground connection of the read/write device or of the function ground are, depending on the system, to be connected to ground either directly / with low impedance or via a suitable RC combination.

4 Basic Knowledge

4.1 Function Principle of Identification Systems

The BIS M identification system is a contactless read and write system. The read/write device consists of evaluation electronics with permanently connected read/write head. The system can be used to program and to read information on a data carrier. The data and current status messages are transmitted from the identification system to the host system via a defined protocol. This protocol can also be used to transmit additional commands to the device, such as switching off the read-head antenna.

The main components of the BIS M identification system are:
– Read/write device,
– Data carrier.

Data is transmitted to the host system via an IO-Link master.

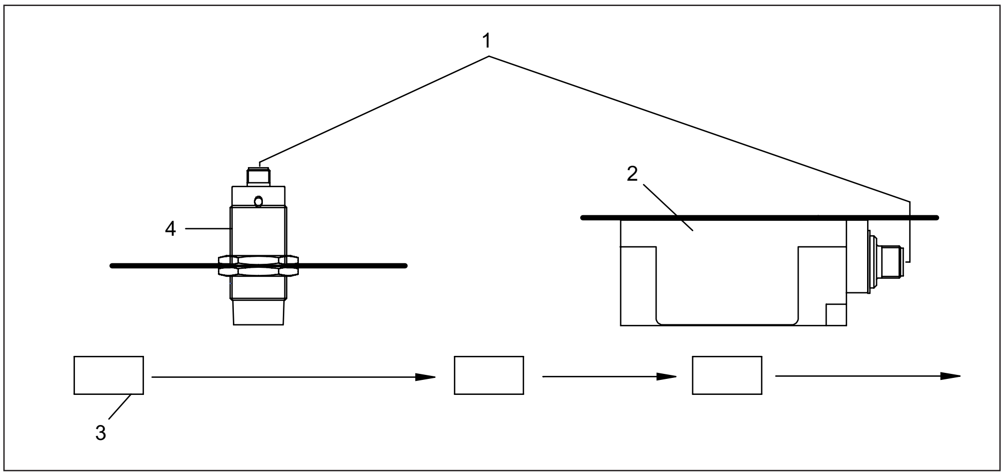


Figure 16: Schematic representation of an identification system

1	Connection to the IO-Link master	**2**	Read/write device
3	Data carrier	**4**	Read/write device

The data carrier is an autonomous unit that is supplied with power by the read/write head. The read/write head continuously sends a carrier signal that is picked up by the data carrier from within a certain distance. As soon as the data carrier is powered up by the carrier signal, a static read operation takes place.

The read/write device manages the data transfer between read/write head and data carrier, serves as a buffer storage device, and sends the data to the host controller.
The data is passed to the IO-Link master using IO-Link protocol, and the master then passes it to the host system.

Host systems may be the following:
– A control computer (e.g. industrial PC)
– A PLC

The main areas of application are:
– In production for controlling material flow (e.g. for model-specific processes, conveying systems that transport workpieces, acquisition of safety-relevant data)
– In warehousing for monitoring material movement
– transportation, and
– conveying technology.

4 Basic Knowledge

4.2 Example

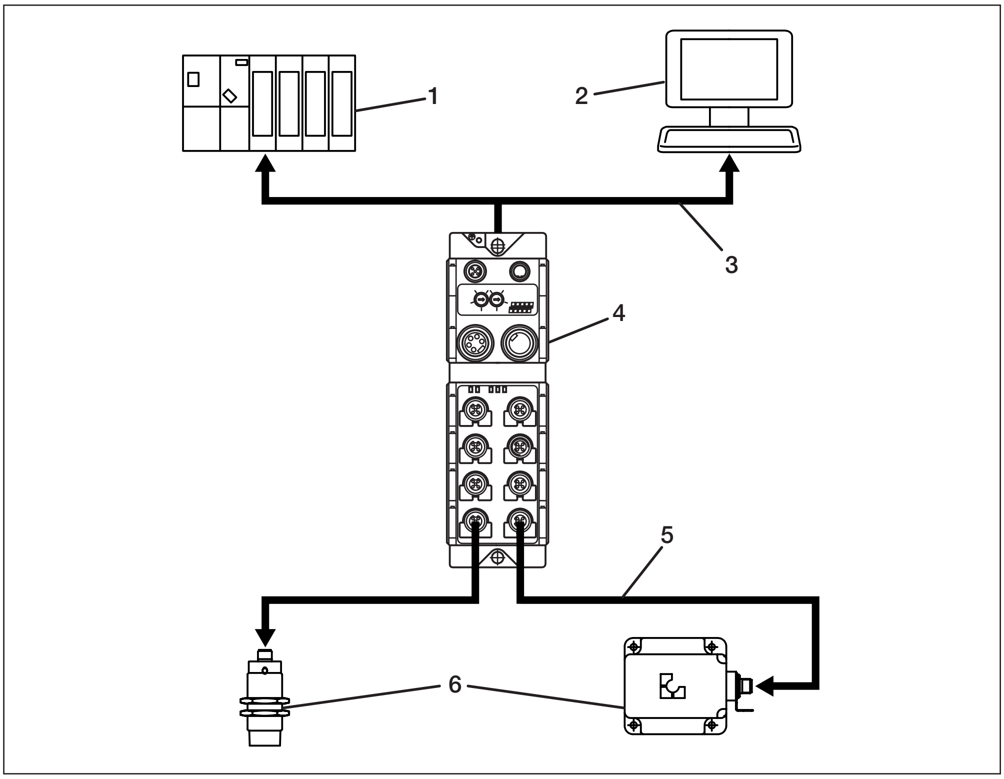


Figure 17: Topology of the BIS M IO-Link identification system

1	PLC	**2**	PC
3	Fieldbus	**4**	IO-Link master
5	Connection to the host system	**6**	BIS M read/write device, IO-Link device

4.3 Read Distance/ Offset

To ensure that data carriers are detected without error and the data can be reliably read, do not exceed a maximum distance and maximum offset between the data carriers and read heads (see chapter 5 "Technical Data" on page 24).
The "distance" value refers to the maximum distance from the data carrier to the sensing surface of the read/write head.
The "offset" value indicates the maximum offset between the center axis of the data carrier and the center axis of the sensing surface.
Data carriers can only be reliably detected and the data reliably read within the permissible read distance and offset.
Data carrier detection is indicated by an LED on the device ("TP – Tag Present", see chapter 5 "Technical Data" on page 24). At the same time, the CP bit is set in the input buffer ("CP – Codetag Present", see chapter 9.2 "Process data" on page 48.

4 Basic Knowledge

4.4 Product Description

BIS M-400-… read/write device:
- M30 threaded tube,
- round connector terminations,
- integrated read/write head,
- the read/write head is suitable for dynamic or static operation,
- data carrier is powered by the read/write head using a carrier signal.

BIS M-4_1-045-0_ _-07-S4 / BIS M-4_1-072-0_ _-07-S4 read/write device:
- plastic housing,
- round connector terminations,
- integrated read/write head,
- the read/write head is suitable for dynamic or static operation,
- data carrier is powered by the read/write head using a carrier signal.

BIS M-402-045-0_ _-07-S4 / BIS M-402-072-0_ _-07-S4 read/write device:
- metal housing,
- round connector terminations,
- integrated read/write head,
- the read/write head is suitable for dynamic or static operation,
- data carrier is powered by the read/write head using a carrier signal.
- read/write head in plastic (...-004-... /...-007-...) or metal housing (...-002-... /...-003-...).

BIS M-404-… :
- M18 threaded tube,
- round connector terminations,
- integrated read/write head,
- the read/write head is suitable for dynamic or static operation,
- data carrier is powered by the read/write head using a carrier signal.

BIS M-405-0_ _-00_-07-S4 read/write device:
- plastic housing,
- round connector terminations over 30 cm cable,
- integrated read/write head,
- the read/write head is suitable for dynamic or static operation,
- data carrier is powered by the read/write head using a carrier signal.

BIS M-406-045-0_ _-07-S4 / BIS M-406-072-0_ _-07-S4 read/write device:
- D30 tube,
- round connector terminations,
- integrated read/write head,
- the read/write head is suitable for dynamic or static operation,
- data carrier is powered by the read/write head using a carrier signal,
- Ecolab certification.

BIS M-4_8-0_ _-001-07-S4 read/write device:
- metal housing,
- round connector terminations over 30 cm cable,
- integrated read/write head,
- the read/write head is suitable for dynamic or static operation,
- data carrier is powered by the read/write head using a carrier signal.

BIS M-414-045-401-07-S4 read/write device:
- M12 metal housing,
- round connector terminations,
- integrated read/write head,
- the read/write head is suitable for dynamic or static operation,
- data carrier is powered by the read/write head using a carrier signal.

4 Basic Knowledge

4.5 Data integrity

To ensure data integrity, data transfer between the data carrier and read/write device can be monitored using a CRC_16 data check.
With the CRC_16 data check, a checksum is written to the data carrier which enables the data to be checked for validity at any time.

Advantages of the CRC_16 data check:

– Very high data integrity, even during the non-active phase (data carrier outside the read/write head)

Restrictions of the CRC_16 data check:

– Longer write times, as the CRC must also be written.
– User bytes are lost on the data carrier (see table on page 23).

Use of CRC_16 can be configured by the user (see chapter „7.2 Mapping of Parameter Data“ auf Seite 44).

4.6 Autoread

The Autoread function is used to immediately read out a specific memory area of the data carrier when the data carrier enters the vicinity of the read head. The data quantity here is 8 bytes (BIS M-4_ _-045-...) or 30 bytes (BIS M-4_ _-072-...), the start address can be configured in the parameters.

If a read error occurs during autoread or if the specified data area lies outside the capacity of the data carrier, no error is displayed. In this case, no data is output.

4 Basic Knowledge

4.7 Supported Data Carrier Types

Mifare

Balluff data carrier type	Manufac-turer	Description	Memory capacity	Usable bytes with CRC	Memory type
BIS M-1_ _-01	NXP	Mifare Classic	752 bytes	658 bytes	EEPROM
BIS M-1_ _-10	NXP	Mifare Classic	736 bytes	644 bytes	EEPROM

Note
Data carriers cannot be used with BIS M-4_ _-0_ _-401-…, read/write devices.

ISO15693

Balluff data carrier type	Manufac-turer	Description	Memory capacity	Usable bytes with CRC	Memory type
BIS M-1_ _-02	Fujitsu	MB89R118	2000 bytes	1750 bytes	FRAM
BIS M-1_ _-03	NXP	SL2ICS20	112 bytes	98 bytes	EEPROM
BIS M-1_ _-04	Texas Inst.	TAG-IT Plus	256 bytes	224 bytes	EEPROM
BIS M-1_ _-05	Infineon	SRF55V02P	224 bytes	196 bytes	EEPROM
BIS M-1_ _-06	EM	EM4135	288 bytes	252 bytes	EEPROM
BIS M-1_ _-07	Infineon	SRF55V10P	992 bytes	868 bytes	EEPROM
BIS M-1_ _-08	NXP	SL2IC553	160 bytes	140 bytes	EEPROM
BIS M-1_ _-09	NXP	SL2ICS50	32 bytes	28 bytes	EEPROM
BIS M-1_ _-11*	Balluff	BIS M-1	8192 bytes	7168 bytes	FRAM
BIS M-1_ _-13*	Balluff	BIS M-1	32768 bytes	28672 bytes	FRAM
BIS M-1_ _-14*	Balluff	BIS M-1	65536 bytes	57344 bytes	FRAM
BIS M-1_ _-15*	Balluff	BIS M-1	131072 bytes	114688 bytes	FRAM
BIS M-1_ _-20	Fujitsu	MB89R112	8192 bytes	7680 bytes	FRAM

* Can only be used in conjunction with BIS M-4_ _-0_ _-401-…read/write device

4.8 IO-Link Basic Knowledge

Advantages of IO-Link:

- Uniform, simple wiring of different devices
- The host system can be used to change the device parameters
- Remote querying of diagnostic information is possible
- Centralized data retention of the device parameters is possible

The manufacturer-specific standard IO-Link sends not only the actual process signal, but also all relevant parameter and diagnostic data on the process level over a single standard cable. Communication is based on a standard UART protocol with 24V pulse modulation; no separate power supply is required.

The BIS M IO-Link uses three-conductor technology (physics 2) and operates with a transfer rate of 38400 (COM2). The data quantity of the process data is 10 bytes (BIS M-4_ _-045-00_-07-S4) or 32 bytes (BIS M-4_ _-072-00_-07-S4) in each direction (see chapter 9 "Process data" on page 48).

5 Technical Data

5.1 Electrical Data (Valid for All Device Versions)

Supply voltage V_S	18...30 VDC LPS/Class 2 supplied only
Ripple	1.3 Vpp
Current consumption	150 mA
Output C/Q	Short-circuit protected
Device interface	IO-Link

5.2 Operating Conditions (Valid for All Device Versions)

Storage temperature	–20 °C … +85 °C
Ambient temperature	0 °C … +70 °C
Approval/Conformity	– CE – cULus – ECOLAB (BIS M-406-0_ _-001-07-S4 only)
EMC – EN 301 489-1/-3 – EN 61000-4-2/-3/-4/-6 – EN 300 330-1	 Class B Severity 2A/2A/4B/XA* Power Class 5
Vibration/shock	EN 60068 Part 2 6/27/29/64/32

*Measured with shielded cable.

5.3 BIS M-400-0_ _-001-07-S4

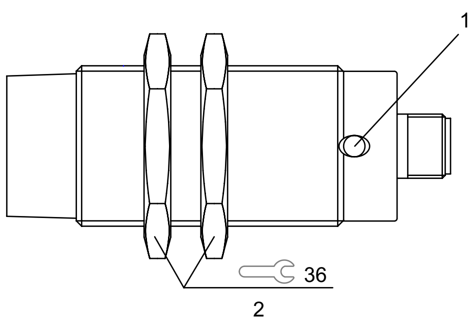


Figure 18: BIS M-400-045-001-07-S4 / BIS M-400-072-001-07-S4 read/write device

1 LED **2** Maximum tightening torque 40 Nm

Mechanical Data

Housing material	Nickel-plated CuZn
Connection	M12, 4-pin plug connection
Degree of protection	IP 67
Weight	100 g

LED

LED	Status	Function
LED	Green	Power
LED	Yellow	Data carrier detected
LED	Green flashing (1 s on / 100 ms off)	IO-Link connection active

5 Technical Data

5.4 BIS M-400-0_ _-002-07-S4

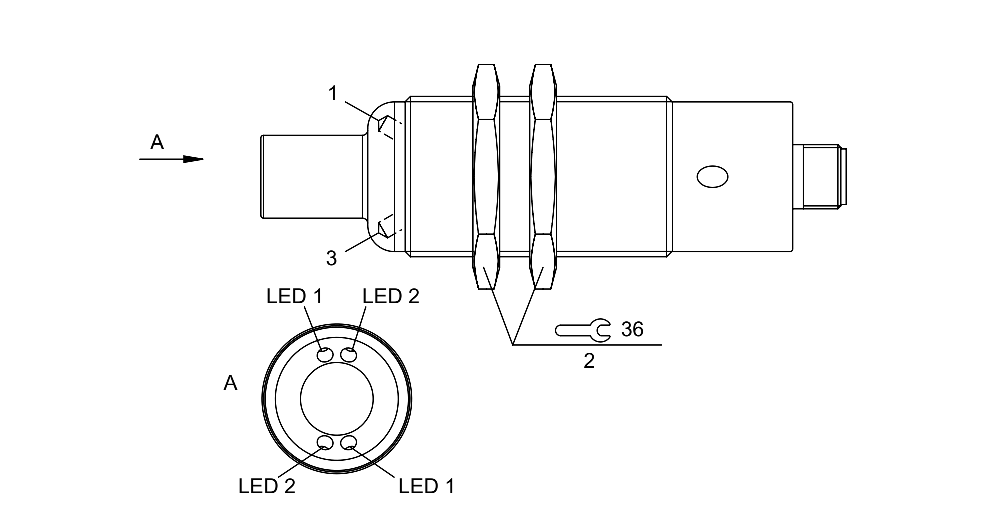


Figure 19: BIS M-400-045-002-07-S4 / BIS M-400-072-002-07-S4 read/write device

1 LED 2 (Power)
2 Maximum tightening torque 40 Nm
3 LED 1 (CP)

Mechanical Data

Housing material	Nickel-plated CuZn
Connection	M12, 4-pin plug connection
Degree of protection	IP 67
Weight	100 g

LED

LED	Status	Function
LED 1	Green	Power
LED 2	Yellow	Data carrier detected
LED 1	Green flashing (1 s on / 100 ms off)	IO-Link connection active

5 Technical Data

5.5 BIS M-400-0_ _ 401-07-S4

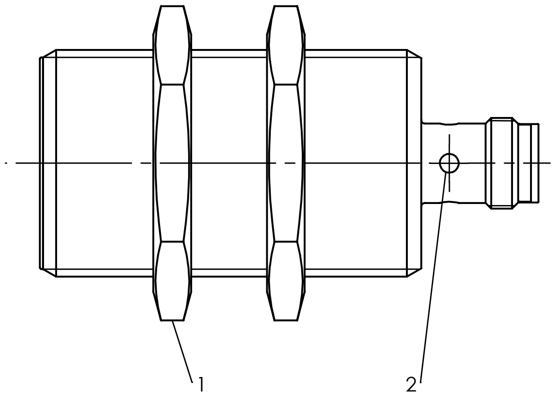


Figure 20: BIS M-400-0_ _-401-07-S4 read/write device

1 Maximum tightening torque 35 Nm **2** LED

Mechanical Data

Housing material	Nickel-plated GD-ZnAl
Connection	M12, 4-pin plug connection
Degree of protection	IP 67
Weight	66 g

LED

LED	Status	Function
LED	Green	Power
LED	Yellow	Data carrier detected
LED	Green flashing (1 s on / 100 ms off)	IO-Link connection active

5 Technical Data

5.6 BIS M-401-0_ _-001-07-S4

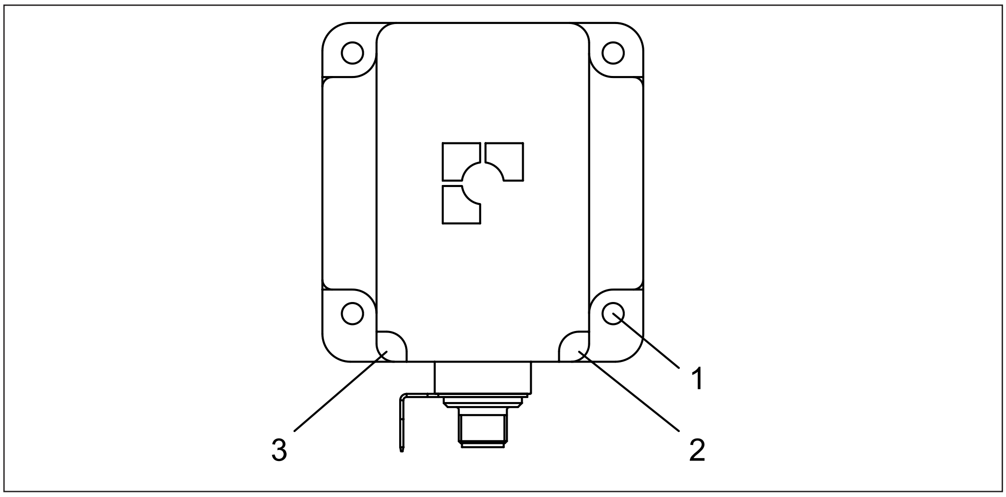


Figure 21: BIS M-401-045-001-07-S4 / BIS M-401-072-001-07-S4 read/write device

1 Maximum tightening torque 3 Nm
2 LED 2 (CP)
3 LED 1 (Power)

Mechanical Data

Housing material	PBT
Connection	M12, 4-pin plug connection
Degree of protection	IP 67
Weight	190 g

LED

LED	Status	Function
LED 1	Green	Power
LED 2	Yellow	Data carrier detected
LED 1	Green flashing (1 s on / 100 ms off)	IO-Link connection active

5 Technical Data

5.7 BIS M-402-0_ _-002-07-S4

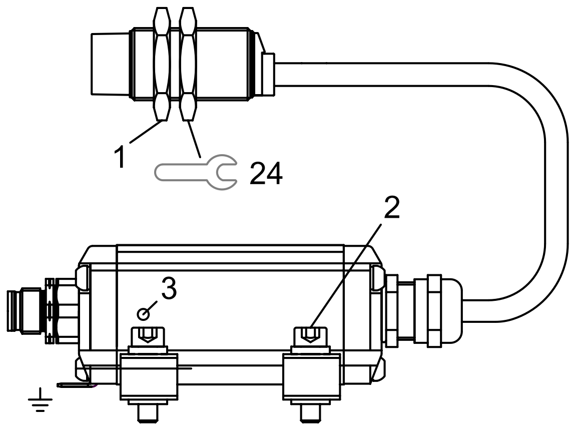


Figure 22: BIS M-402-045-002-07-S4 / BIS M-402-072-002-07-S4 read/write device, values in mm

1 Maximum tightening torque 25 Nm

2 Maximum tightening torque 2 Nm

3 LED

Mechanical Data

Housing material	$AlMGSIO_5$
Read/write head housing material	Nickel-plated CuZn
Connection	M12, 4-pin plug connection
Degree of protection	IP 67
Weight	220 g

LED

LED	Status	Function
LED	Green	Power
LED	Yellow	Data carrier detected
LED	Green flashing (1 s on / 100 ms off)	IO-Link connection active

5 Technical Data

5.8 BIS M-402-0_ _-003-07-S4

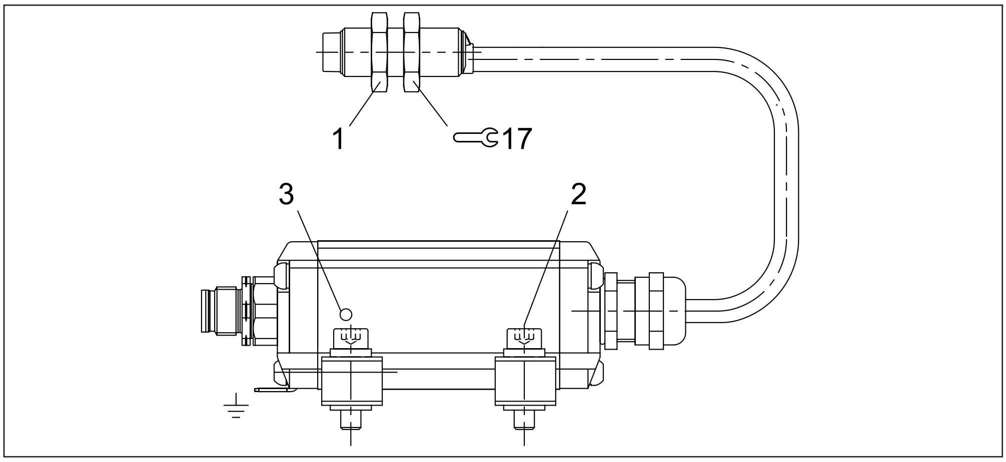


Figure 23: BIS M-402-045-003-07-S4 / BIS M-402-072-003-07-S4 read/write device, values in mm

1 Maximum tightening torque 10 Nm

2 Maximum tightening torque 2 Nm

3 LED

Mechanical Data

Housing material	AlMGSIO$_5$
Read/write head housing material	Nickel-plated CuZn
Connection	M12, 4-pin plug connection
Degree of protection	IP 67
Weight	220 g

LED

LED	Status	Function
LED	Green	Power
LED	Yellow	Data carrier detected
LED	Green flashing (1 s on / 100 ms off)	IO-Link connection active

5 Technical Data

5.9 BIS M-402-0_ _-004-07-S4

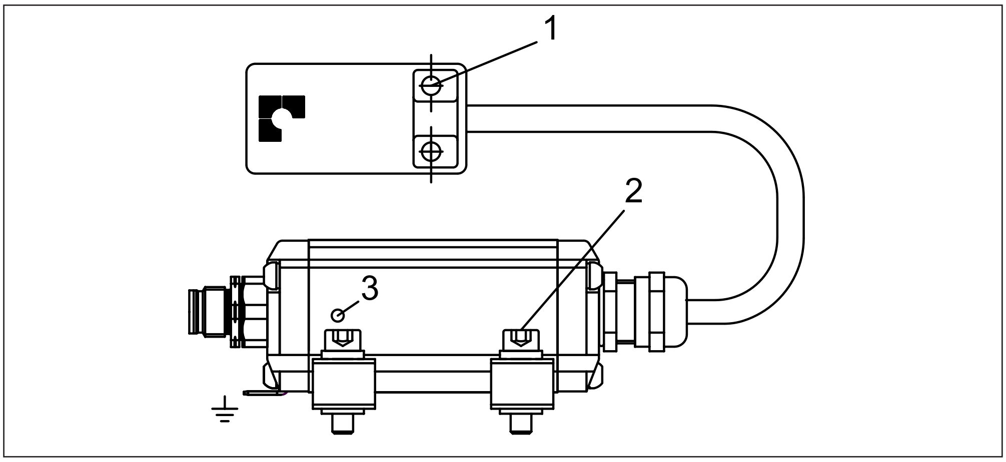


Figure 24: BIS M-402-045-004-07-S4 / BIS M-402-072-004-07-S4 read/write device

1 Maximum tightening torque 1 Nm

2 Maximum tightening torque 2 Nm

3 LED

Mechanical Data

Housing material	$AlMGSIO_5$
Read/write head housing material	Nickel-plated CuZn
Connection	M12, 4-pin plug connection
Degree of protection	IP 67
Weight	220 g

LED

LED	Status	Function
LED	Green	Power
LED	Yellow	Data carrier detected
LED	Green flashing (1 s on / 100 ms off)	IO-Link connection active

5 Technical Data

5.10 BIS M-402-0_ _-007-07-S4

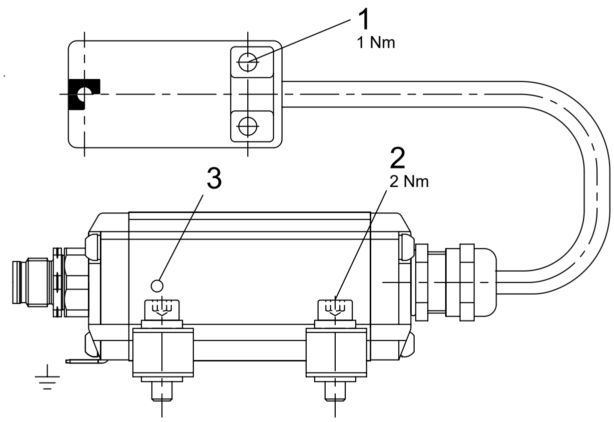


Figure 25: BIS M-402-045-007-07-S4 / BIS M-402-072-007-07-S4 read/write device

1 Sensing surface **2** LED

Mechanical Data

Housing material	$AlMGSiO_5$
Read/write head housing material	Nickel-plated CuZn
Connection	M12, 4-pin plug connection
Degree of protection	IP 67
Weight	220 g

LED

LED	Status	Function
LED	Green	Power
LED	Yellow	Data carrier detected
LED	Green flashing (1 s on / 100 ms off)	IO-Link connection active

5 Technical Data

5.11 BIS M-404-0_ _-401-07-S4

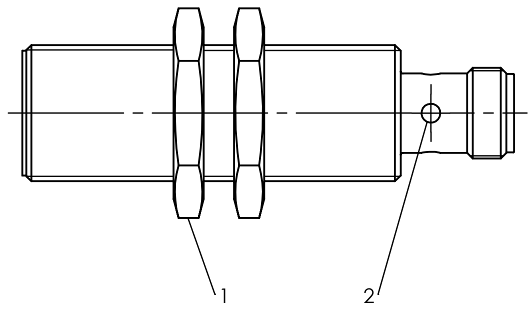


Figure 26: BIS M-404-0_ _-401-07-S4 read/write device

1 Maximum tightening torque 35 Nm **2** LED 2 (CP)

Mechanical Data

Housing material	Nickel-plated GD-ZnAl
Connection	M12, 4-pin plug connection
Degree of protection	IP 67
Weight	36 g

LED

LED	Status	Function
LED	Green	Power
LED	Yellow	Data carrier detected
LED	Green flashing (1 s on / 100 ms off)	IO-Link connection active

5 Technical Data

5.12 BIS M-405-0_ _-00_-07-S4

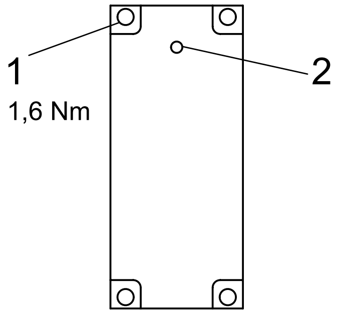


Figure 27: BIS M-405-045-00_-07-S4 read/write device

1 Maximum tightening torque 1,6 Nm **2** LED

Mechanical Data

Housing material	$AlMGSiO_5$
Read/write head housing material	Nickel-plated CuZn
Connection	M12, 4-pin plug connection
Degree of protection	IP 67
Weight	73 g

LED

LED	Status	Function
LED	Green	Power
LED	Yellow	Data carrier detected
LED	Green flashing (1 s on / 100 ms off)	IO-Link connection active

5 Technical Data

5.13 BIS M-406-0_ _-001-07-S4

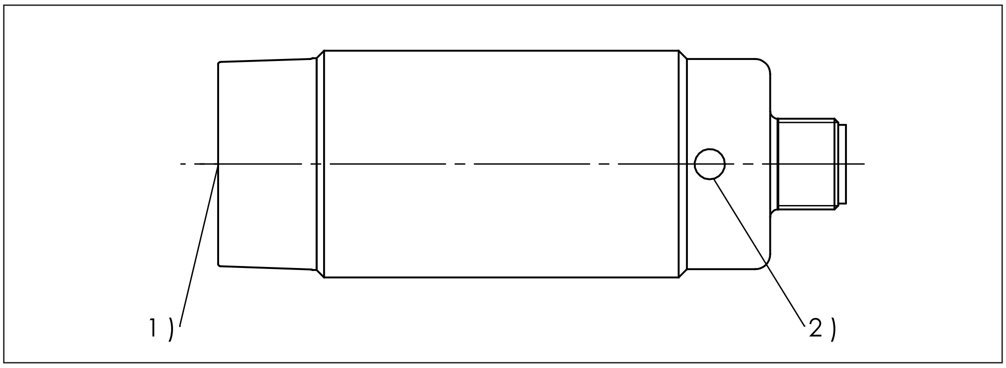


Figure 28: BIS M-406-045-001-07-S4 / BIS M-406-072-001-07-S4 read/write device

1 Sensing surface **2** LED

Mechanical Data

Housing material	Stainless steel 1.4404
Sensing surface	PA12
Connection	M12, 4-pin plug connection
Degree of protection	IP 68 and IP 69 K
Weight	100 g

LED

LED	Status	Function
LED	Green	Power
LED	Yellow	Data carrier detected
LED	Green flashing (1 s on / 100 ms off)	IO-Link connection active

Stainless Steel

IP68
BWN Pr27
BWN Pr20

IP69K

ECOLAB®

5 Technical Data

5.14 BIS M-408-0_ _-001-07-S4

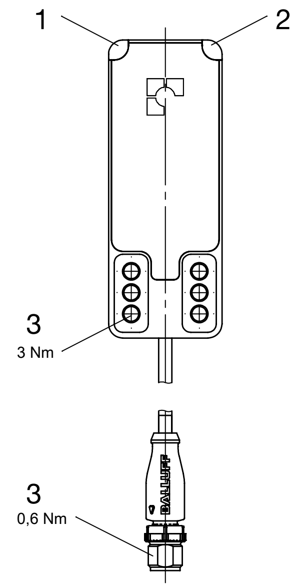


Figure 29: BIS M-408-045-001-07-S4 / BIS M-408-072-001-07-S4 read/write device

1 LED 1 (Power)
2 LED 2 (CP)
3 Tightening torque

Mechanical Data

Housing material	Nickel-plated GD-ZnAl
Connection	M12, 4-pin plug connection
Degree of protection	IP 67
Weight	360 g

LED

LED	Status	Function
LED 1	Green	Power
LED 2	Yellow	Data carrier detected
LED 1	Green flashing (1 s on / 100 ms off)	IO-Link connection active

5 Technical Data

5.15 BIS M-414-0_ _-401-07-S4

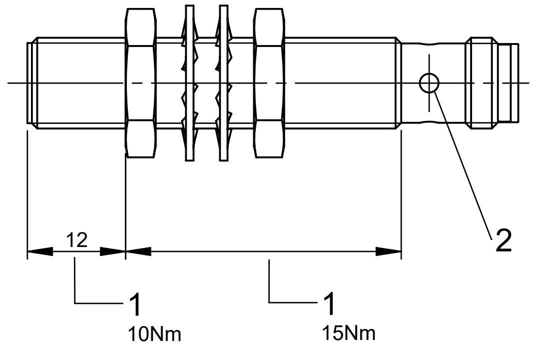


Figure 30: BIS M-414-045-401-07-S4 read/write device

1 Tightening torque **2** LED

Mechanical Data

Housing material	$AlMGSIO_5$
Read/write head housing material	Nickel-plated CuZn
Connection	M12, 4-pin plug connection
Degree of protection	IP 67
Weight	100 g

LED

LED	Status	Function
LED	Green	Power
LED	Yellow	Data carrier detected
LED	Green flashing (1 s on / 100 ms off)	IO-Link connection active

5 Technical Data

5.16 BIS M-451-0_ _-001-07-S4

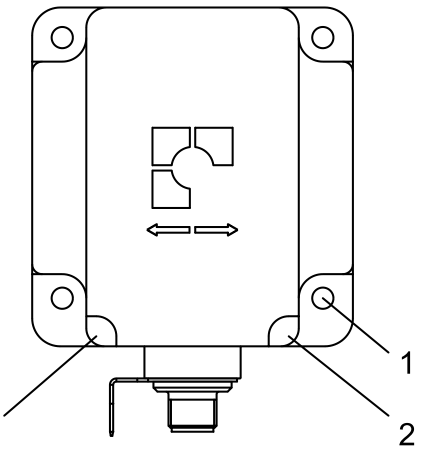


Figure 31: BIS M-451-045-001-07-S4 / BIS M-451-072-001-07-S4 read/write device

1 Maximum tightening torque 3 Nm

2 LED 2 (CP)

3 LED 1 (Power)

Mechanical Data

Housing material	PBT
Connection	M12, 4-pin plug connection
Degree of protection	IP 67
Weight	360 g

LED

LED	Status	Function
LED 1	Green	Power
LED 2	Yellow	Data carrier detected
LED 1	Green flashing (1 s on / 100 ms off)	IO-Link connection active

5 Technical Data

5.17 BIS M-458-0_ _-001-07-S4

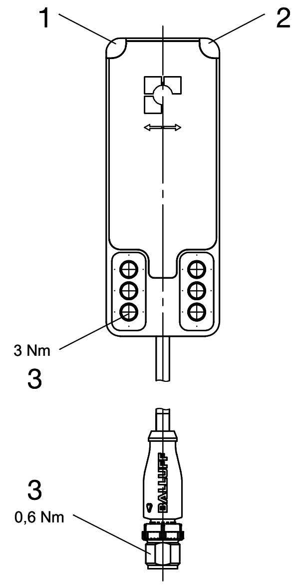


Figure 32: BIS M-458-045-001-07-S4 / BIS M-458-072-001-07-S4 read/write device

1 LED 1 (Power)
2 LED 2 (CP)
3 Tightening torque

Mechanical Data

Housing material	Nickel-plated GD-ZnAl
Connection	M12, 4-pin plug connection
Degree of protection	IP 67
Weight	360 g

LED

LED	Status	Function
LED 1	Green	Power
LED 2	Yellow	Data carrier detected
LED 1	Green flashing (1 s on / 100 ms off)	IO-Link connection active

5 Technical Data

5.18 Dynamic mode

The read/write device can read or write each individual byte on the data carrier. But since the data carrier is divided into 16-byte memory blocks, the actual writing can only be performed in blocks. Our electronic processor unit converts this accordingly.

Memory access

To calculate the read/write times, the block read or write time must, therefore, always be estimated.

Data carrier detection time

The data carrier detection time is ~20 ms.

Read times

Data carrier with 16 bytes per block	Supported data carriers with Mifare	Supported data carriers with ISO 15693
Read bytes 0 to 15	~20 ms	~35 ms
for each additional start of a 16-byte block	~10 ms	~25 ms

Write times

Data carrier with 16 bytes per block	Supported data carriers with Mifare	Supported data carriers with ISO 15693
Write bytes 0 to 15	~40 ms	~65 ms
for each additional start of a 16-byte block	~30 ms	~55 ms

Note
Fluctuations in the ms range are possible. Electrical noise effects may increase the read/write time.
All indicated read/write times refer to the communication between data carriers and the read/write head. These do not include the times for data communication between processor unit and controlling system.

5 Technical Data

Maximum speed

To calculate the permissible speed at which the data carrier and head may move relative to one another, the static distance values are used (see chapter 5 "Technical Data", pages 24 to 40).

The permissible speed is:

$$V_{max.\,perm.} = \frac{\text{Path}}{\text{Time}} = \frac{2 * |\text{offset value}|}{\text{Processing time}}$$

The offset value is dependent on the read/write distance actually used in the system.

Processing time = Data-carrier detection time + Read/write time of first block to be read + n^1 X Read/write time for other started blocks

[1] Number of started blocks

Note
The texts, such as "Read time of first block to be read", can also be represented as variables: t_{L1}.

Read and write 44 bytes starting with address 15 of a BIS M-102-01/L data carrier with EEPROM memory and parameter setting of ALL for "Used data carrier type" using the BIS M-400-045-001-07-S4 read/write device

Example calculation

The distance from the sensing surface of the read/write head to the data carrier is 12 mm. A maximum clear zone is assumed, i.e. installation completely in plastic frame.

Address 15 is in block 1 (15/16 = 0.94 → block 1)
Address 58 is in block 4 (58/16 = 3.63 → block 4)

Therefore, a total of 4 blocks will be processed, where the first block always has a slightly longer read or write time.

Calculation of read/write time:
Total read time = 20 ms + 20 ms + 3 x 10 ms = 70 ms
Total write time = 20 ms + 40 ms + 3 x 30 ms = 150 ms

For the specified values, this yields an offset of ± 20 mm.

Calculation of maximum speed:
$V_{max.perm.read}$ = 40 mm/70 ms = 0.57 m/s
$V_{max.perm.write}$ = 40 mm/150 ms = 0.26 m/s

Note
Fluctuations in the ms range are possible. Electrical noise effects may increase the read/write time.

6 IO-Link basics

6.1 Digital Point-to-point Connection

IO-Link integrates conventional and intelligent actuators and sensors into automation systems. Mixed use of traditional and intelligent devices is possible with no additional expense.
IO-Link is intended as a communications standard below the traditional fieldbus level. Fieldbus-neutral IO-Link transmission uses existing communications systems (fieldbuses or Ethernet-based systems).
The actuators and sensors are connected in point-to-point connection using conventional unshielded cables.
IO-Link devices can send application-specific parameters and data (e.g. diagnostics data) using a serial communication procedure. Flexible telegrams are possible for sending larger quantities of data. Communication is based on a standard UART protocol with 24V pulse modulation. Only one data line is used for communication. This carries both the controller telegram as well as the device telegram. This means that conventional 3-conductor physics is possible.

Three-conductor physics

IO-Link supports both communication mode as well as standard IO mode (SIO). Standard IO provides a switching signal on the communication line, as is used by normal binary switching sensors. This mode is only possible with devices using 3-conductor connection technology. SIO mode is not supported by BIS M-IO-Link devices.

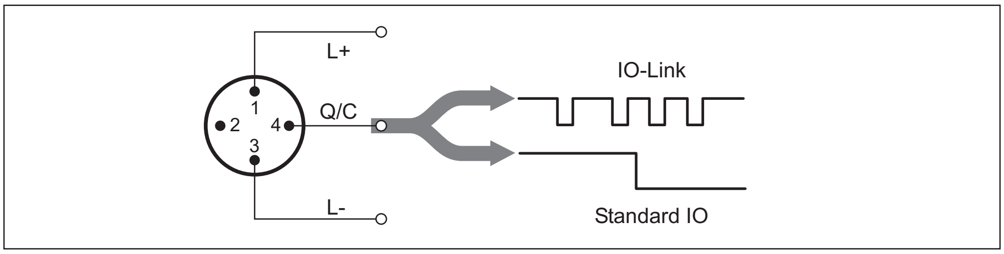


Figure 33: Three-conductor physics of the IO-Link

Communication mode

In communication mode, the BIS M IO-Link device operates with frame type 2. In this transmission type, up to 32 bytes of process data is sent in both directions per frame and 2 bytes of demand data is sent per frame. Process data is the application-specific data; demand data may contain parameters, service or diagnostic data.

6.2 Process Data Container

The IO-Link protocol provides a process data container 32 bytes in size. Addressing occurs in the command byte, which is sent by the IO-Link master. When process data is sent, addressing is directly to the subindices 00_{hex} … $1F_{hex}$.
The BIS M-4_ _-045-... processes 10 bytes of input and 10 bytes of output data (input buffer/output buffer). The process data is mapped to the first 10 bytes of the process data container (subindices 00_{hex}…09_{hex}). The BIS M-4_ _-072-... processes 32 bytes of process data (subindices 00_{hex}…$1F_{hex}$).

IO-Link protocol Subaddress
00_{hex}
⋮
09_{hex}
$0A_{hex}$
⋮
$1F_{hex}$

BIS M-4_ _ - **45**... IO-Link device Subaddress
00_{hex}
⋮
09_{hex}

BIS M-4_ _ - **72**... IO-Link device Subaddress
00_{hex}
⋮
09_{hex}
$0A_{hex}$
⋮
$1F_{hex}$

6 IO-Link basics

6.3 Identification Data and Device Information

Via the Service-PDU, information stored on the device can be read in addition to the application-specific parameters.

	SPDU		Object name	Length	Information
	Index	Subindex			
Identification data	0_{hex}	8 9	Vendor ID	2 bytes	Balluff Vendor ID = 0378_{hex}
		10 11 12	Device ID	3 bytes	Balluff Device ID = $0602xx_{hex}$
	10_{hex}	0	Vendor name	7 bytes	Balluff
	11_{hex}	0	Vendor text	15 bytes	www.balluff.com
	12_{hex}	0	Product name	23 bytes	Device designation
	13_{hex}	0	Product ID	7 bytes	Ordering code
	14_{hex}	0	Product text	27 bytes	IO-Link RFID read-write head
	16_{hex}	0	Hardware revision	5 bytes	Hardware version
	17_{hex}	0	Firmware revision	5 bytes	Firmware version

SPDU Index 0hex Sub-Index 12	**Product name**	**SPDU** Index 0hex Sub-Index 12	**Product name**
01_{hex}	BIS M-400-045-001-07-S4	10_{hex}	BIS M-405-045-001-07-S4
02_{hex}	BIS M-400-045-002-07-S4	11_{hex}	BIS M-408-045-001-07-S4
03_{hex}	BIS M-401-045-001-07-S4	12_{hex}	BIS M-458-045-001-07-S4
04_{hex}	BIS M-402-045-002-07-S4	13_{hex}	BIS M-402-045-007-07-S4
05_{hex}	BIS M-402-045-004-07-S4	14_{hex}	BIS M-406-045-001-07-S4
06_{hex}	BIS M-451-045-001-07-S4	15_{hex}	BIS M-400-045-401-07-S4
07_{hex}	BIS M-400-072-001-07-S4	16_{hex}	BIS M-404-045-401-07-S4
08_{hex}	BIS M-400-072-002-07-S4	17_{hex}	BIS M-405-045-008-07-S4
09_{hex}	BIS M-401-072-001-07-S4	19_{hex}	BIS M-402-045-003-07-S4
$0A_{he}$	BIS M-402-072-002-07-S4	$1D_{hex}$	BIS M-402-045-053-07-S4
$0B_{hex}$	BIS M-402-072-004-07-S4	$1E_{hex}$	BIS M-414-045-401-07-S4
$0C_{hex}$	BIS M-451-072-001-07-S4		

7 Configuring the Read/Write Device

7.1 Demand Data

The device-specific parameters of the identification system can be configured via the SPDU. The parameter data of the BIS M IO-Link device is described in further detail in the following.

	Access SPDU Index	Subindex	Description	Data width	Value range	Factory setting
Parameter data	40_{hex}	1_{hex}	CRC yes/no	1 byte	0 = without CRC 1 = with CRC	0
	40_{hex}	2_{hex}	Dynamic mode - yes/no	1 byte	0 = no 1 = yes	0
	40_{hex}	3_{hex}	Action if tag present	1 byte	0 = no action 1 = serial number and tag type 7 = automatically read 8 bytes of data beginning at a set start address after subindex 4 and 5	1
	40_{hex}	4_{hex}	Low byte of start address for autoread	2 bytes	Observe data-carrier specifications.	0
	40_{hex}	5_{hex}	High byte of start address for autoread			
	40_{hex}	6_{hex}	Used data-carrier type	1 byte	00_{hex}=ALL FE_{hex}=BIS M1_ _-01 FF_{hex}=BIS M1_ _-02	0

For a description of the parameters, see chapter 7.2 "Mapping of Parameter Data" on page 44.

Note
An entire index can be addressed via subindex 0. For example, with index 40_{hex}/subindex 1_{hex}, only the "CRCCheck" parameter is accessed. With index 40_{hex}/subindex 0, on the other hand, all parameters from "RCCheck" to "Used data carrier type" can be addressed. The parameters are then arranged in byte blocks.

7 Configuring the Read/Write Device

7.2 Mapping of Parameter Data

To ensure data integrity, data transfer between the data carrier and read/write device can be monitored using a CRC_16 data check.

CRC_16 Data check

With the CRC_16 data check, a checksum is written to the data carrier which enables the data to be checked for validity at any time.

Advantages of the CRC_16 data check:
- Very high data integrity, even during the non-active phase (data carrier outside the read/write head)

Restrictions of the CRC_16 data check:
- Longer write times, as the CRC must also be written.
- User data capacity is sacrificed.(see table on page 23).

> **Note**
> The CRC_16 data check can only be used in combination with data carriers that have been appropriately initialized. If a data carrier is not initialized and this parameter is nevertheless set, CRC errors occur during reading and writing (see chapter 9.5 "Error Codes" on page 58).

The data carriers can be initialized for using CRC16 with command designator 12_{hex}.
The checksum is written on the data carrier as 2 bytes (per block) of information. Thus, 2 bytes of user data is lost per block.

The following figure applies for this parameter:

Index 40_{hex}, subindex 1_{hex} - 1 byte	
00_{hex}	CRC_16 data check is not used (default setting)
01_{hex}	CRC_16 data check is used

Dynamic mode

If dynamic mode is activated, a job can be sent even if no data carrier is located in the read/write range of the read/write head, which would result in errors without dynamic mode. The job is then stored and is executed as soon as a data carrier is detected.

The following figure applies for this parameter:

Index 40_{hex}, subindex 2_{hex} - 1 byte	
00_{hex}	Dynamic mode not activated (default setting)
01_{hex}	Dynamic mode activated

7 Configuring the Read/Write Device

Action if tag present

The "Action on tag present" parameter specifies how the read/write device is to react if a new data carrier is detected in the field. The default setting is to send the UID (serial number). In addition, it is possible to set that nothing or a selected range of 8 bytes is to be sent immediately as read data. The following values are permissible:

Index 40_{hex}, subindex 3_{hex} - 1 byte	
00_{hex}	No action
01_{hex}	Send UID immediately (default setting)
07_{hex}	Immediately send 8 bytes of data beginning at a set address (parameter "Autoread start address")

Start address for autoread

This parameter is only valid if "Autoread" was selected as the action on tag present. The start address can be set via subindices 4_{hex} (low byte) and 5_{hex} (high byte). The value range is dependent on the specification of the data carrier; take this into account. An incorrect setting prevents autoread from functioning; no data is output.

Data carrier type

This parameter offers the possibility of specifying certain data carrier models that are to be detected. All models, all BIS M1_ _-01 models or all BIS M1_ _-02 models can be selected. The data carriers are detected more quickly if only those that are used are configured. The following values are permissible:

Index 40_{hex}, subindex 6_{hex} - 1 byte	
00_{hex}	All data carrier models supported by Balluff (default setting)
FE_{hex}	All data carriers of type Mifare*
FF_{hex}	All data carriers of type ISO 15693*

* Data carrier types see page 23

7.3 Saving the Parameter Data

The set parameters are stored in the EEPROM memory of the BIS M IO-Link device. On restart, the most recently used parameters are used.
If the IO-Link parameter server is activated on the IO-Link master, configuration occurs automatically when the device is exchanged.

Note
Should it be necessary to exchange a BIS M IO-Link device in the system, make certain that the correct parameter settings are programmed in the new device.

8 Commissioning

For information on commissioning, please read the instructions for your IO-Link master. BIS M IO-Link devices use a process data buffer of 10 bytes each (BIS M-4_ _-045-00_-07-S4) or 32 bytes (BIS M-4_ _-072-00_-07-S4) for both the input and for the output.

9 Device Function

9.1 Function principle

The BIS M identification system is a contactless read and write system. The read/write device consists of evaluation electronics with permanently connected read/write head.

The main components of the BIS M identification system are:
– Read/write device,
– Data carrier.

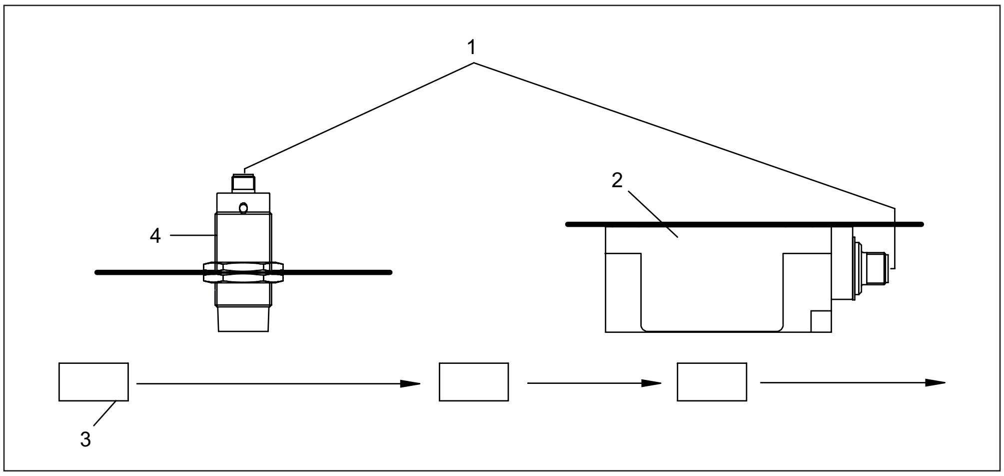


Figure 34: Schematic representation of an identification system

1	Connection to the IO-Link master	**2**	Read/write device
3	Data carrier	**4**	Read/write device

The data carrier is an autonomous unit that is supplied with power by the read/write head. The read/write head continuously sends a carrier signal that is picked up by the data carrier from within a certain distance. Once the data carrier is powered, a static read operation takes place.

The processor manages the data transfer between read/write head and data carrier, serves as a buffer storage device, and sends the data to the controller.
The data is passed to the IO-Link master using IO-Link protocol, and the master then passes it to the host system.

Host systems may be the following:
– A control computer (e.g. industrial PC)
– A PLC

The BIS M-4_ _-045-… supports cyclical data exchange via IO-Link protocol.
During cyclical data exchange, the BIS M-4_ _-045-… cyclically exchanges read data with the controller. It is also possible to read or enter parameter data.

9 Device Function

9.2 Process data

Data exchange occurs via the process data, which, depending on the control system that is used, is mapped in the input and output buffer or in a memory field. The BIS M-4_ _-045-… uses 10 bytes of input data and 10 bytes of output data, the BIS M-4_ _-072-… uses 32 bytes for each. The assignments are described in the following. Subaddress 00_{hex} corresponds to the respective start address in the corresponding data field.

Output/input buffer

The BIS M-4_ _ provides two fields for sending commands and data between the BIS M-4_ _ read/write device and the host system:
– Output buffer
– Input buffer

These fields are embedded in process data transmission via the IO-Link master. As already described, 10 or 32 bytes of process data are sent in each direction.
The mapping of this process data is described in the following:

Output buffer:

Subaddress \ Bit No.	7	6	5	4	3	2	1	0
00_{hex} - 1st bit string		TI	KA			GR		AV
01_{hex}	Command designator or data							
02_{hex}	Start address (low byte) or data							
03_{hex}	Start address (high byte) or data							
04_{hex}	Number of bytes (low byte) or data							
05_{hex}	Number of bytes (high byte) or data							
06_{hex}	Data							
07_{hex}	Data							
08_{hex}	Data							
Last byte - 2nd bit string		TI	KA			GR		AV

Explanations on the output buffer using 10 bytes as an example:

Subaddress	Bit name	Meaning	Function description
00_{hex}	1st bit string		
	TI	Toggle bit	A state change during a job indicates that the controller is ready to receive additional data made available by the read/write device.
	KA	Head on/off	1 = Head off (read/write head switched off)
			0 = Head on (read/write head in operation)
	GR	Basic state	1 = Software reset - causes the BIS to switch to the ground state
			0 = Normal operation
	AV	Job	1 = New job pending
			0 = No new job or job no longer pending

01_{hex}		Command designator	00_{hex} = No command
			01_{hex} = Read data carrier
			02_{hex} = Write data carrier
			12_{hex} = Initialize the CRC_16 data check on the data carrier
			32_{hex} = Write a constant value on the data carrier

9 Device Function

Subaddress	Bit name	Meaning	Function description
		or data	Data that is to be written on the data carrier
02_{hex}		Start address Low byte	Low byte of the start address on the data carrier for the current job
		or data	Data that is to be written on the data carrier
03_{hex}		Start address High byte	High byte of the start address on the data carrier for the current job
		or data	Data that is to be written on the data carrier
04_{hex}		No. of bytes Low byte	Low byte of the data length for the current job
		or data	Data that is to be written on the data carrier
05_{hex}		No. of bytes High byte	High byte of the data length for the current job
		or data	Data that is to be written on the data carrier
06_{hex}		Data	Data that is to be written on the data carrier
07_{hex}		Data	Data that is to be written on the data carrier
08_{hex}		Data	Data that is to be written on the data carrier
09_{hex}	2nd bit string		
	TI, KA, GR, AV		If 1st and 2nd bit strings agree, valid commands or data are present.

Note
When specifiying the starting address and the number of bytes, observe the specifi-cations for the data carrier used and the maximum job size!

Maximum job size:
BIS M-4_ _-0_ _-001-… read/write device: 256 bytes
BIS M-4_ _-0_ _-401-… read/write device: 65536 bytes

9 Device Function

Input buffer:

Subaddress \ Bit No.	7	6	5	4	3	2	1	0
00_{hex} - 1st bit string	BB	HF	TO		AF	AE	AA	CP
01_{hex}	Error code or data or high-byte version							
02_{hex}	Data or low-byte version							
03_{hex}	Data							
04_{hex}	Data							
05_{hex}	Data							
06_{hex}	Data							
07_{hex}	Data							
08_{hex}	Data							
Last byte - 2nd bit string	BB	HF	TO		AF	AE	AA	CP

Explanations on the input buffer using 10 bytes as an example:

Subaddress	Bit name	Meaning	Function description
00_{hex}	1st bit string		
	BB	Power	1 = Device is ready
			0 = Device is in ground state
	HF	Head Failure	1 = Head is turned off
			0 = Head is turned on
	TO	Toggle bit	A state change during a job indicates that the read/write device is ready to transfer other data
	AF	Job error	1 = Job incorrectly processed
			0 = Job processed without errors
	AE	Job end	1 = Job processed without errors
			0 = No job or job running
	AA	Job accepted	1 = The job was detected and accepted. Is being processed.
			0 = No job active
	CP	Codetag Present	Data carrier is in the read range of the read/write head
			No data carrier in read range

9 Device Function

Subaddress	Bit name	Meaning	Function description
01_{hex}		Error code	Error number is entered if the job was incorrectly processed or canceled. Only valid with AF bit!
			00_{hex} = No error
			01_{hex} = No data carrier in read/write range
			02_{hex} = Error during reading
			03_{hex} = Data carrier was removed from the read range of the head during reading
			04_{hex} = Error during writing
			05_{hex} = Data carrier was removed from the write range of the read/write head during writing.
			07_{hex} = AV-bit is set but command designator is invalid or missing. Or: number of bytes is 00_{hex}.
			$0E_{hex}$ = *The CRC on the data carrier does not agree with the calculated CRC for the read data.*
			$0F_{hex}$ = 1st and 2nd bit string of the output buffer do not agree.
			20_{hex} = Addressing of the job lies outside of the memory range of the data carrier
			21_{hex} = Calls up a function that is not possible with the current data carrier.
		or data	Data which was read from the data carrier
		or SW version	High byte of the software version
02_{hex}		Data	Data which was read from the data carrier
		or SW version	Low byte of the software version
03_{hex}		Data	Data which was read from the data carrier
⋮		⋮	⋮
08_{hex}		Data	Data which was read from the data carrier
09_{hex}	2nd bit string		
	BB, HF, TO, AF, AE, AA, CP		Valid data is present if the 1st and 2nd bit strings match

Note
The 1st and 2nd headers must be compared by the user (host system) in order to query the validity of the sent data.

9 Device Function

9.3 Protocol sequence

When communication is initiated by the IO-Link master, transmission of the current process data begins.

As long as no data carrier was detected after start-up of the device, the firmware version of the device is displayed in the first two user bytes (see chapter 9.4 "Protocol examples" on page 53).
If a data carrier is detected, the configured "Reaction to Tag Present" is executed. If, for example, display serial number is set here, the serial number of the currently detected data carrier is displayed in index 01_{hex}...08_{hex}.

The bit strings of the output buffer can be used to control the device. For example, a device restart can be triggered by setting the GR bit or a new job can be passed by setting the AV bit. Furthermore, the write data can be passed to the device here.

The state of the device is displayed in the input buffer. Here, for example, the AF bit indicates an error in the current job and the HF bit indicates that the head is currently switched off. In addition, the input buffer is used to pass read data and status codes. If no data carrier is present, the most recent data is displayed in the input buffer. The deleted CP bit indicates that no data carrier is in the field.

By means of this method, all functions of the read/write device can be used. This includes
– reading,
– writing,
– dynamic reading,
– dynamic writing,
– writing a constant value,
– initializing CRC16 on the data carrier.

Note
Note that a job is restricted to its maximum scope.

Maximum job quantity:
BIS M-4_ _-0_ _-001-… read/write device: 256 bytes
BIS M-4_ _-0_ _-401-… read/write device: 65536 bytes

If the volume of data to be processed exceeds the maximum job quantity, multiple individual jobs must be started

Functions can only be executed if a data carrier is in the read/write range. If a command is to be sent that is not to be executed until the next tag is encountered, the device must be configured for dynamic mode (see chapter „7 Configuring the Read/Write Device“ auf Seite 43).

9 Device Function

9.4 Protocol examples

The following examples show the protocol sequence in various situations.

Example 1.

(for 10 bytes of process data)

Start the device, still no data in the output buffer:

Command from controller / **BIS M-4_ _-045-... reaction**

1. Process output buffer:

00_{hex}	GR, KA, AV = 0
09_{hex}	GR, KA, AV = 0

2. Process input buffer:

00_{hex}	Set BB	
01_{hex}	e.g. 10_{hex}	= V 1.00
02_{hex}	e.g. 10_{hex}	
09_{hex}	Set BB	

Example 2.

(for 10 byte of process data)

Reaction to Tag Present = no and new data carrier in the read range:

Command from controller / **BIS M-4_ _-045-... reaction**

1. Process output buffer:

00_{hex}	GR, KA, AV = 0
09_{hex}	GR, KA, AV = 0

2. Process input buffer:

00_{hex}	Set CP
09_{hex}	Set CP

Example 3.

(for 10 bytes of process data)

Reaction to Tag Present = serial number and new data carrier in the read range:

Command from controller / **BIS M-4_ _-045-... reaction**

1. Process output buffer:

00_{hex}	GR, KA, AV = 0
09_{hex}	GR, KA, AV = 0

2. Process input buffer:

00_{hex}	Set CP
01 ... 08_{hex}	UID
09_{hex}	Set CP

Example 4.

(for 10 bytes of process data)

Reaction to Tag Present = read (start address 5) and data carrier in the read range:

Command from controller / **BIS M-4_ _-045-... reaction**

1. Process output buffer:

00_{hex}	GR, KA, AV = 0
09_{hex}	GR, KA, AV = 0

2. Process input buffer:

00_{hex}	Set CP
01_{hex}	Address 5 read data
...	Address 12 read data
01 ... 08_{hex}	UID
09_{hex}	Set CP

9 Device Function

Example 5.

(for 10 bytes of process data)

Data carrier no longer in detection range of the read/write head:

Command from controller

1. Process output buffer:

00_{hex}	GR, KA, AV = 0
09_{hex}	GR, KA, AV = 0

BIS M-4_ _-045-... reaction

2. Process input buffer:

00_{hex}	Delete CP
09_{hex}	Delete CP

Example 6.

(for 10 bytes of process data)

Initialization of the CRC_16 data check on the data carrier (256 bytes beginning with address 0):

Command from controller

1. Process subaddresses in the order shown:

01_{hex}	Command designator 12_{hex}
02_{hex}	Start address 00_{hex}
03_{hex}	Start address 00_{hex}
04_{hex}	No. of bytes 00_{hex}
05_{hex}	No. of bytes 01_{hex}
$00_{hex}/09_{hex}$	Set AV

BIS M-4_ _-045-... reaction

2. Process input buffer:

$00_{hex}/09_{hex}$	Set AA

3. Process subaddresses:

01_{hex}... 08_{hex}	Enter the first 8 bytes of data
00_{hex}... 07_{hex}	Invert TI

4. Copy received data, process subaddresses of the input buffer:

$00_{hex}/09_{hex}$	Invert TO

5. Process subaddresses:

01_{hex}... 08_{hex}	Enter the second 8 bytes of data
00_{hex}... 09_{hex}	Invert TI

6. Copy received data, process subaddresses of the input buffer:

$00_{hex}/09_{hex}$	Invert TO

65. Process subaddresses:

01_{hex}... 08_{hex}	Enter the last 8 bytes of data
00_{hex}... 09_{hex}	Invert TI

66. Copy received data, process subaddresses of the input buffer:

$00_{hex}/09_{hex}$	Set AE

67. Process subaddresses:

$00_{hex}/09_{hex}$	Delete AV

68. Process subaddresses:

$00_{hex}/09_{hex}$	Delete AA and AE

Note
Repeat the process with the new addresses until the entire memory range of the data carrier is initialized.

Example 7.

(for 10 bytes of process data)

Read 17 bytes starting at data carrier address 10:

Command from controller

1. Process subaddresses in the order shown:

01_{hex}	Command designator 01_{hex}
02_{hex}	Start address $0A_{hex}$
03_{hex}	Start address 00_{hex}
04_{hex}	No. of bytes 11_{hex}
05_{hex}	No. of bytes 00_{hex}
$00_{hex}/09_{hex}$	Set AV

BIS M-4_ _-045-... reaction

2. Process input buffer:

$00_{hex}/09_{hex}$	Set AA and AE
$01_{hex...}\ 08_{hex}$	Enter the first 8 bytes of data

3. Wait here, until AA and AE are set. Copy received data, process subaddresses of the input buffer:

$00_{hex...}\ 09_{hex}$	Invert TI

4. Process subaddresses of the input buffer:

$01_{hex...}\ 08_{hex}$	Enter second 8 bytes of data
$00_{hex}/09_{hex}$	Invert TO

5. Copy received data, process subaddresses of the input buffer:

$00_{hex...}\ 09_{hex}$	Invert TI

6. Process subaddresses of the input buffer:

01_{hex}	Enter last byte of data
$02_{hex...}\ 08_{hex}$	0x00 (empty)
$00_{hex}/09_{hex}$	Invert TO

7. Copy received bytes, process subaddresses of the input buffer:

$00_{hex...}\ 09_{hex}$	Delete AV

8. Process subaddresses of the input buffer:

$00_{hex}/09_{hex}$	Delete AF and AA

Example 8.

(for 10 bytes of process data)

Read 30 bytes starting at address 10 with read error:

Command from controller

1. Process subaddresses in the order shown:

01_{hex}	Command designator 01_{hex}
02_{hex}	Start address $0A_{hex}$
03_{hex}	Start address 00_{hex}
04_{hex}	No. of bytes $1E_{hex}$
05_{hex}	No. of bytes 00_{hex}
$00_{hex}/09_{hex}$	Set AV

BIS M-4_ _-045-... reaction

2. Process input buffer:

Error occurred immediately	
$00_{hex}/09_{hex}$	Set AA
01_{hex}	Enter error number
$00_{hex}/09_{hex}$	Set AF

3. Evaluate error number and process subaddresses of the output buffer:

$00_{hex...}\ 09_{hex}$	Delete AV

4. Process subaddresses of the input buffer:

$00_{hex}/09_{hex}$	Delete AF and AA

9 Device Function

Example 9. **Write 18 bytes starting at data carrier address 20**

(for 10 bytes of process data)

Command from controller

1. Process subaddresses in the order shown:

01_{hex}	Command designator 02_{hex}
02_{hex}	Start address 14_{hex}
03_{hex}	Start address 00_{hex}
04_{hex}	No. of bytes 12_{hex}
05_{hex}	No. of bytes 00_{hex}
$00_{hex}/09_{hex}$	Set AV

BIS M-4_ _-045-... reaction

2. Process input buffer:

$00_{hex}/09_{hex}$	Set AA

3. Process subaddresses:

01_{hex}... 08_{hex}	Enter the first 8 bytes of data
00_{hex}... 07_{hex}	Invert TI

4. Copy received data, process subaddresses of the input buffer:

$00_{hex}/09_{hex}$	Invert TO

5. Process subaddresses:

01_{hex}... 08_{hex}	Enter the second 8 bytes of data
00_{hex}... 09_{hex}	Invert TI

6. Copy received data, process subaddresses of the input buffer:

$00_{hex}/09_{hex}$	Invert TO

7. Process subaddresses:

01_{hex}... 02_{hex}	Enter the remaining 2 bytes of data
00_{hex}... 09_{hex}	Invert TI

8. Copy received data, process subaddresses of the input buffer:

$00_{hex}/09_{hex}$	Set AE

9. Process subaddresses:

$00_{hex}/09_{hex}$	Delete AV

10. Process subaddresses:

$00_{hex}/09_{hex}$	Delete AA and AE

9 Device Function

Example 10. (for 10 bytes of process data)

Write constant data. 20 bytes, value 5A$_{hex}$, starting at address 0:

Command from controller

1. Process subaddresses in the order shown:

01$_{hex}$	Command designator 32$_{hex}$
02$_{hex}$	Start address 00$_{hex}$
03$_{hex}$	Start address 00$_{hex}$
04$_{hex}$	No. of bytes 14$_{hex}$
05$_{hex}$	No. of bytes 00$_{hex}$
06$_{hex}$	Value 5A$_{hex}$
00$_{hex}$/09$_{hex}$	Set AV

BIS M-4_ _-045-... reaction

2. Process input buffer:

00$_{hex}$/09$_{hex}$	Set AA

3. Data is written

00$_{hex}$/09$_{hex}$	Set AE

4. Process subaddresses:

00$_{hex}$/09$_{hex}$	Delete AV

5. Process subaddresses:

00$_{hex}$/09$_{hex}$	Delete AA and AE

Example 11. (for 10 bytes of process data)

Move read/write device to ground state:

Command from controller

1. Process subaddresses:

00$_{hex}$/09$_{hex}$	Set GR

BIS M-4_ _-045-... reaction

2. Process input buffer:

01...08$_{hex}$	00$_{hex}$ (empty)
00$_{hex}$/09$_{hex}$	Delete BB

3. Process subaddresses:

00$_{hex}$/09$_{hex}$	Delete GR

4. Process input buffer:

00$_{hex}$/09$_{hex}$	Set BB

Example 12. (for 10 bytes of process data)

Perform head shutdown:

Command from controller

1. Process subaddresses:

00$_{hex}$/09$_{hex}$	Set KA

→ New data carriers are not detected, antenna is shut down.

BIS M-4_ _-045-... reaction

2. Process input buffer:

00$_{hex}$/09$_{hex}$	Set HF, delete CP

3. Process subaddresses:

00$_{hex}$/09$_{hex}$	Delete KA

→ New data carriers are now detected again.

4. Process input buffer:

00$_{hex}$/09$_{hex}$	Set HF

9 Device Function

9.5 Error Codes

Error code	Meaning	Remedy
01_{hex}	No data carrier in read/write range	Data carriers must already be in the read/write range when a command is sent; otherwise dynamic mode must be configured.
02_{hex}	Read error	Repeat job.
03_{hex}	Data carrier was removed from the read range of the head during reading.	
04_{hex}	Write error	Repeat job.
05_{hex}	Data carrier was removed from the write range of the read/write head during writing.	
07_{hex}	AV is set, but the command designator is invalid or missing. Or: number of bytes is 00_{hex}.	Please check and correct.
$0E_{hex}$	CRC error	Data carrier was not successfully read. Possible causes: – Data carrier defective – Transmission failed – Data carrier not CRC capable
$0F_{hex}$	Bit string error	The two headers in the output buffer and in the host system do not agree. The bit strings must be matched (see "Output buffer," page 48).
20_{hex}	Addressing of the job lies outside of the memory range of the data carrier.	Please correct addressing, taking into account the used data carrier.
21_{hex}	Calls up a function that is not possible with the current data carrier.	Observe permissible commands for the current data carrier.

Note
If an error occurs, a new command cannot be executed until the AV has first been deleted, i.e. the faulty job has been completed in full.

9 Device Function

9.6 Data Transmission Timing

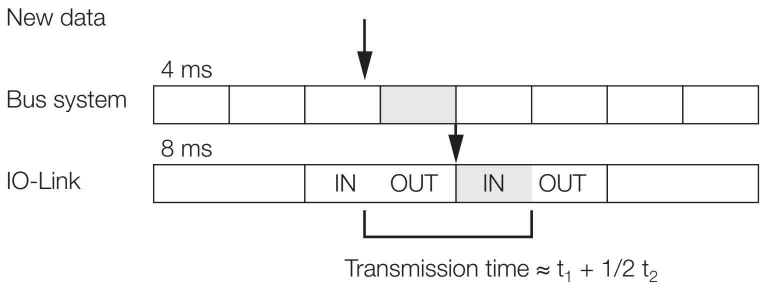
The sequence of the IO-Link communication is shown in the following diagram. Exchange alternates between the input buffer and the output buffer. As soon as current data is pending in one of the buffers, it is exchanged on the next input or output data cycle. The problem arises here that the transmission times can vary greatly. If data is updated shortly before the start of the respective exchange cycle, the transfer lasts just over 1 x cycle time. If, however, data is updated shortly after the start of an exchange cycle, it lasts a maximum of 2 x cycle time.

The processing sequence of a command is shown on the next page using a read job of 9…16 bytes (2 x input buffer for read data) as an example.

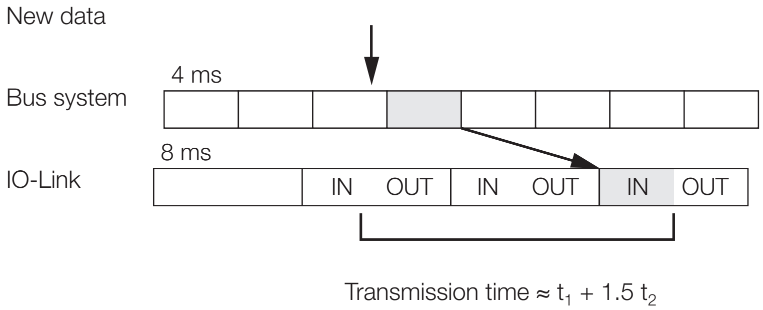
Temporal relationship between primary bus system, IO-Link transmission and transmission time

Assumption:
- Cycle time of bus system 4 ms (t1)
- Cycle time of IO-Link 8 ms (t2)
- Data transmission from the controller to the IO-Link device

Best case:



Worst case:



There is an offset between the bus system and IO-Link because the bus system and IO-Link operate independent of one another (not synchronous).

9 Device Function

Process data cycle:
A process data cycle consists of the complete sending of the input and output data. 10 or 32 bytes of input and output data plus 2 bytes of command data are transmitted.

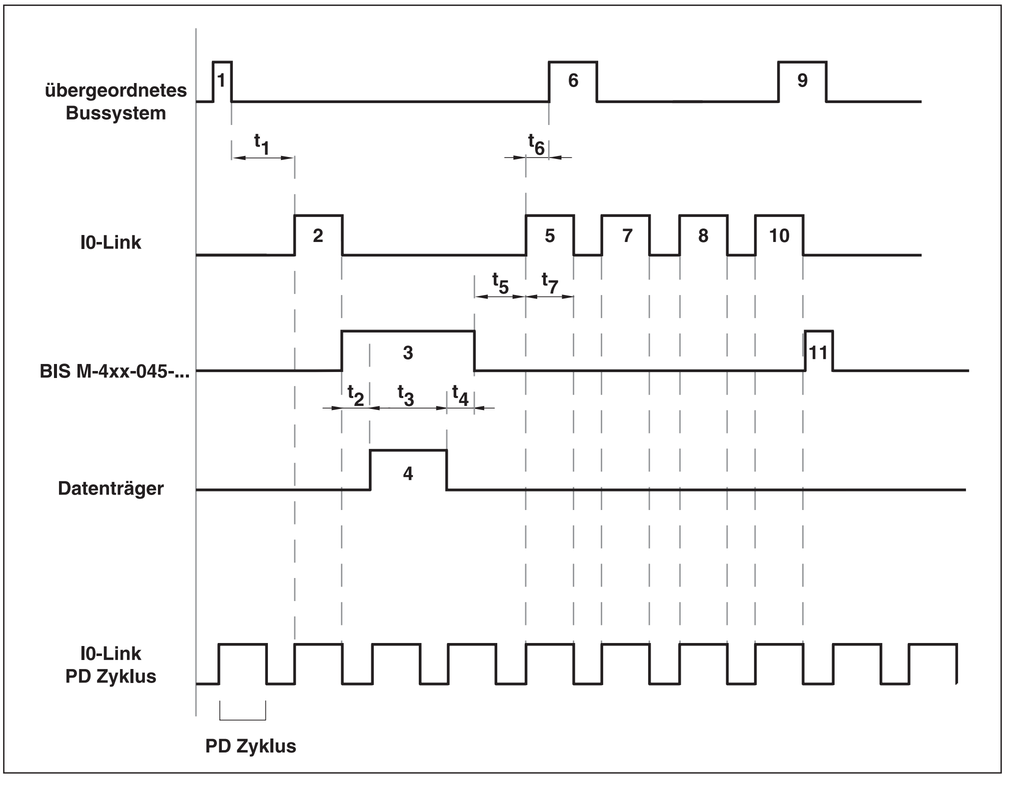


Figure 35: IO-Link transmission sequence

1 The command is passed on to the IO-Link master by the controller via a bus system.
2 After the synchronization time **t1**, the command is passed on to the BIS M-400-… via IO-Link. The duration is dependent on the bus system, the master, the cycle time and the current state of the IO-Link communication (see problem described above).
3 The processing time begins with the arrival of the command at the M-400-… This is composed of the time for the command processing **t2**, the time for the actual read operation **t3** and the evaluation time for the read data **t4**. A flat value of max. 3 ms can be estimated for **t2** and **t4**. The pure read time is calculated as described (see chapter 5.18 "Dynamic mode" on page 39). Please note: If the data carrier that is to be read was already detected by the device, the time for data carrier detection is eliminated.
4 The time for pure data carrier processing is shown here.
5 Following another synchronization time **t5**, the first data is passed on to the IO-Link master with the next input data cycle. In addition, the AE bit is set in the bit string. The time for this is **t7** = 1 x cycle time.
6 The data is only passed on to the controller via the host bus system. The latency period **t6** is dependent on the bus system and the IO-Link master.
7 After the first data arrives at the controller, the toggle bit in the output buffer must be inverted (see chapter 9 "Output/input buffer" on page 48). In the example, it is assumed that this occurs immediately and that the transfer to the IO-Link master happens fast enough that the BIS M-400-… receives the new data on the next output data cycle.
8 Now, the device places the next and, thus, the last bytes of the read data in the input buffer and inverts the toggle bit.
9 The controller retrieves the data and deletes the AV bit.
10 The re-updated output buffer is sent to the BIS M-400-…
11 The device ends the read command and deletes the bits in the bit string in the input buffer that belong to the job.

9 Device Function

Note
The sequence for a write command occurs analogously. Here, the data is transfered via IO-Link and the actual writing on the data carrier is interchanged.

A maximum command processing time can be approximated as follows:

$T_{tot} = 1.5 \times t_{cyc} + t_{read/write} + 5\,ms + 1.5 \times t_{cyc} + n \times t_{cyc}$

$t_{Read/write}$: Calculated time (see 2)

t_{cyc}: Master Cycle Time, in ideal case Min Cycle Time of the device
- M-4_ _-045...: 8.8 ms
- M-4_ _-072...: 24 ms

n: Number of bytes / 8 (rounded up)

Note
The actual required time may be considerably less than the maximum processing duration.

Note
Prerequisite for calculating the maximum command processing time is that no delays occur in the host bus system and in the controller.

Appendix

Type code

BIS M-4_ _-0_ _-_ _ _-07-S4

Balluff Identification System

Model
M = Read and write system, 13.56 MHz

Hardware type
4_ _= Read/write device

Software type
045 = Software number, IO-Link, 10 bytes of process data
072 = Software number, IO-Link, 32 bytes of process data

Compatible data carriers
001/002/004: Mifare ISO/IEC 14443 and 15693
005/007/008/053: Mifare ISO/IEC 14443 and 15693 application-specific antenna geometry
401: ISO/IEC 15693 and Balluff data carriers up to 128 kByte (BIS M-1_ _-11/13/14/15)

Interface
07 = IO-Link

Module
S4 = M12 4-pin male

Accessories (optional, not included in the scope of delivery)

Accessories for the BIS M-4_ _-... can be found in the Balluff IO-Link catalog.

The catalog can be downloaded on the Internet at "www.balluff.de".

Appendix

ASCII Table

Decimal	Hex	Control code	ASCII
0	00	Ctrl @	NUL
1	01	Ctrl A	SOH
2	02	Ctrl B	STX
3	03	Ctrl C	ETX
4	04	Ctrl D	EOT
5	05	Ctrl E	ENQ
6	06	Ctrl F	ACK
7	07	Ctrl G	BEL
8	08	Ctrl H	BS
9	09	Ctrl I	HT
10	0 A	Ctrl J	LF
11	0B	Ctrl K	VT
12	0C	Ctrl L	FF
13	0D	Ctrl M	CR
14	0E	Ctrl N	SO
15	0F	Ctrl O	SI
16	10	Ctrl P	DLE
17	11	Ctrl Q	DC1
18	12	Ctrl R	DC2
19	13	Ctrl S	DC3
20	14	Ctrl T	DC4
21	15	Ctrl U	NAK
22	16	Ctrl V	SYN
23	17	Ctrl W	ETB
24	18	Ctrl X	CAN
25	19	Ctrl Y	EM
26	1 A	Ctrl Z	SUB
27	1B	Ctrl [	ESC
28	1C	Ctrl \	FS
29	1D	Ctrl]	GS
30	1E	Ctrl ^	RS
31	1F	Ctrl _	US
32	20		SP
33	21		!
34	22		"
35	23		#
36	24		$
37	25		%
38	26		&
39	27		‘
40	28		(
41	29		)
42	2 A		*

Decimal	Hex	ASCII
43	2B	+
44	2C	,
45	2D	-
46	2E	.
47	2F	/
48	30	0
49	31	1
50	32	2
51	33	3
52	34	4
53	35	5
54	36	6
55	37	7
56	38	8
57	39	9
58	3 A	:
59	3B	;
60	3C	<
61	3D	=
62	3E	>
63	3F	?
64	40	@
65	41	A
66	42	B
67	43	C
68	44	D
69	45	E
70	46	F
71	47	G
72	48	H
73	49	I
74	4 A	J
75	4B	K
76	4C	L
77	4D	M
78	4E	N
79	4F	O
80	50	P
81	51	Q
82	52	R
83	53	S
84	54	T
85	55	U

Decimal	Hex	ASCII
86	56	V
87	57	W
88	58	X
89	59	Y
90	5 A	Z
91	5B	[
92	5C	\
93	5D	[
94	5E	^
95	5F	_
96	60	`
97	61	a
98	62	B
99	63	c
100	64	d
101	65	e
102	66	f
103	67	g
104	68	h
105	69	i
106	6 A	j
107	6B	k
108	6C	L
109	6D	m
110	6E	n
111	6F	o
112	70	p
113	71	q
114	72	r
115	73	s
116	74	t
117	75	u
118	76	V
119	77	W
120	78	X
121	79	y
122	7 A	Z
123	7B	{
124	7C	|
125	7D	}
126	7E	~
127	7F	DEL

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