BALLUFF

sensors worldwide

BIS M-4xx-045-00x-07-S4

Technical Description, User's Guide

English

www.balluff.com

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 instruction, refer to Chapter "Safety" on page 7.

UL listing
Control No. 3TLJ
File No. E227256

1.2 Scope of delivery

Included in the scope of delivery:
– BIS M-4xx IO-Link device
– BIS software CD
– Condensed manual in printed form (DE, EN)

1.3 About this manual

This manual describes the read/write device of the BIS M-4xx-IO-Link Identification System and includes startup instructions for immediate operation.
This manual does not describe:
– The start-up, 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.

1 User instructions

- ▶ 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. 00hex).

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

Directory paths:
References to paths in which data are stored or are 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 16).

1.6 Symbols

⚠ **Attention!**
This symbol indicates a safety instruction that absolutely must be followed.

ℹ **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-4xx-... series.

2.2 General safety notes

Installation and startup
Installation and startup are only to be performed by trained specialists. 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 Chapter 5 "Technical data" beginning on page 16).

⚠ **Attention!**
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 from unauthorized use.

2.3 Meaning of the warnings

⚠ **Attention!**
The pictogram used with the word "Attention" warns of a possible hazardous situation affecting the health of persons or equipment damage. 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

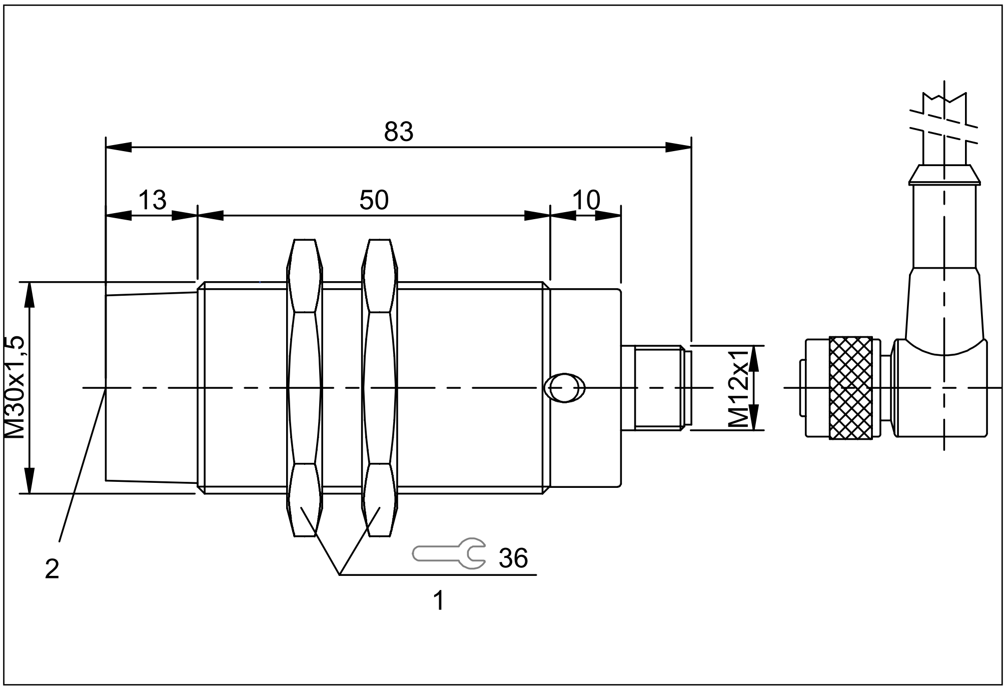


Fig.1: BIS M-400-045-001-07-S4 read/write device, values in mm

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

BIS M-400-...-002

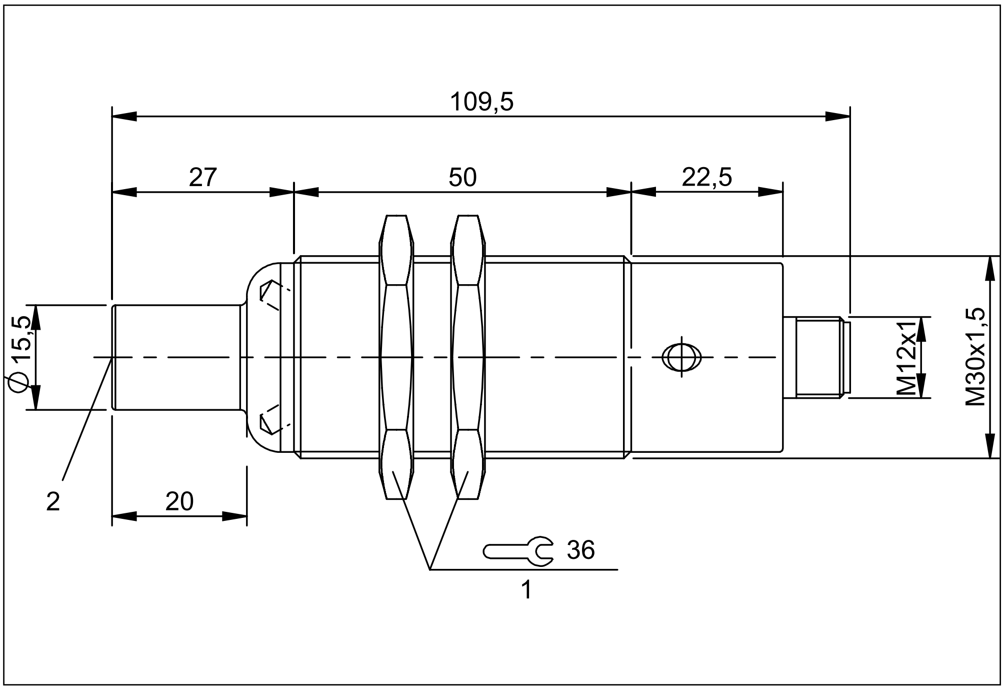


Fig.2: BIS M-400-045-002-07-S4 read/write device, values in mm

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

3 Getting started

BIS M-401-...-001

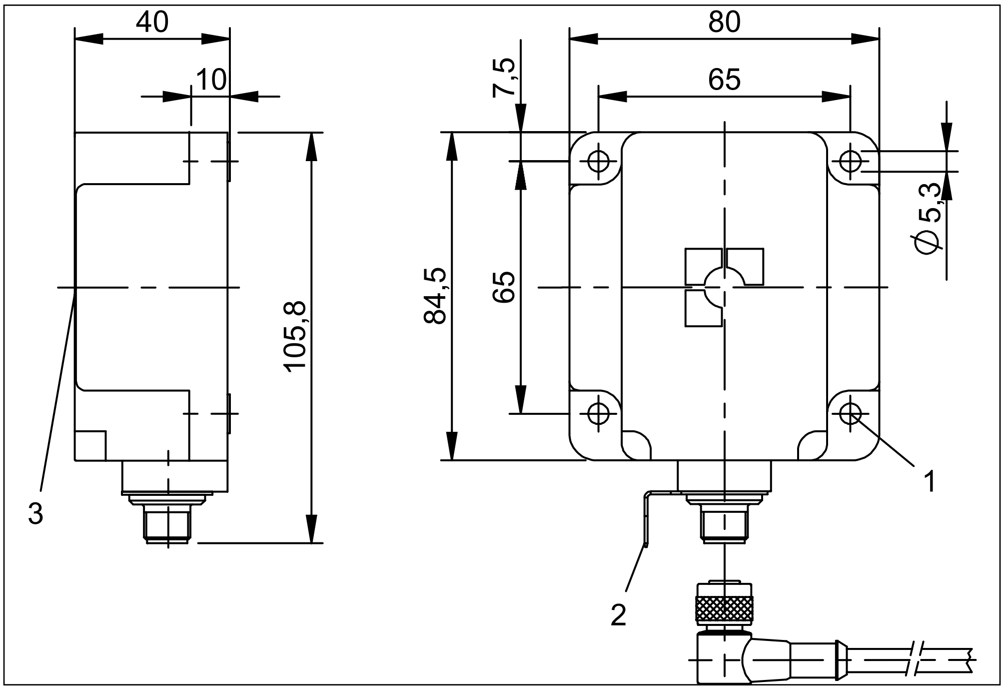


Fig.3: BIS M-401-045-001-07-S4 read/write device, values in mm

- **1** Maximum tightening torque 3 Nm
- **2** Earthing connector
- **3** Sensing surface

BIS M-402-...-002

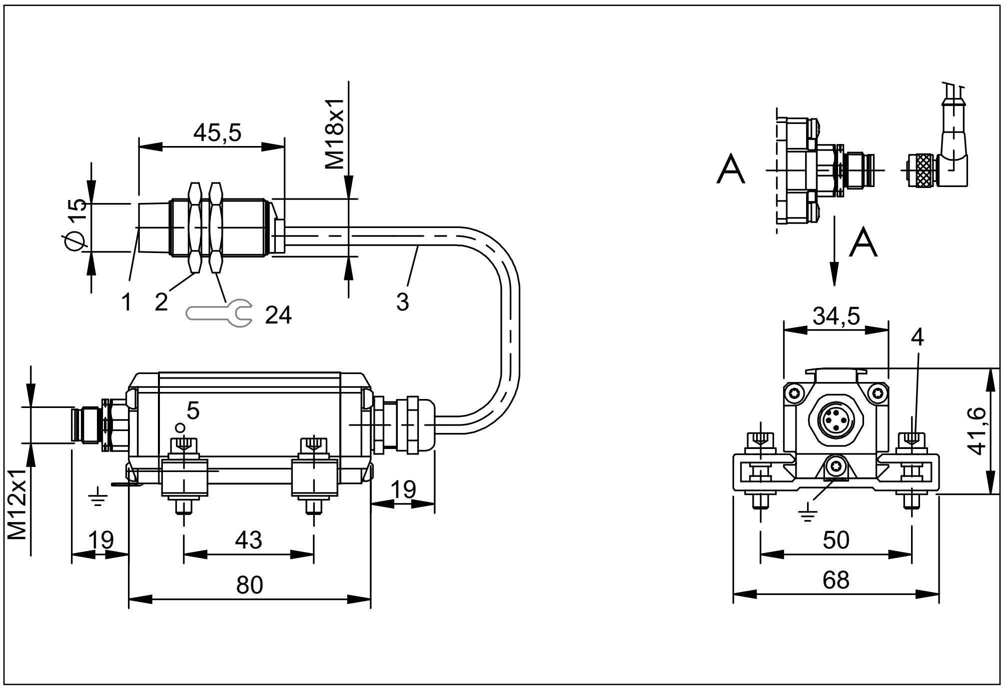


Fig.4: BIS M-402-045-002-07-S4 read/write device, values in mm

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

3 Getting started

BIS M-402-...-004

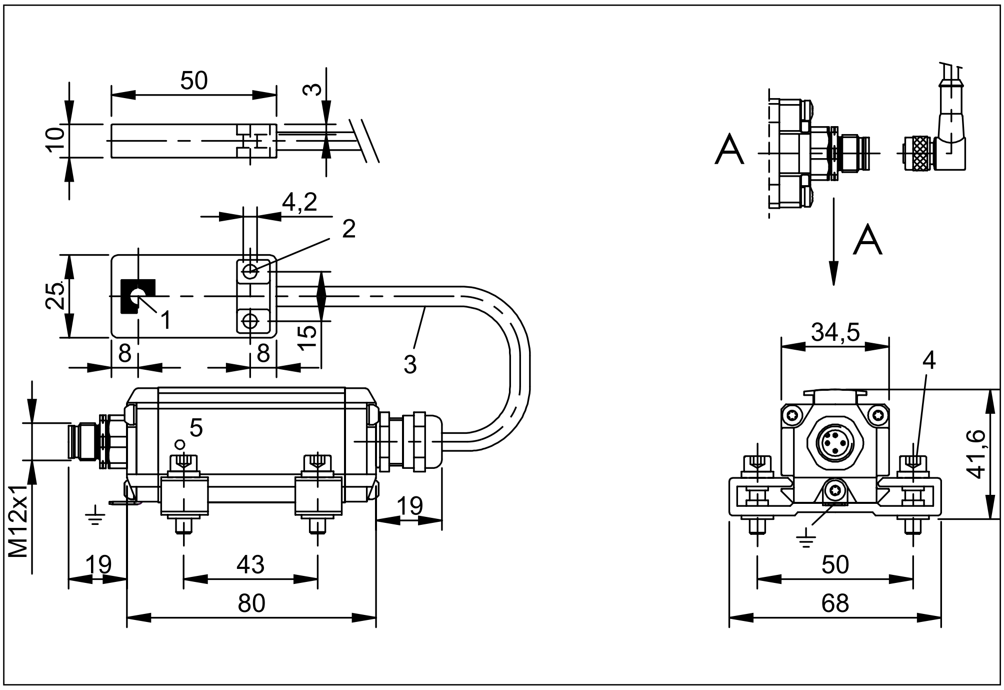


Fig.5: BIS M-402-045-004-07-S4 read/write device, values in mm

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

BIS M-451-...-001

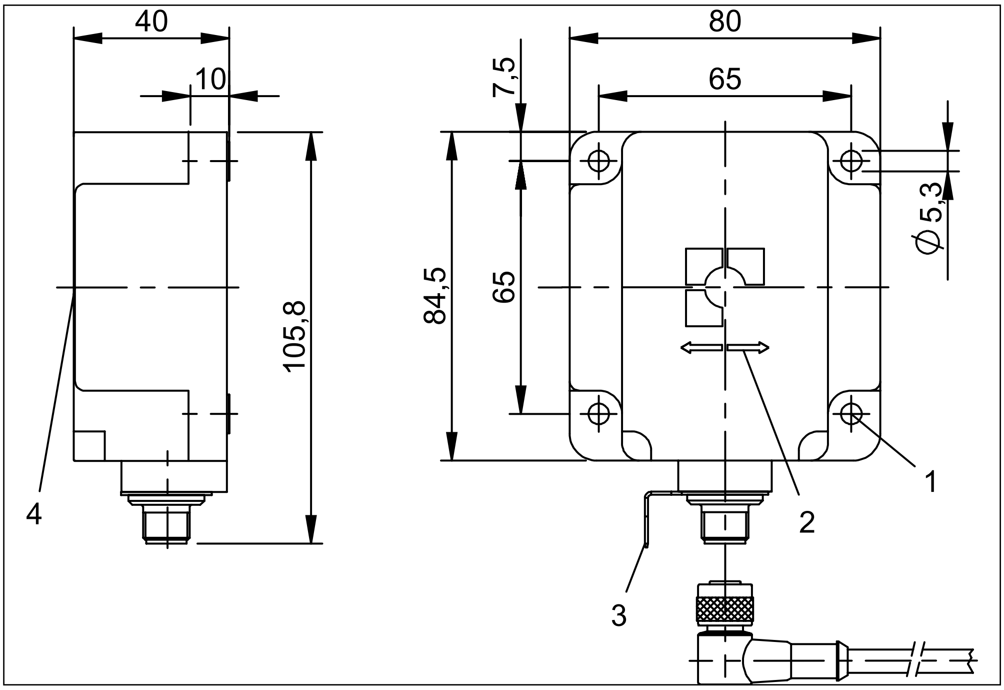


Fig.6: BIS M-451-045-001-07-S4 read/write device, values in mm

1 Maximum tightening torque 3 Nm
2 Read/write axis
3 Earthing connector
4 Sensing surface

3 Getting started

Distance between the data carriers

Data carrier	Distance				
	BIS M-101-... BIS M-106-... BIS M-107-... BIS M-108-... BIS M-110-... BIS M-111-... BIS M-115-...	BIS M-102-... BIS M-112-...	BIS M-105-... BIS M-122-...	BIS M-120-...	BIS M-150-... BIS M-151-...
BIS M-400-045-...	> 10 cm	> 15 cm	> 10 cm	–	–
BIS M-401-045-...	> 20 cm	> 20 cm	–	> 25 cm	–
BIS M-402-045-...	> 10 cm	–	> 10 cm	–	–
BIS M-451-045-...	–	–	–	–	> 25 cm

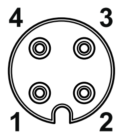
Distance between the read/write devices

Read/write device	Minimum distance
BIS M-400-045-0xx-...	20 cm
BIS M-401-045-001-...	60 cm
BIS M-402-045-001-...	20 cm
BIS M-451-045-001-...	60 cm

Note
When installing two BIS M-4xx-...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.

3.2 Electrical connection

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



PIN	Function
1	+24 V
2	NC
3	GND
4	C/Q

► Connect data line to IO-Link Master.
(See Balluff IO-Link catalog for connection cable and accessories)
Shielded cables are recommended in electromagnetically distorted environments.

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-4xx-045 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 primary components of the BIS M-4xx-045 Identification System are:
– Read/write device,
– Data carrier.

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

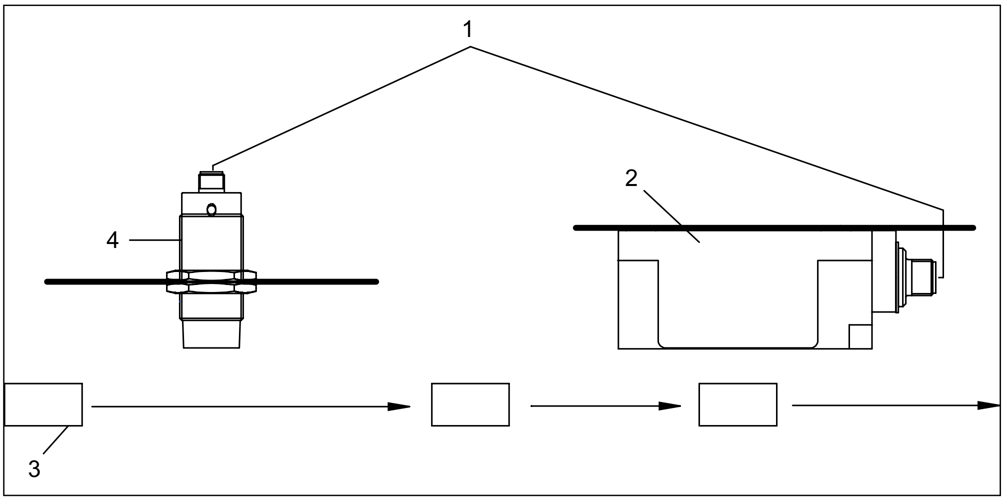


Fig.7: Schematic representation of an Identification System

1	Connection to the IO-Link Master	**2**	Read/write device
3	Data carriers	**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),
– as PLC.

The main areas of application are:
– in production for controlling material flow (e.g. in model-specific processes, in workpiece transport with conveying systems, for acquiring safety-relevant data),
– in warehousing for monitoring material movements,
– transportation, and
– conveying technology.

4 Basic knowledge

4.2 Example

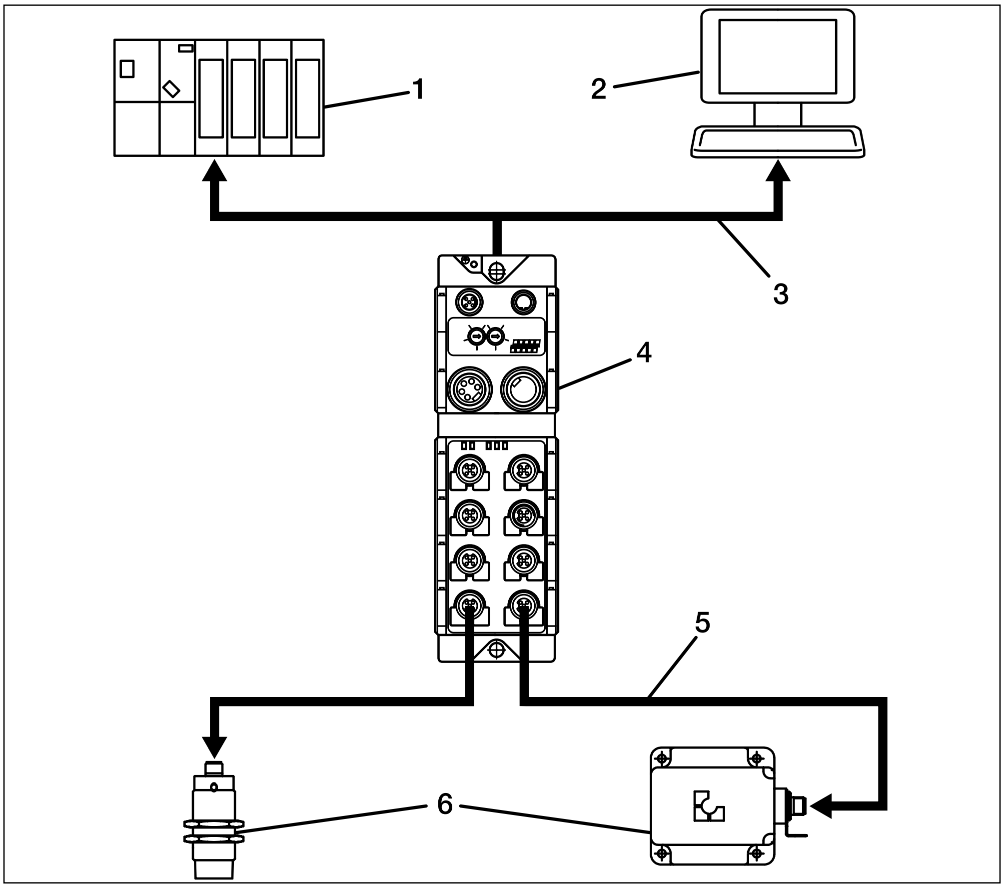


Fig.8: Topology of a BIS M-4xx-045 Identification System

1	PLC	**2**	PC
3	Fieldbus	**4**	IO-Link Master
5	Connection to the host system	**6**	BIS M-4xx-045 **read/write device**

4 Basic knowledge

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“, page 16).
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“, page 16). At the same time, the CP bit is set in the input buffer ("CP – Codetag Present“, see Chapter 9.3 "Process data“, page 32).

4.4 Product description

BIS M-400-045-0xx-07-S4 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-4x1-045-0xx-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-402-045-0xx-07-S4 read/write device:
– metal housing,
– round connector terminations,
– integrated read/write head,
– the read/write head is head 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-...) or metal housing (...-002-...).

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 15).

Use of CRC_16 can be parameterized by the user (see Chapter 7 "Parameterizing the read/write device“, page 26).

4 Basic knowledge

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 in this case is always 8 bytes; the start address can be parameterized.

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.

4.7 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

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

4.8 IO-Link basic knowledge

Advantages of IO-Link:
- Uniform, simple wiring of different devices
- 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-4xx-045-... is an IO-Link device which uses three-conductor technology (Physics 2). The transfer rate can be configured to 4800 (COM1), 38400 (COM2) or 230400 (COM3) baud. The data quantity of the process data is 10 bytes in each direction (see Chapter 9 "Device function“, page 31).

5 Technical data

5.1 Electrical data (valid for all device versions)

Operating voltage Vs	18...30 VDC LPS/Class 2 supplied only
Ripple	1.3 Vss
Current draw	150 mA
Load current capacity in SIO mode	Maximum 50 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
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

*For 230.4 kBaud, use shielded cable.
**Verified with shielded cable.

5.3 BIS M-400-045-001-07-S4

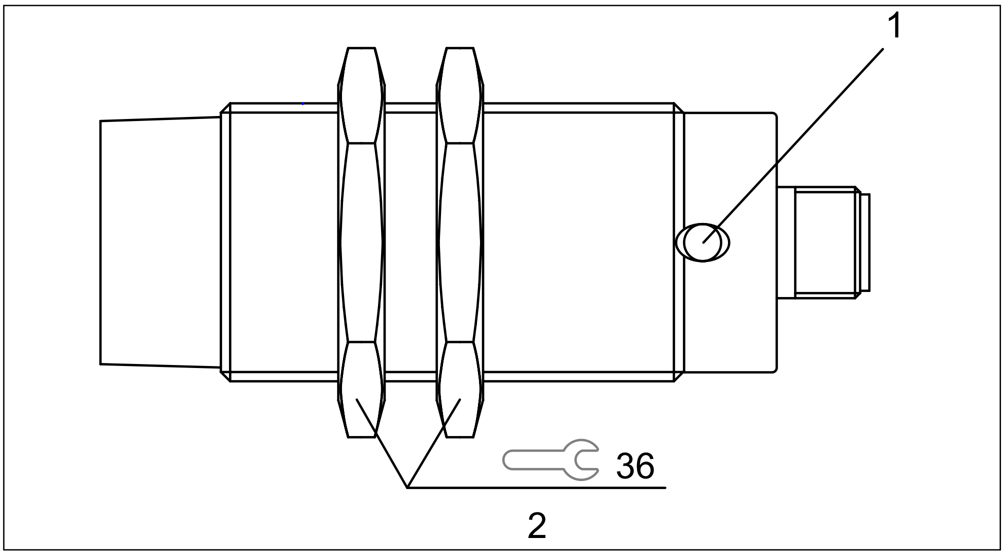


Fig.9: BIS M-400-045-001-07-S4 read/write device

1 LED

2 Maximum tightening torque 40 Nm

Mechanical data

Housing material	Nickel-plated brass
Connection	M12, 4-pin plug connection
Enclosure rating	IP 67
Weight	100 g

5 Technical data

LED

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

5.4 BIS M-400-045-002-07-S4

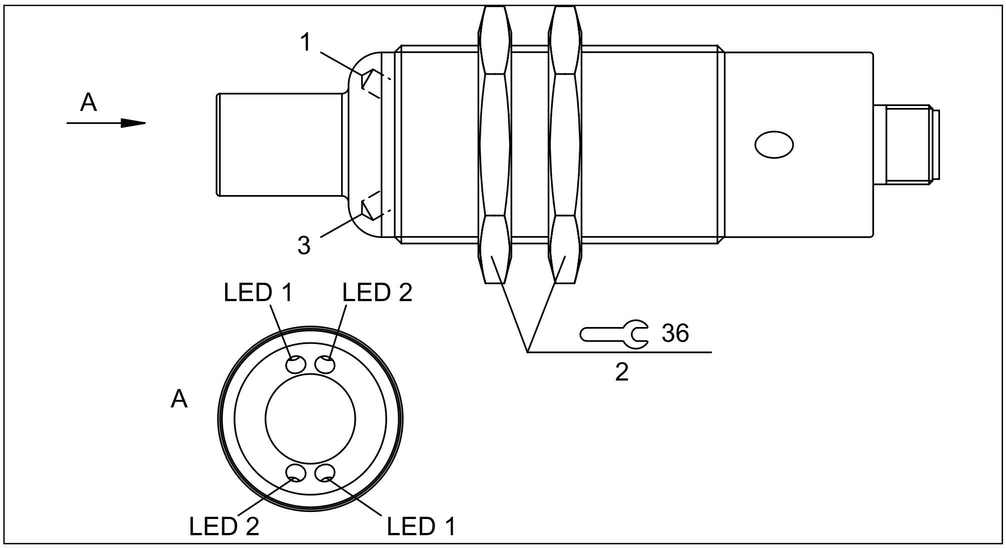


Fig.10: BIS M-400-045-002-07-S4 read/write device

1 LED

2 Maximum tightening torque 40 Nm

Mechanical data

Housing material	Nickel-plated brass
Wiring	M12, 4-pin plug connection
Enclosure rating	IP 67
Weight	100 g

LED

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

5 Technical data

5.5 BIS M-401-045-001-07-S4

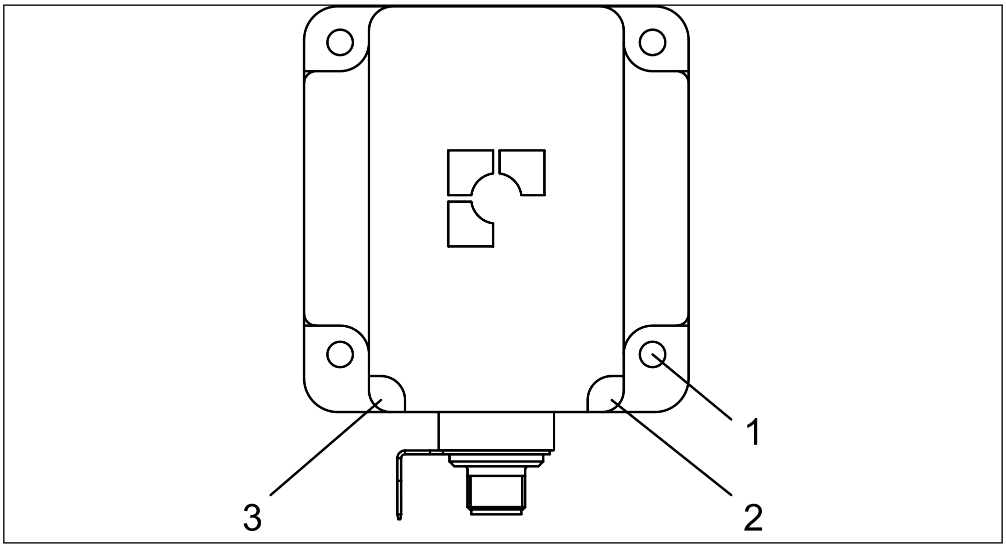


Fig.11: BIS M-401-045-001-07-S4 read/write device

1 Maximum tightening torque 3 Nm

2 Earthing connector

3 Sensing surface

Mechanical data

Housing material	PBT
Connection	M12, 4-pin plug connection
Enclosure rating	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

5.6 BIS M-402-045-002-07-S4

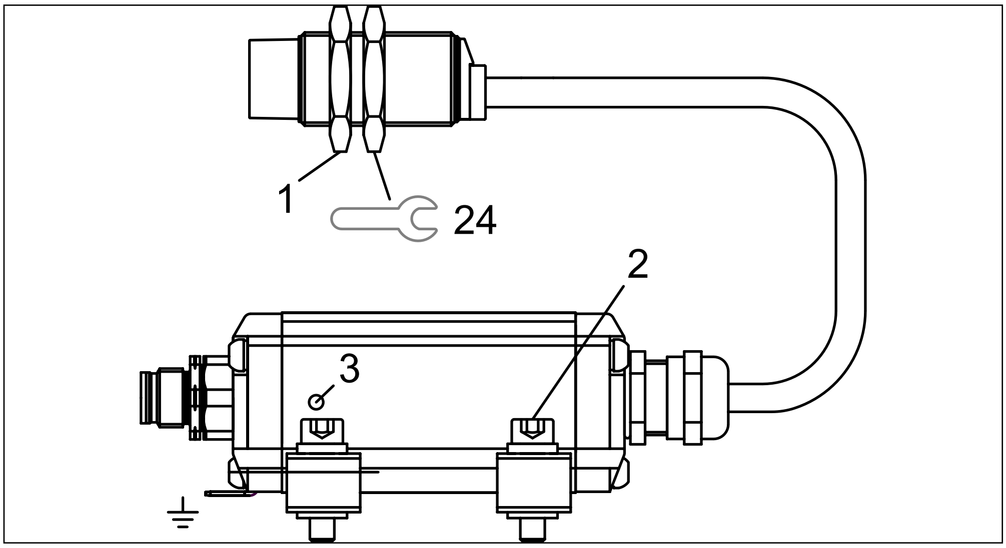


Fig.12: BIS M-402-045-002-07-S4 read/write device, values in mm

1 Maximum tightening torque 25 Nm

2 Maximum tightening torque 2 Nm

3 LED

Mechanical data

Housing material	AlMGSIO5
Read/write head housing material	Nickel-plated brass
Connection	M12, 4-pin plug connection
Enclosure rating	IP 67
Weight	220 g

LED

LED	Status	Function
LED 1	Green	Power
LED 1	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-402-045-004-07-S4

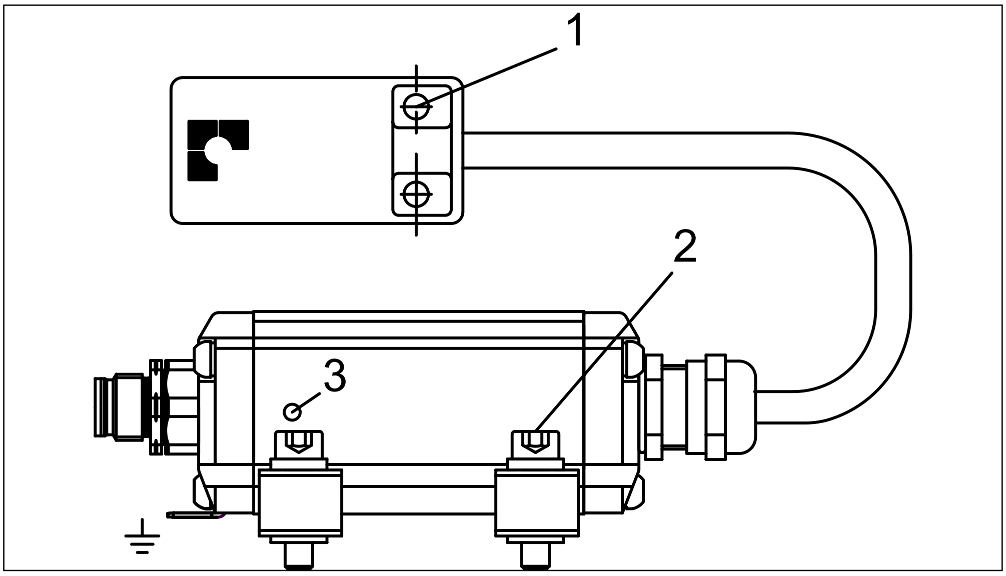


Fig.13: BIS M-402-045-004-07-S4 read/write device

1 Sensing surface
2 Maximum tightening torque 1 Nm
3 LED

Mechanical data

Housing material	AlMGSIO5
Read/write head housing material	ABS-GF16
Connection	M12, 4-pin plug connection
Enclosure rating	IP 67
Weight	220 g

LED

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

5 Technical data

5.8 BIS M-451-045-001-07-S4

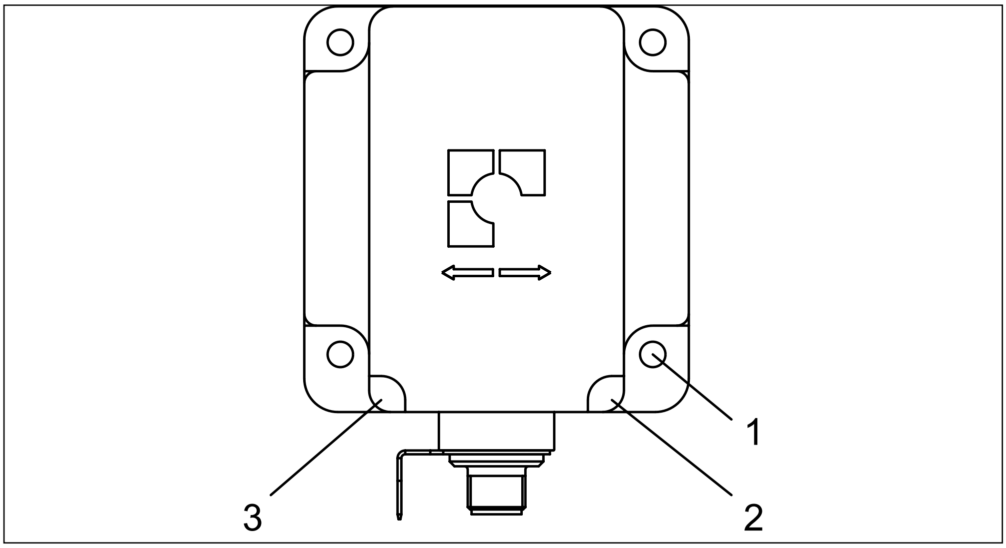


Fig.14: BIS M-451-045-001-07-S4 read/write device

1 Maximum tightening torque 3 Nm

2 Read/write axis

3 Earthing connector

Mechanical data

Housing material	PBT
Connection	M12, 4-pin plug connection
Enclosure rating	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

5.9 Dynamic mode

Memory access

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 processor electronics convert this time accordingly.
To calculate the read/write times, the block read or write time must, therefore, always be estimated.

Data carrier detection time

Data-carrier detection time [mm]	Parameter "Used data carrier type“		
	All	BIS M1xx-01	BIS M1xx-02
BIS M1xx-02 data carrier	≤ 40	-	≤ 27
BIS M1xx-01 data carrier	≤ 30	≤ 18	-

Read times

Data carrier with 16 byte blocks	BIS M-1xx-01	BIS M-1xx-02
First block to be read	≤ 20	≤ 35
Other started 16 bytes	≤ 10	≤ 25

Write times

Data carrier with 16 bytes per block	BIS M-1xx-01	BIS M-1xx-02
First block to be read	≤ 40	≤ 65
Other started 16 bytes	≤ 30	≤ 55

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

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 16 to 23).

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

5 Technical data

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

Example calculation

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

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 = 30 ms + 20 ms + 3 x 10 ms = 80 ms
Total write time = 30 ms + 40 ms + 3 x 30 ms = 160 ms

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

Calculation of maximum speed:
$V_{max.perm.read}$ = 40 mm/80 ms = 0.5 m/s
$V_{max.perm.write}$ = 40 mm/160 ms = 0.25 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.

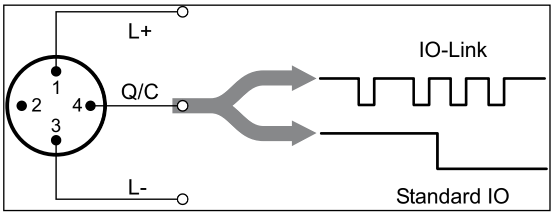


Fig.15: Three-conductor physics of the IO-Link

The BIS M-4xx-045... supports both modes. In SIO mode, the "Data carrier in range" (24 V) or "No data carrier in range" (0 V) signal is made available to the host system as a switching signal. If the BIS M-4xx-045… is not used with an IO-Link Master and without triggering IO-Link communication, it works in SIO mode and can be operated on a digital input.

Communication mode

The BIS M-4xx-045-... works in communication mode with Frame Type 1. In this transmission type, 2 bytes of process data or required data are sent per frame (data block). This can take place either from the IO-Link Master to the device or vice-versa.Process data are the application-specific data; required data may contain parameters, service or diagnostic data.

Interleave mode

So-called "Interleave Mode" makes it possible to send larger quantities of data. There, multiple type 1 frames must be combined into a sequence. One frame with process data and one with required data are sent in alternation.
With the BIS M-4xx-045-..., a sequence consists of 20 individual frames. 10 bytes of process data are sent in each direction per sequence. This process data is described in greater detail in Section 9.3 "Process data“ on page 32.

6 IO-Link basics

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-4xx-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}).

IO-Link protocol Subaddress		BIS M-4xx IO-Link device Subaddress
00_{hex}	⇒	00_{hex}
⋮	⋮	⋮
09_{hex}	⇒	09_{hex}
$0A_{hex}$		
⋮		
$1F_{hex}$		

6.3 Identification data and device information

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

	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	Order 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

7 Parameterizing the read/write device

7.1 Required data

The device-specific parameters of the Identification System can be parameterized via the SPDU. The parameterization data of the BIS M-4xx-045-... is described in the following in greater detail.

	Access SPDU Index	Access SPDU Subindex	Description	Data width	Value range	Factory setting
Parameterization data	40hex	1hex	CRC yes/no	1 byte	0 = without CRC 1 = with CRC	0
Parameterization data	40hex	2hex	Dynamic mode - yes/no	1 byte	0 = no 1 = yes	0
Parameterization data	40hex	3hex	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
Parameterization data	40hex	4hex	Low byte of start address for autoread	2 bytes	Observe data-carrier specifications.	0
Parameterization data	40hex	5hex	High byte of start address for autoread			
	40hex	6hex	Used data-carrier type	1 byte	See Chapter 7.2 "Mapping of parameterization data“, page 27 00hex=ALL FEhex=BIS M1xx-01 FFhex=BIS M1xx-02	0
	41hex	1hex	Baud rate	1 byte	00hex = 4800 baud 01hex = 38400 baud 02hex = 230400 baud	1

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 Parameterizing the read/write device

7.2 Mapping of parameterization 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 15).

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 9.6 "Error codes" page 43).

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							
7-MSB	6	5	4	3	2	1	0-LSB
not relevant							1/0*

* 0 = CRC_16 data check is not used (default setting).
1 = 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							
7-MSB	6	5	4	3	2	1	0-LSB
not relevant							1/0*

* 0 = dynamic mode not activated (default setting).
1 = dynamic mode activated.

7 Parameterizing 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	
0_{hex}	No action
1_{hex}	Send UID immediately
7_{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

This parameter offers the possibility of specifying certain data carrier models that are to be detected. All models, all BIS M1xx-01 models or all BIS M1xx-02 models can be selected. The data carriers are detected more quickly if only those that are used are parameterized. The following values are permissible:

Index 40_{hex}, subindex 6_{hex} - 1 byte	
0_{hex}	All data carrier models supported by Balluff
FE_{hex}	All BIS M1xx-01 model data carriers
FE_{hex}	All BIS M1xx-02 model data carriers

Baud rate

The Baud Rate parameter can be used to set the used transfer rate. The Min Cycle Time, i.e. the time intervals at which the device may be queried by the IO-Link Master, is dependent on the setting of this parameter. The following table applies:

Index 41_{hex}, subindex 1_{hex} - 1 byte			
IO Link designation	**Baud Rate [baud]**	**Parameter setting**	**Min Cycle Time**
COM1	4800	00_{hex}	60_{hex} = 12.8 ms
COM2	38400	01_{hex}	35_{hex} = 5.3 ms
COM3	230400	02_{hex}	20_{hex} = 3.2 ms

Note
Not all IO-Link Masters support COM3. This must absolutely be checked before parameterizing! After the speed has been parameterized once, the device is only parameterized for this speed and can only be reparameterized using a COM3-capable IO-Link Master. The Balluff-USB-Master is recommended for this purpose. Please contact Balluff Sales for further information.
After saving the parameter, the M-4xx-045-... performs a reset. During this process, IO Link communication is interrupted and errors can be displayed in the controller. Only after this reset does the device restart with the newly set baud rate.

7 Parameterizing the read/write device

7.3 Storing the parameterization data

The set parameters are stored in the EEPROM memory of the BIS M-4xx-045-... On restart, the most recently used parameters are used.

Note
Should it be necessary to exchange a BIS M-400-045-... in the system, make certain that the correct parameter settings are programmed in the new device.

8 Startup

For information on starting up, please read the instructions for your IO-Link Master. BIS M4-xx IO-Link devices use a process buffer of 10 bytes for both the input and the output.

9 Device function

9.1 Functional principle

The BIS M-4xx-045 Identification System is a contactless read and write system. The read/write device consists of evaluation electronics with permanently connected read/write head.

The primary components of the BIS M-4xx-045 Identification System are:
– Read/write device,
– Data carrier.

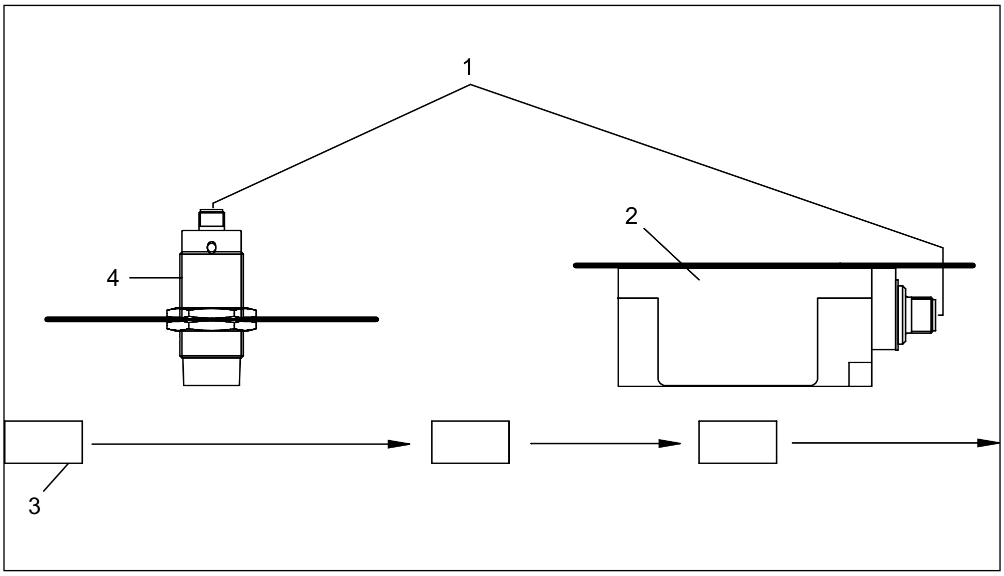


Fig.16: Schematic representation of an Identification System

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

The data carrier is an autonomous unit which is supplied with power by the read/write head. The read/write head continuously sends a carrier signal which 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.

9.2 Functional principle

The BIS M-4xx-045 supports cyclical data exchange via IO-Link protocol and standard IO mode. Detection of a data carrier (Codetag Present, 24 V) or no data carrier present (0 V) is sent on data line C/Q as a digital switching signal.
With cyclical data exchange, read data from the BIS M-4xx-045 are cyclically exchanged with the controller. It is also possible to read or enter parameter data in this operating mode.

9 Device function

9.3 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-4xx-045 uses 10 bytes of input data and
10 bytes of output data; the assignments are described in the following. Subaddress 00_{hex} corresponds to the respective start address in the corresponding data field.

Output/Input buffer

To transfer commands and data between the BIS M-4xx-045 read/write device and the host system, the BIS M-4xx-045 provides two fields:
– Output buffer
– Input buffer

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

Output buffer:

Bit-No. / Subaddress	7	6	5	4	3	2	1	0
00_{hex} - 1st bit header		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							
09_{hex} - 2nd bit header		TI	KA			GR		AV

Explanations for output buffer:

Subaddress	Bit name	Meaning	Function description
00_{hex}	1st bit header		
	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	Ground 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

9 Device function

Subaddress	Bit name	Meaning	Function description
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
		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 header		
	TI, KA, GR, AV		If 1st and 2nd bit headers agree, valid commands or data are present.

Note
To specify the start address and the number of bytes, the specifications of the used data carrier and the maximum job size of 256 bytes are to be observed!

9 Device function

Input buffer:

Subaddress \ Bit-No.	7	6	5	4	3	2	1	0
00hex - 1st bit header	BB	HF	TO		AF	AE	AA	CP
01hex	Error code or data or high-byte version							
02hex	Data or low-byte version							
03hex	Data							
04hex	Data							
05hex	Data							
06hex	Data							
07hex	Data							
08he	Data							
09hex - 2nd bit header	BB	HF	TO		AF	AE	AA	CP

Explanations for input buffer:

Subaddress	Bit name	Meaning	Function description
00hex	1st bit header		
	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 header 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

04_{hex}		Data	Data which was read from the data carrier

05_{hex}		Data	Data which was read from the data carrier

06_{hex}		Data	Data which was read from the data carrier

07_{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 header		
	BB, HF, TO, AF, AE, AA, CP		If 1st and 2nd bit headers agree, there is valid data present

9 Device function

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

9.4 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 9.5 "Protocol examples“, page 37). If a data carrier is detected, the "Reaction to Tag Present" set in the parameterization 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 headers 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 here that a job is limited to a maximum of 256 bytes. If more than 256 bytes are to be processed, 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 parameterized for dynamic mode (see Chapter 7 "Parameterizing the read/write device“, page 26).

9 Device function

9.5 Protocol examples

The following examples show the protocol sequence in various situations.

1st example

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

Command from controller

1. Process output buffer:

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

BIS M-4xx-045-... reaction

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	

2ndexample

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

Command from controller

1. Process output buffer:

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

BIS M-4xx-045-... reaction

2. Process input buffer:

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

3rd example

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

Command from controller

1. Process output buffer:

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

BIS M-4xx-045-... reaction

2. Process input buffer:

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

4th example

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

Command from controller

1. Process output buffer:

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

BIS M-4xx-045-... reaction

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

5th example

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

Command from controller

1. Process output buffer:

00hex	GR, KA, AV = 0
09hex	GR, KA, AV = 0

BIS M-4xx-045-... reaction

2. Process input buffer:

00hex	Delete CP
09hex	Delete CP

6th example

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:

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

BIS M-4xx-045-... reaction

2. Process input buffer:

00hex/09hex	Set AA

3. Process subaddresses:

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

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

00hex/09hex	Invert TO

5. Process subaddresses:

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

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

00hex/09hex	Invert TO

65. Process subaddresses:

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

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

00hex/09hex	Set AE

67. Process subaddresses:

00hex/09hex	Delete AV

68. Process subaddresses:

00hex/09hex	Delete AA and AE

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

9 Device function

7th example **Read 17 bytes starting at data carrier address 10:**

Command from controller

1. Process subaddresses in the order shown:

01hex	Command designator 01hex
02hex	Start address 0Ahex
03hex	Start address 00hex
04hex	No. of bytes 11hex
05hex	No. of bytes 00hex
00hex/09hex	Set AV

BIS M-4xx-045-... reaction

2. Process input buffer:

00hex/09hex	Set AA
01hex... 08hex	Enter the first 8 bytes of data

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

00hex... 09hex	Invert TI

4. Process subaddresses of the input buffer:

01hex... 08hex	Enter second 8 bytes of data
00hex/09hex	Invert TO

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

00hex... 09hex	Invert TI

6. Process subaddresses of the input buffer:

01hex	Enter last byte of data
02hex... 08hex	0x00 (empty)
00hex/09hex	Invert TO, set AE

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

00hex... 09hex	Delete AV

8. Process subaddresses of the input buffer:

00hex/09hex	Delete AF and AA

9 Device function

8th example **Read 30 bytes starting at address 10 with read error:**

Command from controller

1. Process subaddresses in the order shown:

01hex	Command designator 01hex
02hex	Start address 0Ahex
03hex	Start address 00hex
04hex	No. of bytes 1Ehex
05hex	No. of bytes 00hex
00hex/09hex	Set AV

BIS M-4xx-045-... reaction

2. Process input buffer:

Error occurred immediately	
00hex/09hex	Set AA
01hex	Enter error number
00hex/09hex	Set AF

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

00hex... 09hex	Delete AV

4. Process subaddresses of the input buffer:

00hex/09hex	Delete AF and AA

9 Device function

9th example **Write 18 bytes starting at data carrier address 20**

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-4xx-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

10th example

Write constant data. 20 bytes, value 5Ahex, starting at address 0:

Command from controller

1. Process subaddresses in the order shown:

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

BIS M-4xx-045-... reaction

2. Process input buffer:

00hex/09hex	Set AA

3. Data is written

00hex/09hex	Set AE

4. Process subaddresses:

00hex/09hex	Delete AV

5. Process subaddresses:

00hex/09hex	Delete AA and AE

11th example

Move read/write device to ground state:

Command from controller

1. Process subaddresses:

00hex/09hex	Set GR

BIS M-4xx-045-... reaction

2. Process input buffer:

01...08hex	00hex (empty)
00hex/09hex	Delete BB

3. Process subaddresses:

00hex/09hex	Delete GR

4. Process input buffer:

00hex/09hex	Set BB

12th example

Perform head shutdown:

Command from controller

1. Process subaddresses:

00hex/09hex	Set KA

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

BIS M-4xx-045-... reaction

2. Process input buffer:

00hex/09hex	Set HF, delete CP

3. Process subaddresses:

00hex/09hex	Delete KA

→ New data carriers are now detected again.

4. Process input buffer:

00hex/09hex	Set HF

9 Device function

9.6 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 parameterized.
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 header error	The two headers in the output buffer and in the host system do not agree. The headers must be matched (see "Output buffer“, page 32).
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

9.7 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 in or out 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 10 x cycle time (e.g. t2). If, however, data is updated shortly after the start of an exchange cycle, it lasts a maximum of 3 x 10 x cycle time (e.g. t3).

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.

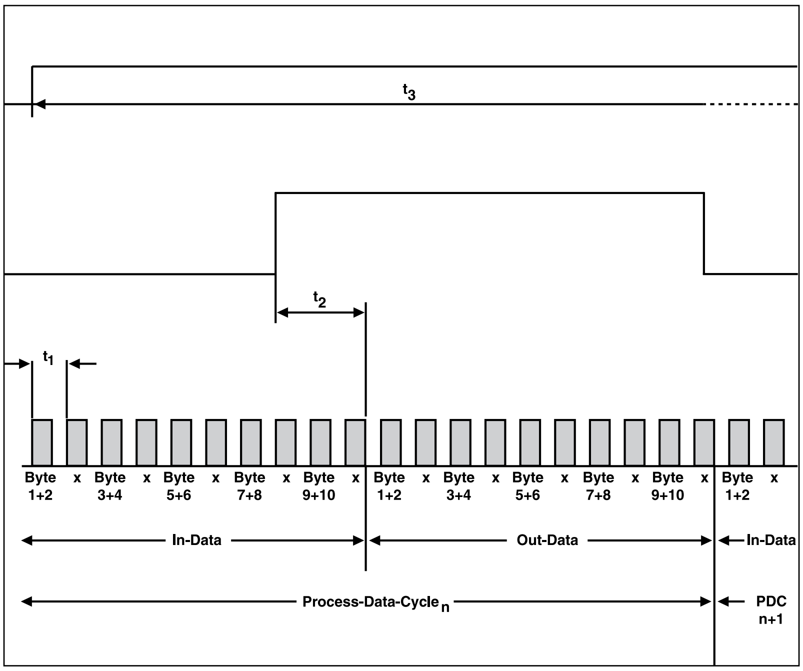


Fig.17: IO-Link transmission sequence

t_1	Cycle time
t_2	Polling time
t_3	Cycle time

In-Data: Input data

Out-Data: Output data

Process Data Cycle: Process data cycle

Byte a+b: Process data

x: Required data

Cycle time t_1:
Time until the data of a data carrier that enters the read range is read. The read time is 70 ms x number of parameterized data comparison counts, default = 2 (see Chapter 7.2 "Mapping of parameterization data“, page 27).

Polling time t_2:
Time until it is recognized that the data carrier is no longer in the read range (polling time). The polling time is xx ms.

Cycle time t_3:
Time between the sending of two frames. The cycle time is dependent on the set baud rate and on the respective Master.

9 Device function

In-Data/Out-Data:
Sending of the input data and output data. 10 frames of 2 bytes each are sent, alternating between process data and required data (x).

Process Data Cycle:
A process data cycle consists of the complete sending of the input and output data. At the beginning of each process data cycle, the current data are polled and immediately sent.

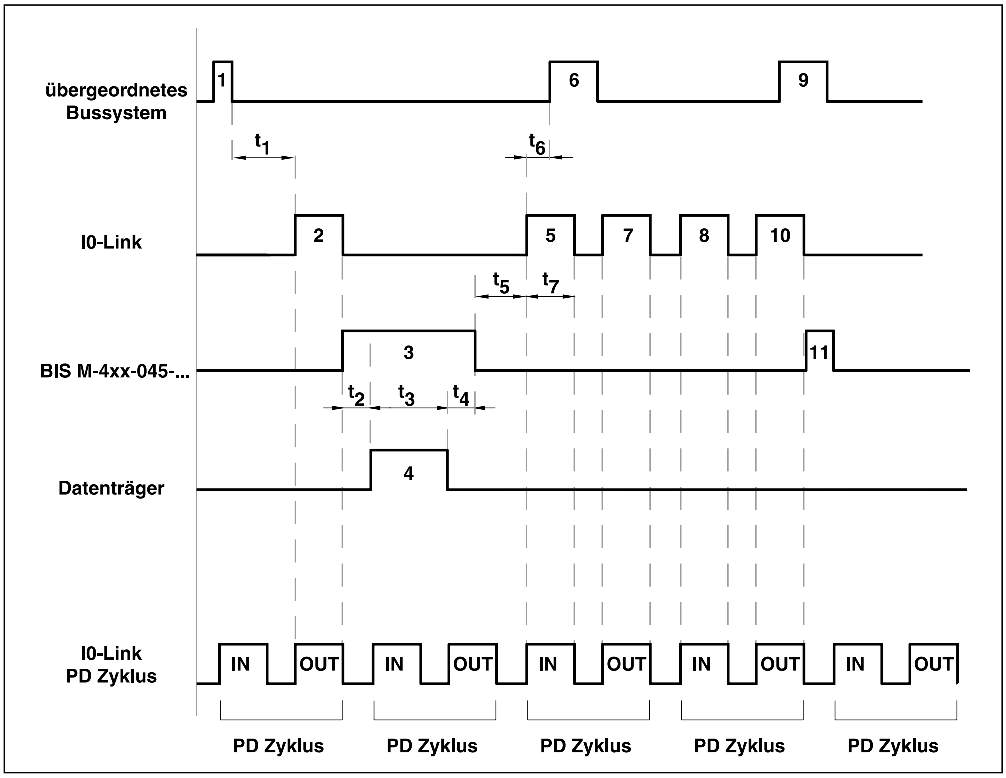


Fig.18: IO-Link transmission sequence

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-400-045-… 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-400-045-…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 **t3**. The pure read time is calculated as described (see Chapter 5.9 "Dynamic mode", page 22). 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 pure time for 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 In-Data cycle. In addition, the AE-bit is set in the bit header. The time for this is **t7** = 10 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 "Device function", page 31). In the example, it is assumed that the this occurs immediately and that the transfer to the IO-Link Master happens fast enough that the BIS M-400-045-… receives the new data on the next Out-Data cycle.

9 Device function

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-400-045-….
11 The device ends the read command and deletes the bits in the bit header in the input buffer that belong to the job .

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:

$Ttot_{proc.max}$ = 40 x t_{cyc} + read/write speed + 5 ms + 30 x t_{cyc} + 20 x t_{cyc} x n[1] =
5 ms + $t_{read/write\ speed}$[2] + t_{cyc}[3] x (70 + 20 x n)

[1] Number of bytes/8 (rounded to the next whole number)
[2] Calculated time for data carrier processing (see Chapter 5.9 "Dynamic mode“, page 22)
[3] Master Cycle Time.

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 designation code

BIS M-4xx-045-0xx-07-S4

Balluff Identification System

Series
M = Read and write system, 13.56 MHz

Hardware type
4xx = Read/write device

Software type
045 = Software number, IO-Link

Version
001 = Standard
002 = Tapered

interface
07 = IO-Link

module
S4 = M12 4-pin male

Accessories (optional, not included)

Accessories for the BIS M-4xx-... 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

Appendix

www.balluff.com

Balluff GmbH
Schurwaldstraße 9
73765 Neuhausen a.d.F.
Germany
Tel. +49 7158 173-0
Fax +49 7158 5010
balluff@balluff.de
www.balluff.com

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