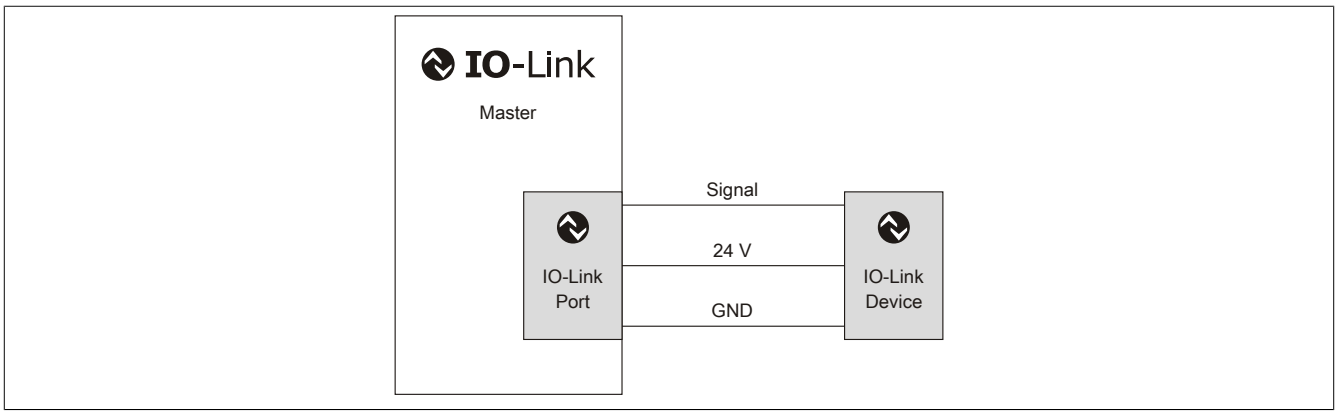
X20DS4387

1 General information

IO-Link is a standardized communication system for connecting intelligent sensors and actuators in an automation system. The standardization includes electrical connection data as well as a digital communication protocol, which is used by the sensors and actuators in the automation system for data exchange.

An IO-Link system consists of an IO-Link master and one or more IO-Link devices, i.e. sensors and actuators. The IO-Link master makes the interface available for higher level control and controls communication with the connected IO-Link devices.

An IO-Link device is an intelligent sensor or actuator. With regard to IO-Link, "intelligent" means that a device possesses a series number or parameter data (sensitivity, switching delays or characteristic curves), which can be written to or read via the IO-Link protocol.



Process optimization

The use of intelligent sensors and actuators contributes to process optimization. Process optimization means that downtimes should be kept as short as possible. These consist mainly of standstills due to errors and setup times.

Integrated communication down to the IO-Link devices offers many advantages in error diagnostics. Errors are detected much faster than before. If a sensor or actuator must be replaced, lengthy configuration work is no longer necessary after the change thanks to a potentiometer, or a configuration tool and laptop. After changing the sensor/actuator, the parameters are automatically transferred to the sensor.

This parameter download is not only beneficial when errors occur. It can also be used for changing parameters when a load change is performed. This shortens setup times, making product changes and small batches more economical.

Integration of IO-Link in X20 System

IO-Link is integrated in the X20 system using this digital module. All 4 channels are IO-Link interfaces, but can also be used as standard inputs or outputs. The specified 3-wire connections can be ideally implemented thanks to the X20 connector system with 12 terminal points per module. All specified transfer rates are also supported.

POWERLINK integration

IO-Link doesn't stop at the I/O module. It must be integrated in the higher-level bus system to fully utilize the benefits. When using POWERLINK, access is made possible via device description files in XML format.

- 4 IO-Link interfaces per module
- Each interface can be configured as a standard input or output
- Seamless integration in POWERLINK
- Supports all transfer rates

2 Order data

Model number	Short description	Figure
	Other functions	
X20DS4387	X20 digital signal module, 4x IO-Link master, 4 digital channels configurable as inputs or outputs, 3-wire connections	
	Required accessories	
	Bus modules	
X20BM11	X20 bus module, 24 VDC keyed, internal I/O supply continuous	
X20BM15	X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous	
	Terminal blocks	
X20TB12	X20 terminal block, 12-pin, 24 VDC keyed	

Table 1: X20DS4387 - Order data

3 Technical data

Model number	X20DS4387
Short description	
I/O module	IO-Link master with 4 IO-Link interfaces
General information	
B&R ID code	0xA38E
Status indicators	IO-Link, operating state, module status
Diagnostics	
Module run/error	Yes, using status LED and software
IO-Link operating state	Yes, using status LED and software
C/Q status	Yes, using status LED and software
Cable specification	
Cable type	3-pin standard sensor cable
Cable length	Max. 20 m
Line capacitance	Max. 3 nF
Loop resistance	Max. 6 Ω
Power consumption	
Bus	0.01 W
Internal I/O	1.6 W
Additional power dissipation caused by actuators (resistive) [W]	-
Certifications	
CE	Yes
KC	Yes
EAC	Yes
UL	cULus E115267 Industrial control equipment
HazLoc	cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5
ATEX	Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X
Sensor/Actuator power supply	
Voltage	I/O supply minus voltage drop for short circuit protection
Voltage drop for short-circuit protection at 0.3 A	Max. 1 VDC
Power consumption	Max. 9 W per interface
Short-circuit proof	Yes
IO-Link in master mode	
Transfer rates	
COM1	4.8 kbaud
COM2	38.4 kbaud
COM3	230.4 kbaud
Limit values for COM3	
Max. connection capacity	47 nF (cable + device)
Max. load	100 Ω / 0.3 A
Data format	1 start bit, 8 data bits, 1 parity bit (even), 1 stop bit
Bus level	24 VDC (active), 0 VDC (resting voltage)
IO-Link device power supply	24 VDC / max. 0.3 A per interface (protected)

Table 2: X20DS4387 - Technical data

Model number	X20DS4387
IO-Link in master mode or in SIO mode "digital output"	
Variant	Bipolar, positive and negative switching
Diagnostics	Output monitoring with 100 ns delay and internal semiconductor protection with 100 µs delay
Peak short-circuit current	<1.5 A
Residual voltage	<1.5 VDC at nominal current 0.2 A
Switching voltage	I/O supply minus voltage drop for short circuit protection and semiconductor switch
Voltage drop on semiconductor switch	Max. 1.5 VDC at 0.2 A
Switching frequency	Typ. 25 kHz 300 kHz in IO-Link master mode
Switching delay	
0 → 1	<10 µs
1 → 0	<10 µs
Switch-on in the event of overload shutdown or short-circuit shutdown	Approx. 10 ms (depends on the module temperature)
Braking voltage when switching off inductive loads	Typ. 52 VDC
Isolation voltage between IO-Link and bus	500 V_{eff}
IO-Link in SIO mode "digital output"	
Nominal voltage	24 VDC
Nominal output current	0.2 A
Total nominal current	0.4 A
Output circuit	Sink or source
Output protection	Thermal cutoff if overcurrent or short circuit occurs, integrated protection for switching inductances
Actuator power supply	24 VDC / max. 0.3 A per interface (protected)
IO-Link in SIO mode "digital input"	
Nominal voltage	24 VDC
Input filter	
Hardware	100 ns
Software	-
Input circuit	Sink
Sensor power supply	24 VDC / max. 0.3 A per interface (protected)
Input voltage	24 VDC -15% / +20%
Input current at 24 VDC	Typ. 5 mA
Input resistance	Typ. 4.8 kΩ
Switching threshold	
Low	<8 VDC
High	>13 VDC
Isolation voltage between IO-Link and bus	500 V_{eff}
Electrical properties	
Electrical isolation	Bus isolated from IO-Link IO-Link not isolated from IO-Link
Operating conditions	
Mounting orientation	
Horizontal	Yes
Vertical	Yes
Installation elevation above sea level	
0 to 2000 m	No limitations
>2000 m	Reduction of ambient temperature by 0.5°C per 100 m
Degree of protection per EN 60529	IP20
Ambient conditions	
Temperature	
Operation	
Horizontal mounting orientation	0 to 55°C
Vertical mounting orientation	0 to 45°C
Derating	-
Storage	-25 to 70°C
Transport	-25 to 70°C
Relative humidity	
Operation	5 to 95%, non-condensing
Storage	5 to 95%, non-condensing
Transport	5 to 95%, non-condensing
Mechanical properties	
Note	Order 1x terminal block X20TB12 separately Order 1x bus module X20BM11 separately
Spacing	$12.5^{+0.2}$ mm

Table 2: X20DS4387 - Technical data

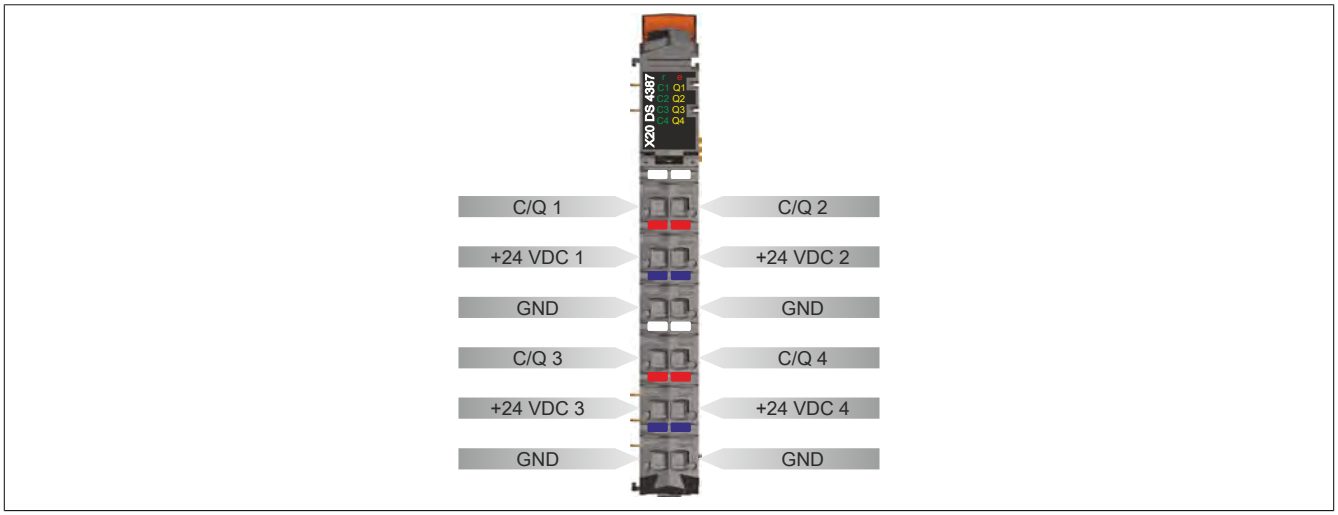
4 LED status indicators

For a description of the various operating modes, see section "Additional information - Diagnostic LEDs" of the X20 system user's manual.

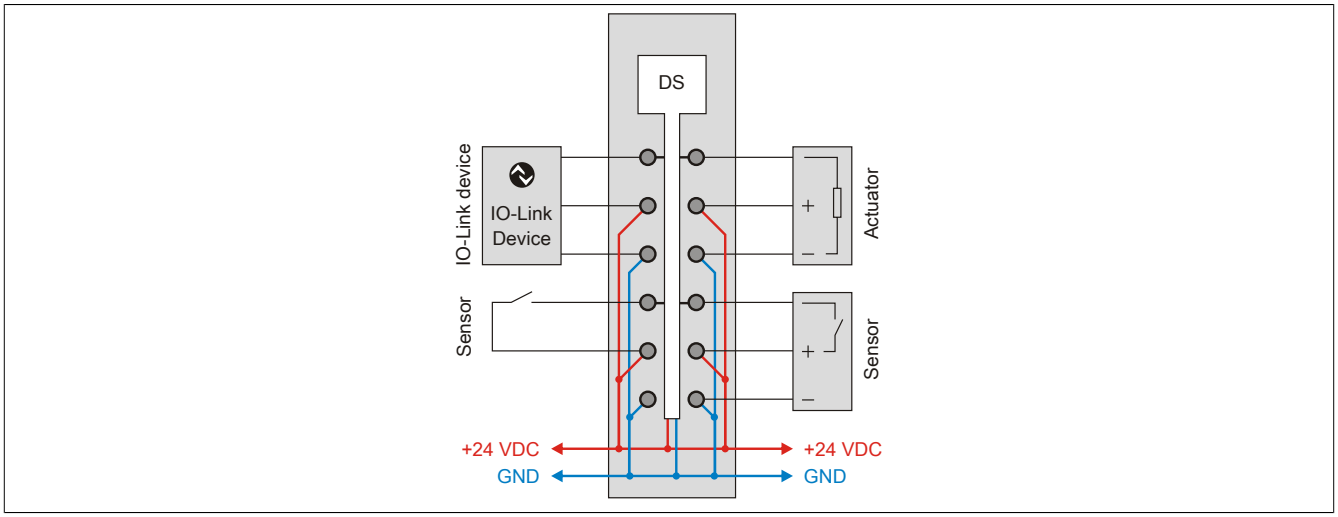
Figure	LED	Color	Status	Description
	r	Green	Off	No power to module
			Single flash	RESET mode
			Double flash	BOOT mode (during firmware update)[1)]
			Blinking	PREOPERATIONAL mode
			On	RUN mode
	e	Red	Off	No power to module or everything OK
			Single flash	Warning / error for an IO-Link interface
	C1 - C4	Green/Red	Off	Interface in SIO mode
			Green	Interface in IO-Link mode
			Red	Output overloaded (short circuit, temperature)
	Q1 - Q4	Orange		Input/output status of the corresponding IO-Link interface

1) Depending on the configuration, a firmware update can take up to several minutes.

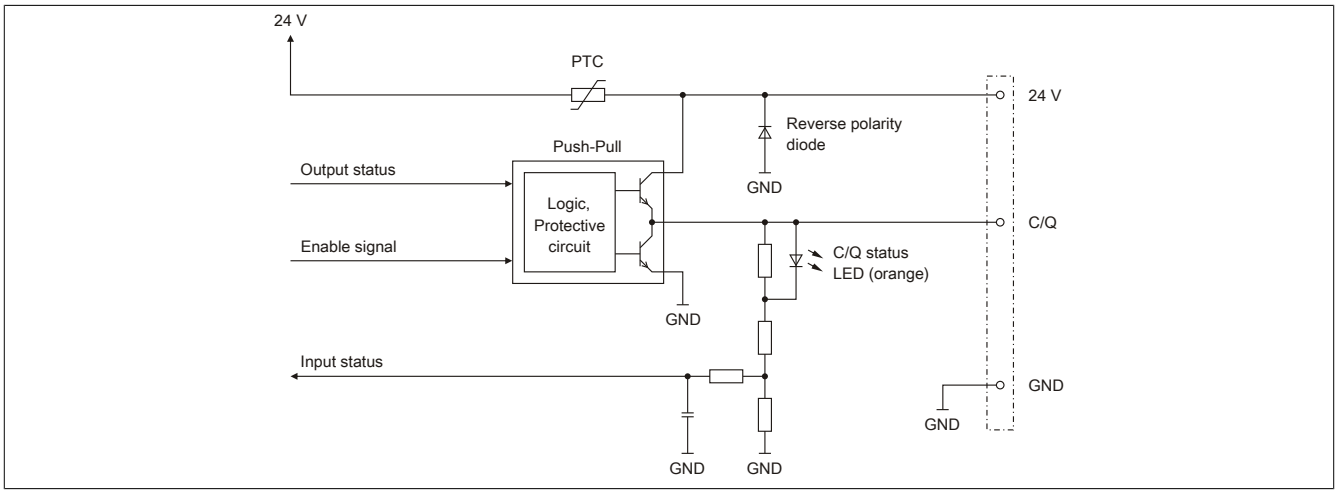
5 Pinout



6 Connection example



7 Output circuit diagram



8 Register description

8.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section "Additional information - General data points" of the X20 system user's manual.

8.2 Function model 0 - default

Register	Name	Data type	Read		Write	
			Cyclic	Acyclic	Cyclic	Acyclic
Interface operation						
321 + (N-1) * 256	Control0N (index N = 1 to 4)	USINT				•
323 + (N-1) * 256	StatusEvents0N (index N = 1 to 4)	U(S)INT	•			
328 + (N-1) * 256	CycleLength0N (index N = 1 to 4)	UINT	•			
342 + (N-1) * 256	DeviceId0N (index N = 1 to 4)	UDINT	•			
336 + (N-1) * 256	FunctionId0N (index N = 1 to 4)	UINT	•			
332 + (N-1) * 256	VendorId0N (index N = 1 to 4)	UINT	•			
255 + N	DataIn01_N (index N = 01 to 27)	USINT	•			
511 + N	DataIn02_N (index N = 01 to 27)	USINT	•			
767 + N	DataIn03_N (index N = 01 to 27)	USINT	•			
1023 + N	DataIn04_N (index N = 01 to 27)	USINT	•			
255 + N	DataOut01_N (index N = 01 to 30)	USINT			•	
511 + N	DataOut02_N (index N = 01 to 30)	USINT			•	
767 + N	DataOut03_N (index N = 01 to 30)	USINT			•	
1023 + N	DataOut04_N (index N = 01 to 30)	USINT			•	
SIO mode						
356 + (N-1) * 256	ChInputFilter0N (index N = 1 to 4)	USINT				•
256 + (N-1) * 256	Digital inputs	USINT	•			
	DigitalInput0N (index N = 1 to 4)	Bit 0				
256 + (N-1) * 256	Digital outputs	USINT			•	
	DigitalOutput0N (index N = 1 to 4)	Bit 0				
Boot configuration						
14852 + N*8	ODW_Data_N (index N = 0 to 127)	UDINT				•
14848 + N*8	ODW_Target_N (index N = 0 to 127)	UDINT				•
Runtime configuration						
7680	ParameterCtrlIn	UINT	•			
7680	ParameterCtrlOut	UINT			•	
7684	ParameterCmdIn	UDINT		•		
7684	ParameterCmdOut	UDINT			•	
7688 + N*4	ParameterDataIn_N (index N = 0 to 57)	UDINT	•[1)]	•		
7688 + N*4	ParameterDataOut_N (index N = 0 to 57)	UDINT			•[1)]	•
Errors and warnings						
325 + (N-1) * 256	ErrorsWarnings0N (index N = 1 to 4)	USINT	•			
IO-Link events						
7937	EventPortSeq	USINT	•			
7939	EventQualifier	USINT	•			
7942	EventCode	UINT	•			
7952	EventQuit	USINT			•	

1) Only parameters with index = 0

8.3 Function model 256 - Bus controller

Register	Offset[1)]	Name	Data type	Read		Write	
				Cyclic	Acyclic	Cyclic	Acyclic
Interface operation							
321 + (N-1) * 256	-	Control0N (index N = 1 to 4)	USINT				•
323 + (N-1) * 256	4 + (N-1) * 8	StatusEvents0N (index N = 1 to 4)	USINT	•			
328 + (N-1) * 256	-	CycleLength0N (index N = 1 to 4)	UINT		•		
342 + (N-1) * 256	-	DeviceId0N (index N = 1 to 4)	UDINT		•		
336 + (N-1) * 256	-	FunctionId0N (index N = 1 to 4)	UINT		•		
332 + (N-1) * 256	-	VendorId0N (index N = 1 to 4)	UINT		•		
255 + N	N - 1	DataIn01_N (Index 0N = 1 to 4)	USINT	•			
511 + N	7 + N	DataIn02_N (Index 0N = 1 to 4)	USINT	•			
767 + N	15 + N	DataIn03_N (Index 0N = 1 to 4)	USINT	•			
1023 + N	23 + N	DataIn04_N (Index 0N = 1 to 4)	USINT	•			
255 + N	N - 1	DataOut01_0N (index N = 1 to 4)	USINT			•	
511 + N	3 + N	DataOut02_0N (index N = 1 to 4)	USINT			•	
767 + N	7 + N	DataOut03_0N (index N = 1 to 4)	USINT			•	
1023 + N	11 + N	DataOut04_0N (index N = 1 to 4)	USINT			•	
SIO mode							
356 + (N-1) * 256	-	ChInputFilter0N (index N = 1 to 4)	USINT				•
256 + (N-1) * 256	(N-1) * 8	Digital inputs	USINT	•			
		DigitalInput0N (index N = 1 to 4)	Bit 0				
256 + (N-1) * 256	(N-1) * 4	Digital outputs	USINT			•	
		DigitalOutput0N (index N = 1 to 4)	Bit 0				
Boot configuration							
14852 + N*8	-	ODW_Data_N (index N = 0 to 127)	UDINT				•
14848 + N*8	-	ODW_Target_N (index N = 0 to 127)	UDINT				•
Runtime configuration							
7680	-	ParameterCtrlIn	UINT		•		
7680	-	ParameterCtrlOut	UINT				•
7684	-	ParameterCmdIn	UDINT		•		
7684	-	ParameterCmdOut	UDINT				•
7688 + N*4	-	ParameterDataIn_N (index N = 0 to 57)	UDINT		•		
7688 + N*4	-	ParameterDataOut_N (index N = 0 to 57)	UDINT				•
Errors and warnings							
325 + (N-1) * 256	5 + (N-1) * 8	ErrorsWarnings0N (index N = 1 to 4)	USINT	•			
IO-Link events							
7937	-	EventPortSeq	USINT		•		
7939	-	EventQualifier	USINT		•		
7942	-	EventCode	UINT		•		
7952	-	EventQuit	USINT				•

1) The offset specifies the position of the register within the CAN object.

8.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use additional registers and functions depending on the fieldbus used.

For detailed information, see section "Additional information - Using I/O modules on the bus controller" of the X20 user's manual (version 3.50 or later).

8.3.2 CAN I/O bus controller

The module occupies 2 analog logical slots on CAN I/O.

8.4 Limitations

The I/O module offers extensive function and configuration options. Many of these options require cycle data. The amount of cycle data required depends on the following parameters:

- Number of interfaces in use
- Use of events
- Runtime configuration in the cycle data

Take note that the amount of cycle data available for each I/O module used in the system is limited:

Sum of the input data:	29 bytes
Sum of the output data:	30 bytes

Runtime configuration and events

Each I/O module requires the following amounts of cycle data for runtime configuration and events, if enabled:

Activated function	Input	Output
Runtime configuration in the cycle data	6	10
Events	4	1

Interface data

The following amounts of cyclic data are required for each interface being used:

Functionality	Operating state							
	OPERATE		DIGINPUT		DIGOUTPUT		INACTIVE	
	Input	Output	Input	Output	Input	Output	Input	Output
Payload	0 to 27[1)]	0 to 30[1)]	1	-	-	1	-	-
Status information	2	-	2	-	2	-	-	-

1) User configurable

8.5 Interface operation

8.5.1 Communication mode

Name:
Control01 to Control04

Writing to this register defines the desired state of the IO-Link device. This register can be used to define if the IO-Link device should be operated in "normal" communication mode (OPERATE), as a digital input (DIGINPUT) or as a digital output (DIGOUTPUT).

Switching to SIO mode can make sense for IO-Link devices that only transfer digital information anyway (e.g. light curtains) but after the basic configuration should be faster than is possible in "normal" communication mode. A parameter configuration for the object directory can also be made in SIO mode.

To deactivate an interface, INACTIV should be used.

Data type	Values	Bus controller default setting
USINT	See the bit structure.	10

Bit structure:

Bit	Description	Value	Information
0 - 3	Communication mode	0	INACTIV
		1	DIGINPUT
		2	DIGOUTPUT
		10	OPERATE (bus controller default setting)
4 - 7	Reserved	-	

8.5.2 Operating state

Name:
StatusEvents01 to StatusEvents04

The actual status of communication between the module and the IO-Link device is indicated in this register. Additionally, the number of events read by the IO-Link device are also counted in this register.

Data type	Value
USINT[1)]	See bit structure.
UINT	

1) In the bus controller or standard function model, of communication mode = INACTIV

Bit structure:

Bit	Description	Value	Information
0 - 3	Status of the IO-Link device	x	See table below
4 - 7 or 15	Event counter from the respective IO-Link device	x	

Status of the IO-Link device

Value	ID	Description
0	INACTIVE	Interface is active: No communication and signal output or input. This state is not changed automatically.
1	DIGINPUT	SIO input mode: The interface acts like a digital input
2	DIGOUTPUT	SIO output mode: The interface acts like a digital output
4	ESTABLISHCOMM	Establishing connection to IO-Link device. This state remains as long as a device is not found.
5	INITMASTER	Consecutive states experienced during booting and configuration of an IO-Link device.
6	INITDEVICE	
7	INITOPERATE	
8	PREOPERATE	
9	READYTOOPERATE	Waiting for valid data from the IO-Link device. This state can follow the OPERATE state if the device reports during operation that it cannot send any more valid data.
10	OPERATE	Communication with the IO-Link device via serial protocol. Valid data is exchanged.
11	COMSTOP	The IO-Link interface is reinitialized. The ESTABLISHCOMM state follows this state.
12	FALLBACK	For switching to SIO mode
13	STARTUP	IO-Link device restart
14	SIO	Switching to SIO mode

States with a gray background are applied continuously, all others are intermediate states. An exception is the state ESTABLISHCOMM (4): This state is applied continuously if there is no device connected.

Dynamic values from the IO-Link device make up the input data for an IO-Link interface if one of the states DIGINPUT, DIGOUTPUT or OPERATE has been reached. These states can also be exited when errors occur. The device is restarted if a fatal error occurs, which means the state reverts back to ESTABLISHCOMM. Another possibility is that there is no new data being read from the device in the OPERATE state. In this case, the state changes to READYTOOPERATE and waits for new data.

During the first boot procedure, the module sends the value 0 for the inputs of an IO-Link interface. If the states DIGINPUT, DIGOUTPUT or OPERATE are exited, then the inputs are frozen at the most recently read value until valid data is able to be read from the device again.

8.5.3 Length of the I/O cycle

Name:
CycleLength01 to CycleLength04

The value in this register specifies how many X2X cycles are required on the respective interface for a the IO-Link process data to be completely updated.

The module automatically selects the best possible IO-Link cycle time per interface for the connected IO-Link device. This is always a multiple of the X2X cycle time. The cycle times of the 4 IO-Link interfaces are independent of one another.

Data type	Values
UINT	0 to 65,535

8.5.4 Reading

Name:
DeviceID01 to DeviceID04

This register contains the IO-Link device ID assigned by the manufacturer. The device ID can be read for every IO-Link interface.

Data type	Values
UDINT	0 to 4,294,967,295

8.5.5 Function ID

Name:
FunctionID01 to FunctionID04

This register contains the IO-Link function ID assigned by the manufacturer. The function ID can be read for every IO-Link interface.

Data type	Values
UINT	0 to 65,535

8.5.6 IO-Link vendor ID

Name:
VendorID01 to VendorID04

This register contains the IO-Link vendor ID. The ID can be read for every IO-Link interface.

Data type	Values
UINT	0 to 65,535

8.5.7 Cyclic input data

Name:
DataIn01_01 to DataIn01_27 (bus controller function model: up to xx01_04)
...
DataIn04_01 to DataIn04_27 (bus controller function model: up to xx04_04)

This register contains the cyclic input data for the respective interface.

Data type	Values
USINT	0 to 255

8.5.8 Cyclic output data

Name:
DataOut01_01 to DataOut01_30 (bus controller function model: up to xx01_04)
...
DataOut04_01 to DataOut04_30 (bus controller function model: up to xx04_04)

This register contains the cyclic output data for the respective interface.

Data type	Values
USINT	0 to 255

8.6 SIO mode

The IO-Link interface can be used like a digital input or output in SIO mode. To activate the SIO mode, the operating state must be set in the "Control0x" on page 8 register to DIGINPUT or DIGOUTPUT. Runtime configuration is not possible during operation in SIO mode, however the boot configuration can be used.

8.6.1 Digital input filter

Name:
ChInputFilter01 to ChInputFilter04

When operated as a digital input, a filter time can be configured in this register. Valid values for the filter time are 0 and 2 to 250. Value 0 disables the filter. Other values specify the filter time as a multiple of 0.1 ms.

Data type	Values	Filter
USINT	0	No software filter
	2	0.2 ms
	...	...
	10	1 ms (bus controller default setting)
	...	...
	250	25 ms - Higher values are limited to this value.

8.6.2 Digital inputs

Name:
DigitalInput01 to DigitalInput04

These registers display the input states of the digital inputs individually for each channel.

Data type	Values
USINT	See the bit structure.

Bit	Name	Value	Information
0	DigitalInput0x	0 or 1	Input state - Digital input x
1 - 7	Reserved	-	

8.6.3 Digital outputs

Name:
DigitalOutput01 to DigitalOutput04

These registers display the output states of the digital outputs individually for each channel.

Data type	Values
USINT	See the bit structure.

Bit	Name	Value	Information
0	DigitalOutput0x	0	Digital output x reset
		1	Digital output x set
1 - 7	Reserved	-	

8.7 Parameter

IO-Link devices can provide user parameters. There are two ways to access these parameters:

- "Boot configuration" on page 12
- "Runtime configuration" on page 12

8.7.1 Boot configuration

The values specified by the user are transferred during the boot procedure (or when the IO-Link device is connected).

Up to 32 parameter values can be specified for each IO-Link interface. 1, 2, and 4 byte parameters are supported.

The boot configuration can be used in the operating states OPERATE, DIGINPUT and DIGOUTPUT.

The following specifications are necessary for parameters that should be set during the boot procedure:

Name	Range of values	Description
Index	0 to 65535	Parameter index according to device manufacturer's specifications
Subindex	0 to 255	Parameter sub index according to device manufacturer's specifications
Length	1, 2, 4	Length of data in bytes
Data	0 to 4,294,967,295	Data to be written. Only low-order bytes are used for 1 or 2 byte parameters.

8.7.2 Runtime configuration

The runtime configuration can also be made after the IO-Link device has booted up. Parameters can be read or written.

The runtime configuration can take place in the cyclic data or through acyclic communication (function blocks AsIOAccRd and AsIOAccWr).

Runtime configuration is available for interfaces in the OPERATE state.

The following specifications are necessary for accessing parameters:

Name	Range of values	Description
Interface	0, 1, 2, 3	Addressed interface of the module
Sequence number	0 to 15	A change to this value indicates a new task. The sequence number is set identically to the value of the request in the response message.
Index	0 to 65535	Parameter index according to device manufacturer's specifications.
Subindex	0 to 255	Parameter sub index according to device manufacturer's specifications.
Length	0 to 228 (229)	Length of data in bytes. Up to 228 bytes are supported for write access and 229 bytes for read access. The length does not have to be specified when requesting a read access (the device reports the length of the read data).
Data		IO-Link supports up to 228 (229) bytes of data each time a parameter is accessed. The length is limited to 1, 2 or 4 bytes in the cyclic data with boot configuration and runtime configuration. The full data range can be used with acyclic runtime configuration (AsIOAcc Library).
Read/write	0, 1	For the request to the IO-Link device. 0 → read 1 → write
Errors	0, 1	Defined in the response from the IO-Link device. 0 → No error occurred 1 → Error When an error occurs, the first two bytes of data are contained in the error code (the reported length is 2).
Sequence number	0 to 15	

Access to an IO-Link device's parameters occurs via a request and subsequent response from the device.

A new request is detected due to a changed sequence number. Therefore, the sequence number must be the last data item that is written.

The response contains the sequence number of the request.

The length is not relevant for a read request. It is automatically determined by the IO-Link device and reported in the response message.

If an error occurs (e.g. due to accessing an index or sub index that does not exist), this is signaled by a set error bit in the response. The error response always has a length of 2. These 2 bytes contain the manufacturer-specific error code.

8.8 Object directory access

Writing to the corresponding registers "ParameterCmdOut" on page 15 and "ParameterCtrlOut" on page 14 defines and sends an order for reading or writing an IO-Link object.

Procedure for sending an order

- Define register "ParameterCmdOut" on page 15 by entering the length, index and subindex
- During write access, write the required parameter data that is to be stored in the object directory to registers "ParameterDataOut_XX" on page 15.
- Define register "ParameterCtrlOut" on page 14 by entering the interface number, read/write ID and the incremental sequence number. Additionally, an error bit can be configured during read access.

The module detects when the sequence number changes and accepts the order. Communication with the IO-Link device takes place.

When evaluating read/write access, the following is available from the register "ParameterCtrlIn" on page 14:

- Access sequence number
- Access interface number
- Type of access
- Payload length for read access to values smaller than 15 bytes
- Read access error bit

When evaluating read/write access, the following is available from the register "ParameterCmdIn" on page 14:

- Payload length for read access
- Access index and subindex

When evaluating read access, the following is available from the register "ParameterDataIn_XX" on page 15:

- Values read/written

During write access, the sequence number in register "ParameterCtrlIn" on page 14 is only set to the written value when processing the order has been completed and the parameter data has been read from the object directory for the IO-Link device and entered in the registers "ParameterDataIn_XX" on page 15.

A response provided by increasing the sequence number must be guaranteed (a timeout may be necessary for this purpose). That means, if the written sequence number from register "ParameterCtrlOut" on page 14 is accepted by register "ParameterCtrlIn" on page 14, then the application can safely assume that access has taken place.

Limit values for write/read access

- Index: 0 to 65535
- Subindex: 0 to 255
- Data length: 1 to 228 bytes for write access
- Data length: 1 to 229 bytes for read access

The resulting changes are written once to the IO-Link device without being temporarily saved on the module. That means, after disconnecting the IO-Link device, the values from the ODW registers are written back to the IO-Link device (see register "ODW_Data_XX" on page 15).

8.8.1 Response to read/write access

Name:
ParameterCtrlIn

This register contains the response for dynamic read/write access of the object directory.

Data type	Values
UINT	See the bit structure.

Bit structure:

Bit	Description	Value	Information
0 - 3	Sequence number	x	
4 - 7	Interface number	00	Interface 1
		01	Interface 2
		10	Interface 3
		11	Interface 4
8 - 11	Payload data length	0000 to 1111	Number of bytes
12 - 13	Reserved	-	
14	Read / write	0	Read access
		1	Write access
15	Errors	0	No error
		1	Errors

Payload data length

The payload data length of the parameter access is copied by the module from the register "ParameterCmdIn" on page 14 (bit 24 to 27). Because this is a 4-bit value, the specification of the payload length is possible for a value with a maximum of 15 bytes. In the event that parameter sets larger than 15 bytes are accessed, the information about the number of bytes read during the parameter access must be taken from "ParameterCmdIn".

8.8.2 Configuration of dynamic read/write access

Name:
ParameterCtrlOut

This register is used to configure dynamic read/write access of the object directory.

Data type	Values	Bus controller default setting
UINT	See the bit structure.	0

Bit structure:

Bit	Description	Value	Information
0 - 3	Sequence number	x	
4 - 7	Interface number	00	Interface 1 (bus controller default setting)
		01	Interface 2
		10	Interface 3
		11	Interface 4
8 - 13	Reserved	-	
14	Read / write	0	Read access (bus controller default setting)
		1	Write access
15	Error response (only defined for read access, this bit should be set to "0" for write access)	0	Inactive (bus controller default setting)
		1	Active

8.8.3 Feedback from I/O object information

Name:
ParameterCmdIn

This register returns the number of bytes read during a read access.

Data type	Values
UDINT	See the bit structure.

Bit structure:

Bit	Description	Value	Information
0 - 15	Object index being used	x	
16 - 23	Object subindex being used	x	
24 - 31	Number of bytes read	x	

8.8.4 Configuration of the I/O object information

Name:
ParameterCmdOut

This register is used to configure dynamic read/write access of the object directory.

Data type	Values	Bus controller default setting
UDINT	See the bit structure.	0

Bit structure:

Bit	Description	Value	Information
0 - 15	Object index	0 to 65535	Bus controller default setting: 0
16 - 23	Object subindex	0 to 255	Bus controller default setting: 0
24 - 31	Payload length in bytes	0 to 255	Bus controller default setting: 0

8.8.5 Runtime parameter data read

Name:
ParameterDataIn_0 to ParameterDataIn_57

The corresponding parameter data is written to this register during read access of the object directory for the IO-Link device.

The length specified in register "ParameterCmdOut" determines how many 4-byte registers are read from the object directory for the IO-Link device and how many in the last byte are still valid.

Data type	Values
UDINT	0 to 4,294,967,295

8.8.6 Runtime parameter data written

Name:
ParameterDataOut_0 to ParameterDataOut_57

The parameter data from this register is written during write access of the object directory for the IO-Link device.

The length specified in register "ParameterCmdOut" on page 15 determines how many 4-byte registers are written to the object directory for the IO-Link device and how many in the last byte are still valid.

Data type	Values	Information
UDINT	0 to 4,294,967,295	Bus controller default setting: 0

8.8.7 Boot parameter data

Name:
ODW_Data_0 to ODW_Data_127

This register contains parameter data for configuration of the IO-Link device.

Data type	Values	Information
UDINT	0 to 4,294,967,295	Bus controller default setting: 0

8.8.8 Boot I/O object information

Name:
ODW_Target_0 to ODW_Target_127

A write procedure on this register will transfer the parameter information from the corresponding "ODW_Data" on page 15 register to the IO-Link device.

Example:

If the ODW_Target_0 register is written to, the parameter data from ODW_Data_0 is applied by the module and transferred to the object dictionary of the IO-Link device.

Unlike short-term access, the values are also stored in RAM on the module in order to be able to reload these parameters in the object directory for the IO-Link device when restarting the IO-Link device.

Information:

"ODW_Data" must be defined before "ODW_Target".

Data type	Values	Bus controller default setting
UDINT	See the bit structure.	0

Bit structure:

Bit	Description	Value	Information
0 - 15	Object index	x	
16 - 23	Subindex	x	
24 - 27	Interface number	00	Interface 1 (bus controller default setting)
		01	Interface 2
		10	Interface 3
		11	Interface 4
28 - 30	Length in bytes	x	

8.9 Errors and warnings

Name:
ErrorsWarnings01 to ErrorsWarnings04

The counter is increased by one if the IO-Link device reports an error or warning.

An error is a fatal event if it causes an IO-Link device to lose its intended functionality. An error causes the IO-Link device to leave the OPERATE state (see "Operating state" on page 9) and re-initialize.

The cause of a warning could be one-time communication disturbances. Warnings are events that deviate from normal operating behavior but do not necessarily result in loss of functionality. Several consecutively occurring warnings can result in an error.

Data type	Values
USINT	See the bit structure.

Bit structure:

Bit	Description	Value	Information
0 - 3	Warning counter	x	Counts the errors that do not immediately lead to ending the communication with the IO-Link device
4-7	Error counter	x	Counts the errors that causes the IO-Link device to change from status "10 = cyclic data exchange" and be reinitialized

8.10 Event handling

If an event occurs on an IO-Link device, then the device retrieves it and stores the data in the following registers:

Register	Description
"EventPortSeq" on page 18	IO-Link device interface that triggered the event.
	Sequence number, incremented with each event
"Event description" on page 17	Event description: Instance, type and mode
"Event code" on page 17	Event code

The sequence number for the event counter is incremented by 1 with each event in order to notify the application. After the application has read the event data, the module has to use the "EventQuit" on page 18 register to signal that the values were retrieved from registers "EventQualifier" and "EventCode" and then the module can read the next event from IO-Link device. The value in register "EventPortSeq" is considered a correct acknowledgment value.

Events are available for interfaces in the OPERATE state. An event inhibit can also be set in Automation Studio. This is specified as a number of X2X Link cycles for an event before it can be overwritten by the next event. Events that occur during the inhibit time are cached on the module.

8.10.1 Event code

Name:
EventCode

This register is used to indicate the manufacturer-specific code for the IO-Link device.
In addition to manufacturer-specific codes, there are also the event codes specified for IO-Link in case the IO-Link device does not provide an EventCode.

Data type	Value	Information
UINT	0 to 65535	Event code
	0x34 / 0xFFF0	Invalid event from the IO-Link device
	0x54 / 0xFF80	IO-Link device message
	0x74 / 0xFF80	IO-Link device error
	0x74 / 0x6320	Parameter error
	0x70 / 0xFF10	Communication error

8.10.2 Event description

Name:
EventQualifier

IO-Link devices can generate events (including manufacturer-specific events). Information about the instance, type and mode of the event can be read from this register.

Data type	Values
USINT	See the bit structure.

Bit structure:

Bit	Description	Value	Information
0 - 2	Instance layer generated by the event	000	Unknown
		001	Hardware
		010	Data exchange layer for the IO-Link device
		011	Application layer for the IO-Link device
		100	Application
		101 to 111	Reserved
3	Reserved	-	
4 - 5	Type of event	00	Reserved
		01	Information
		10	Warning
		11	Errors
6 - 7	Mode of the event	00	Reserved
		01	One-time event
		10	Pending event is gone
		11	Pending event

8.10.3 Event interface

Name:
EventPortSeq

IO-Link devices can generate events (including manufacturer-specific events). Information about the interface that caused the event can be read from this register. By reading the sequence number, the application can determine if a new event has occurred. For this topic, see also "Event handling" on page 17.

Data type	Values
USINT	See the bit structure.

Bit structure:

Bit	Description	Value	Information
0 - 3	Interface	0	Interface 1
		1	Interface 2
		2	Interface 3
		3	Interface 4
		4 - 7	Reserved
4 - 7	Event counter	0 to 15	Sequence number is incremented with each new event that occurs

8.10.4 Acknowledge events

Name:
EventQuit

Register for acknowledging events so that the module can retrieve the next event. The event that has been read must be acknowledged with the value from register "EventPortSeq" on page 18.

Data type	Values
USINT	0 to 255

8.11 IO-Link cycle time

The I/O module automatically selects the best possible IO-Link cycle time per interface for the connected IO-Link device. This is always a multiple of the X2X cycle time. The cycle times of the 4 IO-Link interfaces are independent of one another. The module can read back which cycle time was selected for an IO-Link interface.

The minimum cycle time is 2.3 ms.