TECHNICAL INFORMATION

Photoelectric sensors

SICK Smart Sensors / IO-Link

Device configuration – Advanced operating instructions

SICK
Sensor Intelligence.

SMART SENSORS
IO-Link

Product described

IO-Link – photoelectric sensors

Manufacturer

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Legal information

Original document

This document is an original document of SICK AG.

Contents

1 About this document

1.1 Purpose of this document

This document is used to describe the functionality of individual ISDUs of IO-Link-capable devices from the field of photoelectric sensors, photoelectric proximity sensor and fiber optic sensors (so-called smart sensors). The following detection principles are covered:

WTB, WTF, WTL, WTS, WTT, WL, WLA, WLG, WE, WEO.

The individual range of functions of a specific sensor is shown in full in its IODD and in its technical information "**IODD-Overview**" on the respective product page at www.sick.com. The scope of functions of a specific sensor cannot be inferred from this document.

1.2 Intended use

Use IO-Link only as described in this documentation.

1.3 Symbols

NOTICE
This symbol indicates important information.

NOTE
This symbol provides additional information, e.g., dependencies / interactions between the described function and other functions, or when individual functions are not supported by every sensor.

2 Description of IO-Link

IO-Link communication interface

The product has the IO-Link communication interface.

IO-Link communication is a **Master-Device** communication system.

The sensor can be used in standard I/O mode (SIO) or in IO-Link mode (IOL). All automation functions and other parameter settings are effective in IO-Link mode and in standard I/O mode.

The following functions are supported via this standard IO-Link communication interface:

- Flexible sensor settings
- Digital transmission of the sensor signals to the **IO-Link Master**
- Visualization and configuration of the sensor
- Diagnosis / **Condition Monitoring**
- Device identification
- Easy device replacement
- **Events**

A detailed description of the adjustable functions and associated indices can be found in the technical information “IO-Link description”, available for download at www.sick.com.

IO-Link and control integration

IO-Link is a non-proprietary internationally standardized communication technology which makes it possible to communicate with sensors and actuators in industrial environments (IEC 61131-9).

IO-Link devices communicate with higher-level control systems via an **IO-Link Master**. The IO-Link devices are connected to these via a point-to-point connection.
IO-Link Master are available in different versions. In most cases, they are remote fieldbus gateways or input cards for the backplane bus of the control used.

For an **IO-Link Device** to communicate with the control system, both the **IO-Link Master** and the **IO-Link Device** must be created (integrated) in the hardware configuration in the control system manufacturer's engineering tool.

Not all manufacturers of control systems support the use of the IO-Link device description file (**IO-link Device Descreption = IODDs**). If a third-party **IO-Link Master** is used, the **IO-Link Device** can also be integrated by manually entering the relevant sensor parameters directly during hardware configuration.

To ensure that the **IO-Link Device** can be easily integrated into the control program, SICK also provides function blocks for many control systems. Among other things, these function blocks make it easier to read and write the individual sensor parameters and support the interpretation of the process data supplied by the **IO-Link Device** . You can also download them free of charge from the homepage: www.sick.com.

A number of tutorial videos are available on SICK's YouTube channel to assist with the integration of SICK **IO-Link Mastern**: www.youtube.com/SICKSensors.

If you have any questions, SICK Technical Support is available to help all over the world.

3 Documentation and accessories

Accessory components and additional information are available for integrating and setting the IO-Link device. You will find documentation and software, accessories and links to the **SICK Product ID**.

SICK product ID

The SICK product ID uniquely identifies the product. It also serves as the address of the web page with information on the product.

The SICK product ID comprises the host name pid.sick.com, the part number (P/N), and the serial number (S/N), each separated by a forward slash.

The SICK product ID is displayed as text and QR code on the type label and/or on the packaging.

Figure 1: SICK product ID

Documentation and software

- IODD: Device description file
- IODD overview: List of IODD contents
- IO-Link description: Detailed description of the process, service data and events of the IO-Link device
- SOPAS ET: Configuration software as a free download
- The documentation for SOPAS ET is stored in the system folder on your computer with the download: **C:\Program Files (x86)\SOPAS ET\help**
- Visualization file (SDD = **SOPAS Device Description**) for operation via SOPAS ET.
- Function Block Factory

IO-Link products can be easily connected to a computer via USB using the **SiLink master**. You can quickly and easily test or parameterize the connected products using the **SOPAS ET (SICK Engineering Tool** with graphic user navigation and convenient visualization).

Accessories

- **IO-Link master**
- **SiLink master**
- Connecting cables

4 Physical layer

The device data is automatically communicated to the **IO-Link Master** . It is important to ensure that the **IO-Link Master** used supports this performance data.

NOTICE
The maximum current consumption of the **IO-Link Device** (including load at the outputs) must not exceed the permissible output current of the respective port on the **IO-Link Master** .

The individual IO-Link device data differs from device to device and can be found in the online data sheet of the respective sensor as well as its addendum to operating instructions:

www.sick.com/[part number] --> Downloads --> Documentation

5 Integration of the sensor into the control level

Connecting the IO-Link device to the IO-Link Master

To operate the product in IO-Link mode, it must be connected to a suitable **IO-Link Master.** This is used for further integration into the control system.

NOTE
The cable length between the **IO-Link Master** and **IO-Link device:** maximum 20 m.

To enable the **IO-Link device** to be taken into account in the automation structure, the device must be registered by the **IO-Link Master** or PLC manufacturer via an **engineering tool** and the communication relationship must be parameterized. The device description IODD can be used for this purpose. It contains information on identification, device parameters, process and diagnostics data, communication properties, and more.

Download the **IODD-File** from www.sick.com or from the **IODD-Finder** of the IO-Link consortium (IODD finder). Make sure you always use the latest **IODD-File** .

NOTE
After successful connection of the product to the **IO-Link Master**, the green (Power) LED flashes to indicate a functioning IO-Link communication between the **master** and **device.**

6 Setting, configuration and integration

In addition to the manual setting on the device, the sensor can also be configured via IO-Link.

A list of all functions that can be configured can be found in the IODD and the IO link overview.

SOPAS ET

Setting via buttons (limited setting options if necessary)

Configuration via IO-Link

1. Setting via **SiLink-Box** (SOPAS ET)
2. Setting via **IO-Link Master** (PLC)
   - **IO-Link Master** from the PLC manufacturer
   - **IO-Link Master** from third-party manufacturer (SICK), more manual effort

Integrating the IO-Link device into the PLC

To simplify programming in the PLC, device-specific function blocks can be generated via the **Function Block Factory**.

Function blocks simplify acyclical communication (service data communication) between the PLC and **IO-Link Device** and the interpretation of process data. They provide device parameters and correct device data types and translate the parameters provided into indices and sub-indices.

7 Process data

Download the **IODD-File** from www.sick.com or from the **IODD-Finder** of the IO-Link consortium (IODD finder). Make sure you always use the latest **IODD-File** .

Process data are transmitted cyclically. There is no confirmation of receipt.
The master determines the cycle time, whereby this must not be less than the minimum cycle time of the sensor.

NOTE
The service data (acyclic data) does not influence the cycle time.

Process data structure for WTBxx, WTFxx, WTLxx, WTSxx, WLAxx, WLGxx, WSExx, each with “Base logic” Smart Task

Table 1: Process data structure – Basic logic

Byte offset	Byte 0								Byte 1							
Bit offset	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Name	Reserved														Q_{L2}	Q_{L1}
Data type	---														Boolean	Boolean
Description	Reserved														0 = OFF 1 = ON	0 = OFF 1 = ON

Process data structure for WTBxx, WTFxx, WTLxx, WTSxx, WLAxx, WLGxx, WSExx, each with “Time measurement and debouncing” Smart Task

Table 2: Process data structure – Time measurement and debouncing

Byte offset	Byte 0								Byte 1							
Bit offset	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Name	Time measurement value (tmsval)														Q_{L2}	Q_{L1}
Data type	Unsigned integer 14														Boolean	Boolean
Description	[ms or 10 ms or 100 ms]														0 = OFF 1 = ON	0 = OFF 1 = ON

Process data structure for WTBxx, WTFxx, WTLxx, WTSxx, WLAxx, WLGxx, WSExx, each with “Counter and debouncing” Smart Task

Table 3: Process data structure – Counter and debouncing

Byte offset	Byte 0								Byte 1							
Bit offset	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Name	Count value (cntval)														Q_{L2}	Q_{L1}
Data type	Unsigned integer 14														Boolean	Boolean
Description	---														0 = OFF 1 = ON	0 = OFF 1 = ON

Process data structure for WTBxx, WTFxx, WTLxx, WTSxx, WLAxx, WLGxx, WSExx, each with “Speed and length measurement” Smart Task

Table 4: Process data structure – Speed and length measurement

Byte offset	Byte 0								Byte 1							
Bit offset	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Name	Measurement value length (lngval) resp. Measurement value speed (spdval)														Qint. 1	Q_{L1}
Data type	Integer 14														Boolean	Boolean
Description	[mm] or [mm/s]														0 = OFF 1 = ON	0 = OFF 1 = ON

Process data structure for WTFxx, WTLxx, WTSxx, WLAxx, WLGxx, WSExx, each with “Object and gap monitor” Smart Task

Table 5: Process data structure – Object and gap monitor

Byte offset	Byte 0								Byte 1							
Bit offset	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Name	Time measurement value (tmsval)													Qint.1	$Q_{L\ Gap}$	$Q_{L\ Object}$
Data type	Unsigned integer 13													Boolean	Boolean	Boolean
Description	[ms]													0 = OFF 1 = ON	0 = OFF 1 = ON	0 = OFF 1 = ON

NOTE
In order to be able to use the maximum switching frequency for the switching output via pin 2 at the same time as IO-Link communication, configure pin 2 as Q/or Qint.1. **Pin 2/5 configuration** (Index 121).

Process data structure for WTT with or without Smart Task “Basic logic”

Table 6: Process data structure - WTTxx with or without Smart Task “Base Logic”

Byte offset	Byte 0								Byte 1								Byte 2								Byte 3							
Bit offset	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Name	Distance to object																Reserved						Qint .8	Qint .7	Qint .6	Qint .5	Qint .4	Qint .3	Qint .2	Qint .1	QL 2	QL 1
Data type	Unsigned integer 16																-						Boolean									
Description	[mm]																Reserved						0 = OFF 1 = ON									

8 Service data

Service data is only exchanged between the control and IO-Link sensor via the IO-Link master on request by the control (acyclically).

The respective counterpart confirms receipt of the data.

If the sensor does not answer within five seconds, the master reports a communication error.

NOTE
Not every function described in this document is available in every sensor. The complete list of the parameters available in the individual devices can be found in the “Addendum to operating instructions” document, which is found on the web page of the respective device: www.sick.com/[part number] --> Downloads --> Documents.

8.1 Device identification

Table 7: Device identification

ISDU			Name	Data type	Data repository	Length	Access	Default value	Value/range
Index		Sub-index							
DEC	HEX								
16	10	-	**Vendor Name**	String	-	7 bytes	ro	SICK AG	
18	12		**Product Name**			18 bytes			
19	13		**Product ID**			7 ... 64 bytes max. (device specific)			
219	DB	0	**Product ID**	Record		7 bytes			
		1	**Product ID IO-Link Device**	String		7 bytes			

The **Product ID** contains the part number of the connected IO-Link device. However, older devices may also contain a reference to index 219. In this case, the **Product ID** (part number) is stored under index 219.

*Table 8: Device identification – **Product Text / Serial Number***

ISDU			Name	Data type	Data repository	Length	Access	Default value	Value/range
Index		Sub-index							
DEC	HEX								
20	14	-	**Product Text**	String	-	45 ... 64 bytes max. (device specific)	ro		
21	15	-	**Serial Number**			8 ... 16 bytes max. (device specific)			

Serial number format:
YYWWnnnn (Y = year, W = week, n = sequential numbering)

NOTE
The serial number combined with the part number (**Product ID**) enables the device to be clearly identified.

*Table 9: Device identification – **Specific Tag / Specific Name***

ISDU			Name	Data type	Data repository	Length	Access	Default value	Value/range
Index		Sub-index							
DEC	HEX								
24	18	-	**Application Specific Tag**	String	yes	32 bytes	rw	*******	
64	40	-	**Device Specific Name**		no			*******	

Any text with a maximum of 32 characters can be stored in the **Application Specific Tag** . This can be useful for describing the exact position or task of the sensor in the overall machine. The **Application Specific Tag** is saved via the data repository.

Any text with a maximum of 32 characters can also be stored in the **Device Specific Name** . This name is not saved via the data storage and is therefore available for temporary/only valid information for this sensor.

*Table 10: Device identification - **Version***

ISDU			Name	Data type	Data repository	Length	Access	Default value	Value/range
Index		Sub-Index							
DEC	HEX								
22	16	-	Hardware version	String	-	4 ... 64 bytes (device specific)	ro	xxxx	
23	17	-	Firmware version			12 ... 64 bytes (device specific)	ro	Vxxx.xxx.xxx	

This ISDU indicates the hardware and software versions.

*Table 11: Device identification - **Find me***

ISDU			Name	Data type	Data repository	Length	Access	Default value	Value/range
Index		Sub-index							
DEC	HEX								
204	CC	-	Find me	UInt	no	8 bits	rw	0	0 = Find me deactivated 1 = Find me activated

The sensor can be uniquely identified using **Find me**. For machines with several identical sensors, it is therefore possible to uniquely identify the device with which communication is currently taking place.
When **Find me** is activated, either the yellow LED or all LEDs of the sensor flash at 1 Hz, depending on the sensor type.

8.2 General device settings

*Table 12: General device settings - **Standard command***

ISDU			Name	Data type	Data repository	Length	Access	Default value	Value/range
Index		Sub-index							
DEC	HEX								
2	02	-	Standard command	UInt	-	1 byte	wo		129 = Application Reset 130 = Restore Factory Settings 208 = Load selected job number 209 = Store to selected job number

Application Reset: resets application-specific settings.

Restore Factory Settings: the sensor is reset to the factory settings.

Load selected job number: the sensor is set to the settings defined by the selected job.

Store to selected job number: the current sensor settings are saved under the selected job.

*Table 13: General device settings - **Device access locks***

ISDU			Name	Data type	Data repository	Length	Access	Default value	Value/range	
Index		Sub-index								
DEC	HEX									
12	02	-	Device access locks (key lock)	Record	yes	2 bytes	rw		Bit no.	
									0	Not available
			Data storage lock					0	1	0 = Unlocked 1 = Locked
			Not available						2	Not available
			Local user interface lock					0	3	0 = Unlocked 1 = Locked
			Not available						4 – 15	Not available

Various functions of a sensor can be locked or unlocked with **Device access locks** . The functionality has been recorded in the IO-Link interface specification.

Bit 1	**Data storage lock**	You can lock the data repository functionality using bit 1. When the bit is set, the sensor rejects data repository write requests from the IO-Link master with an error message. For newer devices, the data repository function can no longer be deactivated.
Bit 2	**Local Parameterization Lock**	If the bit is set, the local control elements and the external input on the sensor are disabled.

Bit 3	**Local user interface lock**	The local control elements on the sensor are locked when the bit is set. The lock can be unlocked for a period of 30 seconds: Press the teach-in button for 8 seconds. After the 30 seconds have elapsed, the control elements are automatically locked again.[1] **Local user interface lock** is not available if the sensor does not have a housing operating element.

[1] If necessary, observe device-specific behavior.

*Table 14: General device settings - **Physical input / output type configuration pin 2***

ISDU			Name	Data type	Data repository	Length	Access	Default value	Value/range
Index		Sub-index							
DEC	HEX								
92	5C	-	Physical input / output type configuration pin 2	UInt	yes	1 byte	rw	3	1 = PNP 2 = NPN 3 = Push-pull

Physical input/output type configuration pin 2 makes it possible to determine the wiring on pin 2. If the device is used in an NPN network and pin 2 should be used as an input function, this parameter must be set to 2 = NPN in advance.

NOTE
Dependency: **Pin 2 configuration** (Index 121)

*Table 15: General device settings - **Sender configuration***

ISDU			Name	Data type	Data repository	Length	Access	Default value	Value/range
Index		Sub-index							
DEC	HEX								
97	61	-	Sender configuration	UInt	-	1 byte	rw	0	0 = Sender active 1 = Sender not active

This ISDU can be used to switch off the Send LED.
Alternatively, the sensor's Send LED can also be deactivated using the HIGH signal on pin 2 (when **Pin 2 configuration** (ISDU 121) is **Sender off**).
If the settings contradict one another, the Switch-off signal is dominant.
If the sensor does not have a Send LED (e.g. with WExx): **Sender configuration** is not available.

NOTE
Dependency: **Pin 2 configuration Sender off** (ISDU 121)

*Table 16: General device settings - **Oscillation frequency at output***

ISDU			Name	Data type	Data repository	Length	Access	Default value	Value/range
Index		Sub-Index							
DEC	HEX								
115	73	0	Oscillation frequency at output	UInt	yes	1 byte	rw	10	1 ... 50

The **Oscillation frequency at output** can be used to set the frequency (in Hz) at which the digital output of the sensor should oscillate when an object is detected.

NOTE
Only available for **MulitPulse** devices. For more details on **MultiPulse** functionality, see the operating instructions for the corresponding device.

*Table 17: General device settings - **Process data select***

ISDU			Name	Data type	Data repository	Length	Access	Default value	Value/range
Index		Sub-index							
Dec	Hex								
120	78	-	Process data select	UInt	yes	1 byte	rw	0	0 = device specific 1 = device specific 2 = device specific 3 = ...

Process data select can be used to determine which process data structure of the sensor is to be output cyclically. The possible process data structures are fixed. See the respective device documentation for details on the process data structures.

*Table 18: General device settings - **Pin 2 configuration***

ISDU			Name	Data type	Data repository	Length	Access	Default value	Value/range
Index		Sub-index							
DEC	HEX								
121	79	-	Pin2 configuration	UInt	yes	1 byte	rw	Device specific	0 = Deactivated / no function Inputs: 1 = External input (Smart Task) 16 = Sender off 17 = Teach-in Outputs: 32 = Detection output Q/ 33 = Quality of run alarm output 34 = Switching signal QL2 35 = Detection output Qint.1 36 = Detection output Qint.2 39 = Switching signal QL1 40 = Switching signal QL1/ 43 = Health output

Pin 2 configuration can be used to assign a range of input and output functions to pin 2 in the device connector (or the white wire when using a connecting cable).

Deactivated	The signal level at pin 2 is not evaluated.
External input (Smart Task)	Input signal; is processed in Smart Task (if present).
Sender off	Input signal; Level at pin 2 HIGH [1]: Sender LED of the sensor switched off Level at pin 2 LOW [2]: Sender LED of the sensor switched on (unless deactivated via the **Sender configuration** (Index 97). Does not apply for WExx devices.
Teach-in	Input signal; Level at pin 2 HIGH for at least 1 second [1]: Triggers the teach command. For WTBxx, WTFxx, WTLxx, WTSxx, WTTxx; the current distance between the sensor and the object in the light beam is set as the sensing range, if necessary corrected by the set **Teach-in offset** value (ISDU 90). For WLxx, WLGxx, WLAxx and, if necessary, WExx; the sensor's sensitivity is adjusted to the current energetic situation.
Detection output Q/	Output signal; signal level device specific WTBxx, WTFxx, WTLxx, WTSxx: LOW[2] if the detection object is detected by the sensor. WLxx, WLGxx, WLAxx, WExx: HIGH[1] if the detection object is detected by the sensor.
Quality of run alarm output	Output signal; HIGH[1] if the **Quality of run** value (ISDU 175) undercuts the set alarm threshold (**Quality of run alarm threshold**, ISDU 176).
Switching signal QL2	Output signal; switching signal generated from Smart Task.
Detection output Qint.1	Output signal; HIGH[1] when detection object is detected by sensor via Qint.1 channel.
Detection output Qint.2	Output signal; HIGH[1] when detection object is detected by sensor via Qint.2 channel.
Switching signal QL1	Output signal; switching signal generated from Smart Task.
Switching signal QL1/	Output signal; inverted signal to **QL1**.

Health output	Output signal; inverted signal to **Quality of run alarm output**.

1) HIGH = Signal level to L+
2) LOW = signal level at ground or pin/wire not connected

NOTE
Not every device supports each individual pin 2 function. See IODD of the relevant device for more information.

*Table 19: General device settings - **Notification Handling***

ISDU			Name	Data type	Data repository	Length	Access	Default value	Value/range
Index		Sub-index							
DEC	HEX								
227	E3	-	Notification Handling	Uint	yes	1 byte	rw	0	0 = All enabled 1 = All disabled 2 = Events enabled, PD invalid flag disabled 3 = Events disabled, PD invalid flag enabled

Notification Handling enables the generation of IO-Link events in the sensor and the function for marking the process data as invalid to be activated/deactivated.

*Table 20: General device settings - **Display settings***

ISDU			Name	Data type	Data repository	Length	Access	Default	Value/range
Index		Sub-Index							
DEC	HEX								
234	EA	0	Display settings	Record	Yes	8 bytes	rw	-	
		1	Display indicator mode, channel 1	Uint		8 bits (Offset 56 bits)		0	0 = Digits 1 = Bar graph 2 = Percentage value 3 = Counter value 4 = Edge value
		2	Display indicator mode, channel 2	Uint		8 bits (Offset 48 bits)		0	0 = Digits 1 = Bar graph 2 = Percentage value 3 = Counter value 4 = Edge value
		3	Display brightness	Uint		8 bits (Offset 40 bits)		50	10 ... 100
		4	Energy saving mode	Uint		8 bits (Offset 32 bits)		0	0 = OFF 1 = ON
		5	Turn display	Uint		8 bits (Offset 24 bits)		0	0 = OFF 1 = ON
		6	Display inversion	Uint		8 bits (Offset 16 bits)		0	0 = OFF 1 = ON
		7	Display alerts	Uint		8 bits (Offset 8 bits)		0	0 = OFF 1 = ON
		8	Display language	Uint		8 bits (Offset 0 bits)		1	1 = English 2 = German 7 = Chinese 8 = Japanese 10 = Korean

Display indicator mode, channel 1	Display mode channel 1 (corresponds to Qint.1) for displaying the ACTUAL and setpoint values on the display in relation to each other.
Display indicator mode, channel 2	Display mode channel 2 (corresponds to Qint.2) for displaying the ACTUAL and setpoint values on the display in relation to each other.
Display brightness	Display brightness
Energy saving mode	When energy-saving mode is activated, the display is deactivated 120 seconds after the last input.
Turn display	Rotation of the display by 180°.
Display inversion	Inversion of the display colors of the display.
Display alerts	Alarm indicator on the display.
Display language	Language of the display texts.

NOTE
The availability of the individual functions is device-specific.

*Table 21: General device settings - **Eco mode***

ISDU			Name	Data type	Data reposi-tory	Length	Access	Default value	Value/range
Index		Sub-index							
DEC	HEX								
235	IB	0	**Eco mode**	UInt	yes	3 bytes	rw	0	0 = **Off** 1 = **On**

When activating eco mode, the display is deactivated 20 s after the last entry.

*Table 22: General device settings – **Inverter external input***

ISDU			Name	Data type	Data stor-age	Length	Access	Default value	Value/Range
Index		Sub-index							
Dec	Hex								
1093	445	-	**Inverter external input**	UInt	yes	1 byte	rw	0	0 = **Not inverted** 1 = **Inverted**

If the **Inverter external input** is activated, all binary input signals read via pin 2 are inverted before device-internal processing. Teach-in input signals are exceptions. These are always processed non-inverted regardless of the **Inverter external input** setting.

NOTE
Depending on the device generation, the **Inverter external input** only functions for Smart Task input signals and therefore depending on the setting under ISDU 121 **Pin 2 configuration.**

*Table 23: General device settings - **Device ID setup***

ISDU			Name	Data type	Data reposi-tory	Length	Access	Default value	Value/Range
Index		Sub-index							
Dec	Hex								
16000	3E80	-	**Device ID setup**	UInt	no	4 bytes	rw	Device ID	Device specific

You can use **Device ID setup** to set which **Device-ID** the sensor should work with (according to the value range supported by the respective sensor). Individual IO-Link device parameters and possibly also the IO-Link device behavior differ depending on the **Device-ID** setting. By switching the **Device-ID**, for example, a fundamentally different device mode can be activated or the IO-Link-related device behavior of an already controlled predecessor device can be activated in the current device, thus establishing backwards compatibility.

Switching to **Device-ID** only takes effect the next time the device is started up.

NOTE
If an older **Device-ID** is activated, the index 16000 **Device ID setup** may disappear from the index space of the sensor. In this case, the system command **Restore Factory Settings** (index 2, value 130) can be used to restore the default **Device-ID**, which supports index 16000 **Device ID setup.**

NOTE
The IO-Link parameters and IO-Link communication properties for each supported **Device-ID** are described in the corresponding IODD.

8.3 Teach-in/detection settings for WTB, WTF, WTM, WTL and WTS devices

*Table 24: Teach-in/detection - **Standard Command***

ISDU			Name	Data type	Data repository	Length	Access	Default value	Value/range
Index		Sub-Index							
DEC	HEX								
2	2	-	Standard command	UInt	-	1 byte	wo	-	65 = Single value teach / Teach SP1 67 = Teach SP1 TP1 68 = Teach SP1 TP2 79 = Abort Teach-in sequence

After triggering the command **Single value teach** or **Teach SP1** , the current distance between the sensor and the object in the light beam is set as the sensing range. **Qint.1 SP1 sensing range** (index 60) and **Qint.2 SP1 sensing range** (index 62) change accordingly.

Alternatively, the sensing range can also be set by first teaching the distance between the sensor and the object (→ command **Teach SP1 TP1**) and then teaching the distance between the sensor and the background (→ command **Teach SP1 TP2**). This completes the teach-in sequence and the sensing range is placed in the middle of the two teach-in points. The command **Teach SP1 TP2** is only executed by the sensor if the command **Teach SP1 TP1** has been issued beforehand. Instead of the second command **Teach SP1 TP2**, this teach-in sequence can also be ended using the command **Abort Teach-in sequence**; the last valid SP1 is retained. **Teach SP1 TP1** and **Teach SP1 TP2** is only available in the **Operation modes** "BGS ..." (see index 83).

NOTE
The command **Single value teach** or **Teach SP1** can also be triggered as follows:

- Triggering teach-in using the teach-in button on the sensor housing (if present).
- Triggering the teach-in using the HIGH signal (L+) on pin 2 (when **Pin 2 configuration** (index 121)) is set to **Teach-in**).

NOTE
Dependency:

- **Teach-in channel** (Index 58)
- **Qint.1 SP1 sensing range** (Index 60)
- **Qint.2 SP1 sensing range** (Index 62)
- **Operation mode** (Index 83)
- **Quality of Teach** (Index 114)

*Table 25: Teach-in/detection - **Teach-in channel / Teach state***

ISDU			Name	Data type	Data repository	Length	Access	Default value	Value/range
Index		Sub-Index							
DEC	HEX								
58	3A	-	Teach-in channel	UInt	no	1 byte	rw	0	0 = Default Qint. = Qint.1 1 = Qint.1 2 = Qint.2
59	3B	-	Teach-in state	Record	-	1 byte	ro	-	
			Teach flag SP1 TP2	Boolean		1 bit (Offset 5 bit)			0 = SP1 TP2 not taught or not successfull 1 = SP1 TP2 successfully taught
			Teach flag (SP1 TP1)	Boolean		1 bit (Offset 4 bit)			0 = SP1 (TP1) not taught or not successfull 1 = SP1 (TP1) successfully taught
			Teach state	UInt		4 bit (Offset 0 bit)			0 = IDLE 1 = SP1 SUCCESS 4 = WAIT FOR COMMAND 5 = BUSY 7 = ERROR

Teach-in channel allows you to select the Qint. channel to which the teach-in commands (index 2, value 65, 67 and 68) apply. Depending on the device type, only one teach-in channel is available for the teach-in process. No teach-in channel other than the preset one can then be used.

The **Teach-in state** shows the current status of the teach-in procedure.

A teach-in can only be sent in IDLE, SP1 SUCCESS and ERROR status. The status always refers to the Qint. channel currently selected in Teach-in channel (index 58). The teach flags are designed according to the individual device equipment.

*Table 26: Teach-in/detection - **Qint.1***

ISDU			Name	Data type	Data repository	Length	Access	Default value	Value/range
Index		Sub-Index							
DEC	HEX								
60	3C	0	**Qint.1 SP1 / SP2**	Record	yes	3 bytes	rw	-	
		1	**Qint.1 SP1 sensing range**			16 bits		device specific	device specific
		2	**Qint.1 SP2 sensing range**			8 bits		-	not used
61	3D	0	**Qint.1 configuration**	Record	yes	4 bytes	rw	-	
		1	**Qint.1 Switchpoint logic**			8 bits (Offset 24 bits)		128	128 = **Vendor specific**
		2	**Qint.1 Switchpoint mode**			8 bits (Offset 16 bits)		128	128 = **Vendor specific**
		3	**Qint.1 Switchpoint hysteresis**			16 bits (Offset 0 bits)		0	0 = **Auto-defined hysteresis**

Qint.1 SP1 sensing range can be used to adjust the switching distance of the sensor (in mm).
The permissible value range is device-specific and can be found in the data sheet of the respective sensor. Depending on the device generation, value inputs are accepted over the full 16-bit value range and, if necessary, automatically corrected by the sensor to the permissible maximum or minimum (older device generations, recognizable by a value range according to IODD of 0 ... 65535). With newer device generations, the value range according to IODD already corresponds to the actual operating distance range of the device plus ten percent; entries beyond this value range are rejected with an error message. The previous input value is retained.

If the current distance between sensor and detection object is the same or less than the set **Qint.1 SP1 sensing range** value, the Qint.1 detection signal switches to HIGH.

The selected sensing range can be overwritten by:

- Triggering teach-in using the teach-in button on the sensor housing.
- Triggering teach-in using the HIGH signal (L+) on pin 2 (when **Pin 2 configuration** (index 121) is set to **Teach-in**).

Qint.1 SP2 sensing range has no function.

Depending on the device, **Qint.1 SP1 / SP2** (index 60) and **Qint.2 SP1 / SP2** (index 62) are synchronized with each other.
A change to one index is automatically applied to the other index.

NOTE
Dependency:

- **Single value teach** system command (index 2, value 65).
- **Qint.2 SP1 sensing range** (Index 62).

Qint.1 Switchpoint logic has no function.
Qint.1 Switchpoint mode has no function.
Qint.1 Switchpoint hysteresishas no function.

*Table 27: Teach-in/detection - **Qint.2***

ISDU			Name	Data type	Data repository	Length	Access	Default value	Value/range
Index		Sub-Index							
DEC	HEX								
62	3E	0	**Qint.2 SP1 / SP2**	Record	yes	3 bytes	rw	-	
		1	**Qint.2 SP1 sensing range**			16 bits		device specific	device specific
		2	**Qint.2 SP2 sensing range**			8 bits		-	not used

ISDU			Name	Data type	Data repository	Length	Access	Default value	Value/range
Index		Sub-Index							
DEC	HEX								
63	3F	0	**Qint.2 configuration**	Record	yes	4 bytes	rw	-	
		1	**Qint.2 Switchpoint logic**			8 bits (Offset 24 bits)		128	128 = **Vendor specific**
		2	**Qint.2 Switchpoint mode**			8 bits (Offset 16 bits)		128	128 = **Vendor specific**
		3	**Qint.2 Switchpoint hysteresis**			16 bits (Offset 0 bits)		0	0 = **Auto-defined hysteresis**

The switching distance of the sensor can be set via **Qint.2 SP1 sensing range** (in mm). The permissible value range is device-specific and can be found in the data sheet of the respective sensor. Depending on the device generation, value inputs are accepted over the full 16-bit value range and, if necessary, automatically corrected by the sensor to the permissible maximum or minimum (older device generations, recognizable by a value range according to IODD of 0 ... 65535). With newer device generations, the value range according to IODD already corresponds to the actual operating distance range of the device plus ten percent; entries beyond this value range are rejected with an error message. The previous input value is retained.

If the current distance between sensor and detection object is the same or less than the set **Qint.2 SP1 sensing range** value, the Qint.2 detection signal switches to HIGH.

The selected sensing range can be overwritten by:

- Triggering teach-in using the teach-in button on the sensor housing.
- Triggering teach-in using the HIGH [1)] signal on pin 2 (if **Pin 2 configuration** (index 121) is set to **Teach-in**).

Qint.2 SP2 sensing range has no function.

Depending on the device, **Qint.1 SP1** / **SP2** (index 60) and **Qint.2 SP1** / **SP2** (index 62) are synchronized with each other. Any changes made to one of the ISDUs are automatically accepted by the other ISDU.

NOTE
Dependency:

- **Single value teach** system command (index 2, value 65).
- **Qint.1 SP1 sensing range** (Index 60).

Qint.2 Switchpoint logic has no function.
Qint.2 Switchpoint mode has no function.
Qint.2 Switchpoint hysteresis has no function.

Table 28: Teach-in/detection - ***Detection mode***

ISDU			Name	Data type	Data repository	Length	Access	Default value	Value/range
Index		Sub-Index							
DEC	HEX								
83	53	-	**Detection mode**	UInt	yes	1 byte	rw	0	0 = **Switching mode** 1 = **Distance measuring mode**

Photoelectric proximity sensors which can not only detect binary detection signals, but also the distance to the object, feature the **Detection mode** function. Depending on the setting, the photoelectric proximity sensor is in switching or measuring mode.

The setting of **Detection mode** also affects **Process data select** (Index120):

- In the setting "0 = **Switching mode**", **Process data select** is automatically set to "0 = **Switching signals**".
- In the setting "1 = **Distance measuring mode**", **Process data select** is automatically set to "1 = **Distance to object**".

NOTE
Dependency:

- **Process data select** (Index 120)

1) HIGH = signal level on L+

*Table 29: Teach-in/Detection - **Operation mode***

ISDU			Name	Data type	Data repository	Length	Access	Default value	Value/range
Index		Sub-Index							
DEC	HEX								
83	53	-	Operation mode	UInt	yes	1 byte	rw	0	0 = BGS Qint.1, 1 point teach, AS 1 1 = BGS Qint.1, 1 point teach, AS 2 2 = BGS Qint.1, 2 point teach, AS 1 4 = BGS Qint.1 and Qint.2, 1 point teach, AS 1 6 = FGS Qint.1, 1 point teach, AS 1 16 = Distance measurement

In newer generation devices, index 83 as an **Operation mode** performs more functions. Explanation of abbreviations:

BGS = **Background suppression**	Setting the switching point to the surface of the object to be detected or slightly behind it. Objects further away are not detected. Objects at the switching point or closer objects are detected.
FGS = **Foreground suppression**	Setting the switching point to an unchangeable, fixed background object (e.g. machine part) within the maximum sensor scanning range according to the data sheet. Closer objects and a loss of the optical signal (e.g. due to reflection) are interpreted by the sensor as object detection.
AS = **ApplicationSelect**	Enables an application-specific fine adjustment of the selected **Operation mode**. **ApplicationSelect** 1: Standard scanning range of the sensor with maximum switching frequency. **ApplicationSelect** 2: Increases the scanning range of the sensor and improves the detection of black and obliquely-oriented objects. This also reduces the switching frequency of the sensor.

The various operating modes correspond to the corresponding settings that can be made via the **BluePilot** control unit on the sensor itself.

Functioning in detail:

BGS Qint.1, 1 point teach, AS 1 **BGS Qint.1, 1 point teach, AS 2** **BGS Qint.1, 2 point teach, AS 1**	Activates BGS mode on Qint.1 with AS 1 or AS 2. The teach-in variant is also defined, which can be activated using the teach-in button on the sensor housing. “1 **point teach**” corresponds to the **Teach SP1** system command (index 2, value 65). “2 **point teach**” corresponds to the **Teach SP1 TP1** and **Teach SP1 TP2** system command (index 2, value 67 and 68). Regardless of the mode selected here, any teach-in command via system command (index 2) can be used. Qint.2 has no function in these modes.
BGS Qint.1 and Qint.2, 1 point teach, AS 1	Activates BGS mode on Qint.1 and Qint.2 with AS 1. Defined teach-in variant that can be triggered via the teach-in button on the sensor housing: “1 **point teach**” corresponds to the **Teach SP1** system command (index 2, value 65). Regardless of this mode, any teach-in command via system command (index 2) can be used.
FGS Qint.1, 1 point teach, AS 1	Activates FGS mode on Qint.1 with AS 1. Defined teach-in variant that can be triggered via the teach-in button on the sensor housing and via system command (index 2): “1 **point teach**” or **Teach SP1** system command (index 2, value 65). System command **Teach SP1 TP1** and **Teach SP1 TP2** (index 2, value 67 and 68) are not available. Qint.2 has no function in this mode.
BGS Window Qint.1 and Qint.2, 1 point teach, AS 1	Activates BGS mode on Qint.1 and Qint.2 with AS 1. Defined teach-in variant that can be triggered via the teach-in button on the sensor housing: “1 **point teach**” corresponds to the **Teach SP1** system command (index 2, value 65). Regardless of this mode, any teach-in command via system command (index 2) can be used. The window function is implemented via the logical connection of the Qint.1 and Qint.2 signals in the Smart Task A00 → see see "Smart Task “Basic logic” (A00)", page 42. The relevant smart task indices are reconfigured accordingly.
Distance measurement	Activates the distance measurement function. Teach-in commands as well as Qint.1 and Qint.2 are not available.

The **Operation mode** setting also affects **Process data select** (Index120):

- In the “16 = **Distance measuring**” setting, **Process data select** is automatically set to “1 = **Distance to object**”.
- For all other settings, **Process data select** is automatically set to “0 = **Switching signals**”.

NOTE

Dependency:

- **Process data select** (Index 120)

*Table 30: Teach-in/Detection - **Teach-in offset***

ISDU			Name	Data type	Data repository	Length	Access	Default value	Value/range
Index		Sub-Index							
DEC	HEX								
90	5A	-	Teach-in offset	Int	yes	1 byte	rw	0	-100 ... +100 Alternatively: -50 ... +50

When this function is in use, when triggering a teach-in command (via the teach-in button on the sensor housing or via the **Single value teach** system command (ISDU 2, value 65)), the defined detection point is corrected by the set value.

This function makes it possible to increase detection reliability, especially for teach-in ongoing processes, by moving the detection point with the **Teach-in offset** e.g. “into the object”.

NOTE
Dependency:

Single value teach system command (ISDU 2, value 65)

NOTE
The **Teach-in offset** does not work if a sensing range is set directly via **Qint.x SP1/SP2** (ISDU 60/62).

*Table 31: Teach-in/Detection - **Current receiver level***

ISDU			Name	Data type	Data repository	Length	Access	Default value	Value/range
Index		Sub-Index							
DEC	HEX								
180	B4	-	Current receiver level (live)	UInt	-	1 byte	ro	-	0 ... 16383

Current receiver level (live) shows the sensor’s current energy-related receiver level as an absolute value in digits. This value therefore delivers additional information about the object on which the sensor light spot falls at the time of read out.

The displayed value is not affected by the teach-in or from other sensor settings. It also does not directly affect the detection behavior of the sensor. The value is not calibrated and can fluctuate from sensor to sensor.

*Table 32: Teach-in/Detection - **Distance to object***

ISDU			Name	Data type	Data repository	Length	Access	Default value	Value/range
Index		Sub-Index							
DEC	HEX								
229	E5	0	Distance to object	Record	-	3 bytes	ro	-	
		1	Distance	UInt		16 bits (Offset 8)			0 ... 30000
		2	Distance qualifier	UInt		2 bits (Offset 0)			0 = Distance in range / valid 3 = No distance information / distance invalid

This parameter can be used to output the measured distance to the object or the background (if available and in sensing range) as a **Distance** in mm or 1/10 mm (depending on the device – see IODD of the respective device for details). If no measured value can be detected (e.g. because the sensor is facing empty space) or if the measured value is outside of the specified sensing range, the sensor delivers output value “30,000”, which is to be interpreted as an invalid measurement.

Each measured value must be linked with the **Distance qualifier.** This value specifies whether the current output measured value is valid or not.

NOTE
Separate access to sub-index 1 or 2 is not possible.

8.4 Teach-in / detection settings for WL and WLA devices

*Table 33: Teach-in/Detection - **Standard Command***

ISDU			Name	Data type	Data repository	Length	Access	Default value	Value/range
Index		Sub-Index							
DEC	HEX								
2	2	-	**Standard command**	UInt	-	1 byte	wo	-	65 = **Single value teach**

For WL devices, we recommend performing a teach-in process after connecting the sensor and aligning it to the reflector. This automatically adjusts the sensor's receiver sensitivity, taking into account the current light receiver level, so that the detection signal is as reliable as possible.

For WLA devices, a teach-in process is not required for detector-related reasons, as these systems guarantee reliable and robust object detection even at maximum sensitivity (= delivery status).

To be able to use all of the following functions/parameters to their full extent, a teach-in process must be triggered:

- **Qint.1 SP1 / SP2** (ISDU 60) or **Qint.2 SP1 / SP2** (ISDU 62)
- **Quality of run** (ISDU 175)
- **Quality of run alarm** (ISDU 176)
- **Current receiver level** (ISDU 180)

With every teach-in process, the sensor's current light receiver level, **Current receiver level** (live) (ISDU 180), is standardized at 100%. These 100% levels are the energy-based reference values for the aforementioned functions and parameters. If the teach-in process is not performed, the reference value is undefined and the listed functions and parameters do not deliver any valid information.

To achieve the same effect as the "Single value teach" standard command, you can trigger teach-in using the teach-in pushbutton on the sensor housing (if present) or trigger teach-in via the HIGH signal (L+) at pin 2 (when **Pin 2 configuration** (ISDU 121) is set to **Teach-in**).

NOTE
Dependency:

- **Qint.1 SP1 / SP2** (ISDU 60)
- **Qint.2 SP1 / SP2** (ISDU 62)
- **Quality of run** (ISDU 175)
- **Quality of run alarm** (ISDU 176)
- **Current receiver level (live)** (ISDU 180)

*Table 34: Teach-in/Detection - **Teach-in channel / Teach state***

ISDU			Name	Data type	Data repository	Length	Access	Default value	Value/range
Index		Sub-Index							
DEC	HEX								
58	3A	-	**Teach-in channel**	UInt	-	1 byte	rw	0	0 ... 2 = **Default BDC**
59	3B	-	**Teach-in state**	Record	-	1 byte	ro	-	
			Teach flags			1 bit (Offset 4 bits)			0 = **Teachpoint 1** not taught 1 = **Teachpoint 1** successfully taught
			Teach state			4 bits (Offset 0 bits)			0 = **IDLE** 1 = **SP1 SUCCESS** 5 = **BUSY** 7 = **ERROR**

Selection of the Qint. channel that is affected by the **Single value teach** (ISDU 2, value 65) system command.
Only one teach-in channel is available for the teach-in process for WL and WLA devices. Only the preset teach-in channel can be used.

The **Teach state** shows the current status of the teach-in process.
A teach-in process can only be performed when the status is **IDLE**, **SP1 SUCCESS** and **ERROR**.
The status always refers to the Qint. channel selected in **Teach-in channel** (ISDU 58).

The **Teach flags** have no function for WL and WLA devices.

*Table 35: Teach-in / detection - **Qint.1***

ISDU			Name	Data type	Data repository	Length	Access	Default value	Value/range
Index		Sub-Index							
DEC	HEX								
60	3C	0	**Qint.1 SP1 / SP2**	Record	yes	2 bytes	rw	-	
		1	**SP1 upper threshold (switch-on)**			8 bits (Offset 8 bits)		50	50
		2	**SP2 lower threshold (switch-off)**			8 bits (Offset 0 bits)		45	45
61	3D	0	**Qint.1 configuration**	Record		4 bytes		-	
		1	**Switchpoint logic**			8 bits (Offset 24 bits)		128	128 = **Vendor specific**
		2	**Switchpoint mode**			8 bits (Offset 16 bits)			
		3	**Switchpoint hysteresis**			16 bits (Offset 0 bits)		0	0 = **Auto-defined hysteresis**

Qint.1 SP1 / SP2 is used to defined the switch-on and switch-off threshold for the detection signal (as percentages). The selected values are based on the energy-based receiver value (=100%) defined during the last teach-in process.

SP1 upper threshold (switch-on): Switch-on threshold.
If the **Current receiver level (live)** (ISDU 180) exceeds the selected switch-on threshold, the **Qint.1** detection signal changes to LOW (no object detected in beam path).

SP2 lower threshold (switch-off): Switch-off threshold.
If the **Current receiver level (live)** (ISDU 180) falls below the set switch-off threshold, the **Qint.1** detection signal switches to HIGH (object detected in beam path).

NOTE
The default switch-on and switch-off thresholds cannot be adjusted in WL / WLA devices. This is only possible in WLG devices (see "Teach-in / detection settings for WLG devices", page 26). The settings and their effects are redundant to those in ISDU 62.

NOTE
Dependency:

- **Qint.2 SP1 / SP2** (ISDU 62)
- **Current receiver level** (live) (ISDU 180)

Switchpoint logic has no function.
Switchpoint mode has no function.
Switchpoint hysteresis has no function.

*Table 36: Teach-in / detection - **Qint.2***

ISDU			Name	Data type	Data repository	Length	Access	Default value	Value/range
Index		Sub-Index							
DEC	HEX								
62	3E	0	**Qint.2 SP1 / SP2**	Record	yes	2 bytes	rw	-	
		1	**SP1 upper threshold (switch-on)**			8 bits (Offset 8 bits)		50	50
		2	**SP2 lower threshold (switch-off)**			8 bits (Offset 0 bit)		45	45
63	3F	0	**Qint.2 configuration**	Record		4 bytes		-	
		1	**Switchpoint logic**			8 bits (Offset 24 bits)		128	128 = **Vendor specific**
		2	**Switchpoint mode**			8 Bit (Offset 16 bits)			
		3	**Switchpoint hysteresis**			16 bits (Offset 0 bits)		0	0 = **Auto-defined hysteresis**

Qint.2 SP1 / SP2 is used to defined the switch-on and switch-off threshold for the detection signal (as percentages). The selected values are based on the energy-based receiver value (=100%) defined during the last teach-in process.

SP1 upper threshold (switch-on): Switch-on threshold.
If the **Current receiver level (live)** (ISDU 180) exceeds the selected switch-on threshold, the **Qint.1** detection signal changes to LOW (no object detected in beam path).

SP2 lower threshold (switch-off): Switch-off threshold.
If the **Current receiver level (live)** (ISDU 180) falls below the selected switch-off threshold, the **Qint.1** detection signal changes to HIGH (object detected in beam path).

NOTE
The default switch-on and switch-off thresholds cannot be adjusted in WL / WLA devices. This is only possible in WLG devices (see "Teach-in / detection settings for WLG devices", page 26). The settings and their effects are redundant to those in ISDU 60.

NOTE
Dependency:

- **Qint.1 SP1 / SP2** (ISDU 60)
- **Current receiver level (live)** (ISDU 180)

Switchpoint logic has no function.
Switchpoint mode has no function.
Switchpoint hysteresis has no function.

*Table 37: Teach-in / detection - **Current receiver level***

ISDU			Name	Data type	Data repository	Length	Access	Default value	Value/range
Index		Sub-Index							
DEC	HEX								
180	B4	-	Current receiver level (live)	UInt	-	1 byte	ro	-	0 ... 255

Current receiver level (live) shows the sensor's current energy-related receiver level (as a percentage). The reference point (equivalent to 100%) is the **Current receiver level (live)** at the time of the last teach-in.
For further details, see the **Single value teach** standard command (ISDU 2, value 65).

NOTE
Dependency:

- System command **Single value teach** (ISDU 2, value 65)

8.5 Teach-in / detection settings for WLG devices

*Table 38: Teach-in/detection - **Standard Command***

ISDU			Name	Data type	Data repository	Length	Access	Default value	Value/range
Index		Sub-index							
DEC	HEX								
2	2	-	Standard command	UInt	-	1 byte	wo	-	65 = Single value teach

For WLG devices, a teach-in process must be performed after connecting the sensor and aligning it to the reflector. This automatically adjusts the receiver sensitivity of the sensor, taking into account the current light reception level, so that the detection signal is as reliable as possible, even for highly transparent objects.
In addition, with every teach-in, the current light reception level of the sensor, **Current receiver level (live)** (index 180), is standardized at 100%. This 100% level is the energy reference value for the following appliance functions:

- **Qint.1 SP1 / SP2** (Index 60) or **Qint.2 SP1 / SP2** (ISDU 62)
- **Quality of teach** (Index 114)
- **Quality of run** (Index 175)

- **Upper threshold (switch-on) dynamic** (index 181); effective detector-related switch-on and switch-off thresholds
- **Lower threshold (switch-off) dynamic** (index 182); effective detector-related switch-on and switch-off thresholds

The teach-in process must be repeated each time the sensor or reflector is realigned or whenever the sensor or reflector is replaced in order to guarantee that the energy-related reference signal is always up-to-date, e.g., for assessing contamination on the sensor's front screen or the reflector. This also applies to the use of the data repository function (see "Sensor replacement/data storage", page 60).

If the teach-in process is not performed, the reference value is undefined and the listed functions and parameters do not deliver any valid information.

The **Single value teach** standard command has the same effect:

- Triggering teach-in using the teach pushbutton on the sensor housing (if present).
- Triggering teach-in using the HIGH signal (L+) on pin 2 (if **Pin 2 configuration** (index 12) is set to **Teach-in**).

NOTE

Dependency:

- **Qint.1 SP1 / SP2** Index 60)
- **Qint.2 SP1 / SP2** (Index 62)
- **Quality of run** (Index 175)
- **Quality of run alarm** (Index 176)
- **Current receiver level (live)** (Index 180)
- **Upper threshold (switch-on) dynamic** (Index 181)
- **Lower threshold (switch-off) dynamic** (Index 182)

*Table 39: Teach-in/detection - **Teach-in channel / Teach state***

<table>
<tr><th colspan="3">ISDU</th><th rowspan="3">Name</th><th rowspan="3">Data type</th><th rowspan="3">Data reposi-tory</th><th rowspan="3">Length</th><th rowspan="3">Access</th><th rowspan="3">Default value</th><th rowspan="3">Value/range</th></tr>
<tr><th colspan="2">Index</th><th rowspan="2">Sub-index</th></tr>
<tr><th>DEC</th><th>HEX</th></tr>
<tr><td>58</td><td>3A</td><td>-</td><td>Teach-in channel</td><td>UInt</td><td>-</td><td>1 byte</td><td>rw</td><td>0</td><td>0 ... 2 = Default BDC</td></tr>
<tr><td rowspan="3">59</td><td rowspan="3">3B</td><td rowspan="3">-</td><td>Teach-in state</td><td>Record</td><td rowspan="3">-</td><td>1 byte</td><td rowspan="3">ro</td><td rowspan="3">-</td><td></td></tr>
<tr><td>Teach flags</td><td></td><td>1 bit
(Offset 4 bits)</td><td>0 = Teachpoint 1 not taught
1 = Teachpoint 1 successfully taught</td></tr>
<tr><td>Teach state</td><td></td><td>4 bits
(Offset 0 bit)</td><td>0 = IDLE
1 = SP1 SUCCESS
5 = BUSY
7 = ERROR</td></tr>
</table>

Selection of the Qint. channel that is affected by the **Single value teach** system command (index 2, value 65).
With WLG devices, only one teach-in channel is available for the teach-in process. Only the preset teach-in channel can be used.

The **Teach state** shows the current status of the teach-in process. A teach-in process can only be performed in the status **IDLE, SP1 SUCCESS** and **ERROR** .
The status always refers to the Qint. channel currently selected via the **Teach-in channel** (index 58).
The **Teach flags** do not have a function for WLG devices.

*Table 40: Teach-in/detection - **Qint.1***

ISDU			Name	Data type	Data repository	Length	Access	Default value	Value/range
Index		Sub-index							
DEC	HEX								
60	3C	0	**Qint.1 SP1 / SP2**	Record	yes	2 bytes	rw	-	
		1	**SP1 upper threshold (switch-on)**			8 bits (Offset 8 bits)		90	10 to 90 110 to 200
		2	**SP2 lower threshold (switch-off)**			8 bits (Offset 0 bit)		85	5 to 85 105 to 195
61	3D	0	**Qint.1 configuration**	Record		4 bytes		-	
		1	**Switchpoint logic**			8 bits (Offset 24 bits)		128	128 = **Vendor specific**
		2	**Switchpoint mode**			8 bits (Offset 16 bits)			
		3	**Switchpoint hysteresis**			16 bits (Offset 0 bits)		0	0 = **Auto-defined hysteresis**

*Table 41: Teach-in/detection - **Qint.2***

ISDU			Name	Data type	Data repository	Length	Access	Default value	Value/range
Index		Sub-index							
DEC	HEX								
62	3E	0	**Qint.2 SP1 / SP2**	Record	yes	2 bytes	rw	-	
		1	**SP1 upper threshold (switch-on)**			8 bits (Offset 8 bits)		90	10 to 90 110 to 200
		2	**SP2 lower threshold (switch-off)**			8 bits (Offset 0 bits)		85	5 to 85 105 to 195
63	3F	0	**Qint.2 configuration**	Record		4 bytes		-	
		1	**Switchpoint logic**			8 bits (Offset 24 bits)		128	128 = **Vendor specific**
		2	**Switchpoint mode**			8 bits (Offset 16 bits)			
		3	**Switchpoint hysteresis**			16 bits (Offset 0 bits)		0	0 = **Auto-defined hysteresis**

Qint.1 / **Qint.2 SP1** / **SP2** is used to define the switch-on and switch-off threshold for the detection signal (as percentages). The selected values are based on the energy-based receiver value (=100%) defined during the last teach-in process.

SP1 upper threshold (switch-on)switch-on threshold.
If the **Current receiver level (live)** (index 180) exceeds the selected switch-on threshold or the dynamic switch-on threshold (see **AutoAdapt**, index 112), the detection signal **Qint.1** changes to LOW (no object detected in the beam path).

SP2 lower threshold (switch-off)switch-off threshold.
If the **Current receiver level (live)** (index 180) falls below the selected switch-off threshold or the dynamic switch-off threshold (see **AutoAdapt**, index 112), the detection signal **Qint.1** changes to HIGH (object detected in the beam path).

The switch-on threshold must always be higher than the switch-off threshold.
The minimum distance between the switch-on and switch-off threshold is 5% (= hysteresis).
Both switching thresholds must always be both below 100% or above 100%.

Depending on the mode selected via **Detection Mode** (index 83), the switch-on and switch-off thresholds are automatically adjusted.

Qint.1 SP1 / **SP2** (index 60) and **Qint.2 SP1** / **SP2** (index 62) are always synchronized.
Any changes made to one of the ISDUs are accepted by the other ISDU.

NOTE
Dependency:

- **Qint.1 SP1** / **SP2** (Index 60)
- **Qint.2 SP1** / **SP2** (Index 62)
- **Current receiver level (live)** (Index 180)

Switchpoint logic has no function.
Switchpoint mode has no function.
Switchpoint hysteresis has no function.

*Table 42: Teach-in/detection - **Detection mode***

ISDU			Name	Data type	Data repository	Length	Access	Default value	Value/range
Index		Sub-index							
DEC	HEX								
83	53	-	Detection mode	UInt	yes	1 byte	rw	0	Value / Range set 1: 0 = Highly-transparent objects 1 = Semi-transparent objects 2 = Opaque objects 3 = Bottles / trays 4 = Foil tear 255 = Manual Value / Range set 2: 0 = Transparent object mode 1 = Transparent film mode 2 = Non-transparent mode 3 = Manual mode

Value / Range set 1 or **Value / Range set 2** is implemented depending on the device type.

Detection modes can be used to select how the sensor detects pre-defined object types.
The following factors change depending on the settings:

- The switch-on and switch-off thresholds **Qint.1 SP1 / SP2** (index 60) and **Qint.2 SP1 / SP2** (index 62).
- The settings for **AutoAdapt / Continuous threshold adaption** (index 112) according to the following table.

Table 43: Switching thresholds

	Switch-on threshold	Switch-off threshold	AutoAdapt / Continuous switching threshold tracking
Highly transparent objects	90%	85%	On - time-based
Semi-transparent objects	82%	77%	On - time-based
Opaque objects	50%	45%	On - time-based
Bottles/trays	90%	50%	On - time-based
Film tear	110%	105%	On - time-based
Transparent object mode	90%	85%	On - time-based
Transparent film mode	110%	105%	On - time-based
Non-transparent mode	50%	45%	Off
Manual	As before	As before	As before

Manual mode is activated as soon as the user manually accesses **Qint.1 SP1 / SP2** (ISDU 60), **Qint.2 SP1 / SP2** (ISDU 62) or **AutoAdapt / Continuous threshold adaption** (ISDU 112). Switching to manual mode itself does not change any of the remaining parameters.

NOTE
Dependency:

- **Qint.1 SP1 / SP2** (index 60) or **Qint.2 SP1 / SP2** (index 62); nominal detector switch-on and switch-off thresholds
- **AutoAdapt / Continuous threshold adaption** (Index 112)
- **Threshold presetting** (Index 113)

*Table 44: Teach-in/detection - **AutoAdapt***

ISDU			Name	Data type	Data repository	Length	Access	Default value	Value/range
Index		Sub-index							
DEC	HEX								
112	70	-	AutoAdapt / Continuous threshold adaption	UInt	yes	1 byte	rw	0	0 = Off 1 = On – time based 2 = On – event based

AutoAdapt or **Continuous threshold adaption** cause the detector switch-on and switch-off thresholds to be adjusted automatically if the sensor detects gradual contamination of the sensor's front screen or reflector.
As a result, object detection remains stable and secure for longer, even for highly transparent objects. In addition, cleaning cycles can be extended.

NOTE
The automatic adjustments of the switch-on and switch-off thresholds by **AutoAdapt** affect the dynamic switch-on and switch-off threshold **Upper threshold (switch-on) dynamic** (index 181) and **Lower threshold (switch-off) dynamic** (index 182).
The adjustable switch-on and switch-off thresholds **Qint.1 SP1 / SP2** (index 60) and **Qint.2 SP1 / SP2** (index 62) remain unaffected.
If the **AutoAdapt** causes the switch-on and switch thresholds under **Qint.1 / Qint.2** to deviate from the dynamic switch-on and switch-off thresholds, the dynamic switch-on and switch-off thresholds are always used to evaluate the object detection.

Off — **AutoAdapt** is deactivated.
On – time based — When this setting is used, the dynamic switching thresholds are adjusted as soon as the sensor detects that its front screen or reflector is contaminated. This setting is recommended as the default setting.
On – event based — With this setting, the dynamic switching thresholds are adjusted incrementally with each object detection (= event) if the sensor front screen or reflector is contaminated.

NOTE
Dependency:

- **Detection mode** (Index 83)
- **Upper threshold (switch-on) dynamic** (Index 181)
- **Lower threshold (switch-off) dynamic** (Index 182)

*Table 45: Teach-in / **Threshold presetting***

ISDU			Name	Data type	Data repository	Length	Access	Default value	Value/range
Index		Sub-index							
DEC	HEX								
113	71	-	Threshold presetting	UInt	yes	1 byte	rw	0	0 = 10% (Transparent mode) 1 = 18% (Transparent mode) 2 = 40% (Transparent mode) 3 = Non-transparent mode 4 = Manual mode

For **Detection modes Transparent object mode** and **Transparent foil mode** (index 83), the function **Threshold presetting** can be used to set the signal attenuation above which object detection should be triggered. The highest sensitivity setting is 10% and the lowest is 40%.

If **Detection mode Non-transparent objects** is selected, **Threshold presetting** automatically switches to **Non-transparent** mode. If the switch-on and switch-off thresholds are adjusted manually via **Qint.1 SP1 / SP2** (index 60 and 62), **Threshold presetting** jumps to **Manual mode**.

NOTICE
Changes to **Threshold presetting** can cause the **Detection modes** (index 83) to change.

NOTE
This function is not available in all WLG devices.

NOTE
Dependency:

- **Detection mode** (Index 83)
- **Upper threshold (switch-on) dynamic** (Index 181)
- **Lower threshold (switch-off) dynamic** (Index 182)
- **Qint.1 SP1 / SP2** (Index 60)
- **Qint.2 SP1 / SP2** (Index 62)

*Table 46: Teach-in / detection - **Current receiver level***

ISDU			Name	Data type	Data repository	Length	Access	Default value	Value/range
Index		Sub-index							
DEC	HEX								
180	B4	-	Current receiver level (live)	UInt	-	1 byte	ro	-	0 ... 255

The **Current receiver level (live)** shows the current energy reception level of the sensor (as a percentage). The reference point (equivalent to 100%) is the light receiver level at the time of the last teach-in.
For further details, see the **Single value teach** standard command (index 2, value 65).

NOTE
Dependency:

- **System command Single value teach** (Index 2, value 65)

*Table 47: Teach-in/detection - **Threshold***

ISDU			Name	Data type	Data repository	Length	Access	Default value	Value/range
Index		Sub-index							
DEC	HEX								
181	B5	-	Upper threshold (switch-on) dynamic	UInt	-	1 byte	ro	0	0 ... 255
182	B6	-	Lower threshold (switch-off) dynamic	UInt	-	1 byte	ro	0	0 ... 255

The automatic adjustments of the switch-on and switch-off thresholds (in percent) by **AutoAdapt / Continuous threshold adaption** (index 112) affects the dynamic switch-on and switch-off thresholds **Upper threshold (switch-on) dynamic** (index 181) and **Lower threshold (switch-off) dynamic** (index 182).
The switch-on and switch-off thresholds **Qint.1 SP1 / SP2** (index 60) and **Qint.2 SP1 / SP2** (index 62) that can be adjusted by the operator, remain unaffected.

If the **AutoAdapt** function causes the switch-on or switch-off thresholds in **Qint.1 / Qint.2** to deviate from the dynamic switch-on or switch-off threshold, the dynamic switch-on and switch-off thresholds are always used to evaluate the object detection.

NOTE
Dependency:

- **AutoAdapt** (Index 112)

8.6 Teach-in / detection settings for WE / WEO devices

*Table 48: Teach-in/detection - **Standard Command***

ISDU			Name	Data type	Data repository	Length	Access	Default value	Value/range
Index		Sub-index							
DEC	HEX								
2	2	-	Standard command	UInt	-	1 byte	wo	-	65 = Single value teach

After connecting the sender and receiver devices and aligning them with each other, a teach-in must be triggered in order to make full use of the functions described below.
With every teach-in process, the sensor's current light receiver level is standardized at 100%. This 100% level is the energy reference value for the following appliance functions:

- **Quality of teach** (Index 114)
- **Quality of run** (Index 175)

The teach-in process should be repeated again after each realignment of the sender or receiver and after each replacement of the sender or receiver in order to always ensure an up-to-date energy reference signal, e.g. for evaluating the contamination on the sender's or receiver's front screen.

For WE/WEO devices, the teach-in process automatically adjusts the sensor's receiver sensitivity, taking into account the current light receiver level, so that the detection signal is as reliable as possible.

Triggering the teach-in process using the teach button on the sensor housing (if available) and triggering the teach-in process using the HIGH signal (L+) on pin 2 (if **Pin 2 configuration** (index 121) is set to Teach-in is set), if available.

NOTE
Dependency:

- **Quality of run** or operating reserve (index 175)

*Table 49: Teach-in/detection - **Teach-in channel** / **Teach state***

ISDU			Name	Data type	Data repository	Length	Access	Default value	Value/range
Index		Sub-index							
DEC	HEX								
58	3A	-	Teach-in channel	UInt	-	1 byte	rw	0	0 ... 2 = Default BDC
59	3B	-	Teach-in state	Record	-	1 byte	ro	-	
			Teach flags			1 bit (Offset 4 bits)			0 = Teachpoint 1 not taught 1 = Teachpoint 1 successfully taught
			Teach state			4 bits (Offset 0 bit)			0 = IDLE 1 = SP1 SUCCESS 5 = BUSY 7 = ERROR

Selection of the Qint. channel that is affected by the **Single value teach** system command (index 2, value 65).
For WE/WEO devices, only one teach-in channel is available for the teach-in process. Only the preset teach-in channel can be used.

The **Teach state** shows the current status of the teach-in process.
A teach-in can only be sent in the status **IDLE, SP1 SUCCESS** and **ERROR** .
The status always refers to the Qint. channel currently selected via **Teach-in channel** (index 58).
The **Teach flags** do not have a function for WE/WEO devices.

*Table 50: Teach-in/detection - **Qint.1***

ISDU			Name	Data type	Data repository	Length	Access	Default value	Value/range
Index		Sub-index							
DEC	HEX								
60	3C	0	Qint.1 SP1 / SP2	Record	yes	2 bytes	rw	-	
		1	SP1 upper threshold (switch-on)			8 bits (Offset 8 bits)		0	0
		2	SP2 lower threshold (switch-off)			8 bits (Offset 0 bits)		0	0
61	3D	0	Qint.1 configuration	Record		4 bytes		-	
		1	Switchpoint logic			8 bits (Offset 24 bits)		128	128 = Vendor specific
		2	Switchpoint mode			8 bits (Offset 16 bits)			
		3	Switchpoint hysteresis			16 bits (Offset 0 bits)		0	0 = Auto-defined hysteresis

SP1 upper threshold (switch-on) has no function.
SP2 lower threshold (switch-off) has no function.
Switchpoint logic has no function.
Switchpoint mode has no function.
Switchpoint hysteresis has no function.

*Table 51: Teach-in/detection - **Qint.2***

ISDU			Name	Data type	Data repository	Length	Access	Default value	Value/range
Index		Sub-index							
DEC	HEX								
62	3E	0	**Qint.2 SP1 / SP2**	Record	yes	2 bytes	rw	-	
		1	**SP1 upper threshold (switch-on)**			8 bits (Offset 8 bits)		0	0
		2	**SP2 lower threshold (switch-off)**			8 bits (Offset 0 bits)		0	0
63	3F	0	**Qint.2 configuration**	Record		4 bytes		-	
		1	**Switchpoint logic**			8 bits (Offset 24 bits)		128	128 = **Vendor specific**
		2	**Switchpoint mode**			8 bits (Offset 16 bits)			
		3	**Switchpoint hysteresis**			16 bits (Offset 0 bits)		0	0 = **Auto-defined hysteresis**

SP1 upper threshold (switch-on) has no function.
SP2 lower threshold (switch-off) has no function.
Switchpoint logic has no function.
Switchpoint mode has no function.
Switchpoint hysteresis has no function.

8.7 Teach-in/Detection settings for WTT devices

*Table 52: Teach-in/detection - **Teach Command***

ISDU			Name	Data type	Data repository	Length	Access	Default value	Value/range
Index		Sub-Index							
DEC	HEX								
2	02	-	**Standard command**	UInt	-	1 byte	wo		65 = **Single Value Teach SP1** 66 = **Single Value Teach SP2**

After the teach-in command has been triggered, the current distance between the sensor and the object in the light beam is set as the sensing range. Depending on the selected **Teach-in channel** (index 58), **Qint.x SP1 sensing range** or **Qint.x SP2 sensing range** (index 60, 62, 16384, 16386, 16388, 16390, 16392 or 16394) change accordingly.

NOTE
Dependency:

- **Teach-in channel** (Index 58)
- **Qint.x SP1 sensing range** or **Qint.x SP2 sensing range** (ISDU 60, 62, 16384, 16386, 16388, 16390, 16392 or 16394)

*Table 53: Teach-in/detection - **Teach-in channel / Teach state***

ISDU			Name	Data type	Data repository	Length	Access	Default value	Value/range
Index		Sub-Index							
DEC	HEX								
58	3A	-	**Teach-in channel**	UInt	-	1 byte	rw	0	0 = Default Qint = Qint.1 1 = Qint.1 2 = Qint.2 3 = Qint.3 4 = Qint.4 5 = Qint.5 6 = Qint.6 7 = Qint.7 8 = Qint.8

ISDU			Name	Data type	Data repository	Length	Access	Default value	Value/range
Index		Sub-Index							
DEC	HEX								
59	3B	0	**Teach-in state**	Record	-	1 byte	ro	-	
		1	**Teach flag SP2**			1 bit (Offset 6 bits)			0 = **Teachpoint not taught** 1 = **Teachpoint successfully taught**
		2	**Teach flag SP1**			1 bit (Offset 4 bits)			0 = **Teachpoint not taught** 1 = **Teachpoint successfully taught**
		3	**Teach state**			4 bits (Offset 0 bits)			0 = **IDLE** 1 = **SP1 SUCCESS** 2 = **SP2 SUCCESS** 5 = **BUSY** 7 = **ERROR**

Selection of the Qint. channel that affects the **Single value teach SP1 / SP2** system command (index 2, value 65 or value 66).

The **Teach state** shows the current status of the teach-in process.
A teach-in can only be sent in the status **IDLE**, **SP1 SUCCESS**, **SP2 SUCCESS** and **ERROR** .
The status always refers to the Qint. channel currently selected in **Teach-in channel** (index 58). The **Teach flags** have no function for WTT devices.

*Table 54: Teach-in/detection - **Qint.1 ... Qint.8***

ISDU			Name	Data type	Data repository	Length	Access	Default value	Value/range
Index		Sub-Index							
DEC	HEX								
60	3C	0	**Qint.1 SP1 / SP2**	Record	yes	4 bytes	rw	-	
		1	**Qint.1 SP1 sensing range**	UInt		16 bits (Offset 16 bits)		device specific	0 ... 65535
		2	**Qint.1 SP2 sensing range**	UInt		16 bits (Offset 0 bits)		device specific	0 ... 65535
61	3D	0	**Qint.1 configuration**	Record	yes	4 bytes	rw	-	
		1	**Qint.1 Switchpoint logic**	UInt		8 bits (Offset 24 bits)		0	0 = **not inverted**
		2	**Qint.1 Switchpoint mode**	UInt		8 bits (Offset 16 bits)		1	0 = **Deactivated** 1 = **Single point mode** 2 = **Window mode** 3 = **Two point mode**
		3	**Qint.1 Switchpoint hysteresis**	UInt		16 bits (Offset 0 bits)		0	0 = **Vendor specific default**
62	3E	0	**Qint.2 SP1 / SP2**	Record	yes	4 bytes	rw	-	
		1	**Qint.2 SP1 sensing range**	UInt		16 bits (Offset 16 bits)		device specific	0 ... 65535
		2	**Qint.2 SP2 sensing range**	UInt		16 bits (Offset 0 bits)		device specific	0 ... 65535
63	3F	0	**Qint.2 configuration**	Record	yes	4 bytes	rw	-	
		1	**Qint.2 Switchpoint logic**	UInt		8 bits (Offset 24 bits)		0	0 = **not inverted**
		2	**Qint.2 Switchpoint mode**	UInt		8 bits (Offset 16 bits)		1	0 = **Deactivated** 1 = **Single point mode** 2 = **Window mode** 3 = **Two point mode**
		3	**Qint.2 Switchpoint hysteresis**	UInt		16 bits (Offset 0 bits)		0	0 = **Vendor specific default**
16384	4000	0	**Qint.3 SP1 / SP2**	Record	yes	4 bytes	rw	-	
		1	**Qint.3 SP1 sensing range**	UInt		16 bits (Offset 16 bits)		device specific	0 ... 65535
		2	**Qint.3 SP2 sensing range**	UInt		16 bits (Offset 0 bits)		device specific	0 ... 65535
16385	4001	0	**Qint.3 configuration**	Record	yes	4 bytes	rw	-	
		1	**Qint.3 Switchpoint mode**	UInt		8 bits (Offset 24 bits)		0	0 = **not inverted**
		2	**Qint.3 Switchpoint mode**	UInt		8 bits (Offset 16 bits)		1	0 = **Deactivated** 1 = **Single point mode** 2 = **Window mode** 3 = **Two point mode**
		3	**Qint.3 Switchpoint hysteresis**	UInt		16 bits (Offset 0 bits)		0	0 = **Vendor specific default**

ISDU			Name	Data type	Data repository	Length	Access	Default value	Value/range
Index		Sub-Index							
DEC	HEX								
16386	4002	0	Qint.4 SP1 / SP2	Record	yes	4 bytes	rw	-	
		1	Qint.4 SP1 sensing range	UInt		16 bits (Offset 16 bits)		device specific	0 ... 65535
		2	Qint.4 SP2 sensing range	UInt		16 bits (Offset 0 bits)		device specific	0 ... 65535
16387	4003	0	Qint.4 configuration	Record	yes	4 bytes	rw	-	
		1	Qint.4 Switchpoint logic	UInt		8 bits (Offset 24 bits)		0	0 = not inverted
		2	Qint.4 Switchpoint mode	UInt		8 bits (Offset 16 bits)		1	0 = Deactivated 1 = Single point mode 2 = Window mode 3 = Two point mode
		3	Qint.4 Switchpoint hysteresis	UInt		16 bits (Offset 0 bits)		0	0 = Vendor specific default
16388	4004	0	Qint.5 SP1 / SP2	Record	yes	4 bytes	rw	-	
		1	Qint.5 SP1 sensing range	UInt		16 bits (Offset 16 bits)		device specific	0 ... 65535
		2	Qint.5 SP2 sensing range	UInt		16 bits (Offset 0 bits)		device specific	0 ... 65535
16389	4005	0	Qint.5 configuration	Record	yes	4 bytes	rw	-	
		1	Qint.5 Switchpoint logic	UInt		8 bits (Offset 24 bits)		0	0 = not inverted
		2	Qint.5 Switchpoint mode	UInt		8 bits (Offset 16 bits)		1	0 = Deactivated 1 = Single point mode 2 = Window mode 3 = Two point mode
		3	Qint.5 Switchpoint hysteresis	UInt		16 bits (Offset 0 bits)		0	0 = Vendor specific default
16390	4006	0	Qint.6 SP1 / SP2	Record	yes	4 bytes	rw	-	
		1	Qint.6 SP1 sensing range	UInt		16 bits (Offset 16 bits)		device specific	0 ... 65535
		2	Qint.6 SP2 sensing range	UInt				device specific	0 ... 65535
16391	4007	0	Qint.6 configuration	Record	yes	4 bytes	rw	-	
		1	Qint.6 Switchpoint logic	UInt		8 bits (Offset 24 bits)		0	0 = not inverted
		2	Qint.6 Switchpoint mode	UInt		8 bits (Offset 16 bits)		1	0 = Deactivated 1 = Single point mode 2 = Window mode 3 = Two point mode
		3	Qint.6 Switchpoint hysteresis	UInt		16 bits (Offset 0 bits)		0	0 = Vendor specific default
16392	4008	0	Qint.7 SP1 / SP2	Record	yes	4 bytes	rw	-	
		1	Qint.7 SP1 sensing range	UInt		16 bits (Offset 16 bits)		device specific	0 ... 65535
		2	Qint.7 SP2 sensing range	UInt		16 bits (Offset 0 bits)		device specific	0 ... 65535
16393	4009	0	Qint.7 configuration	Record	yes	4 bytes	rw	-	
		1	Qint.7 Switchpoint logic	UInt		8 bits (Offset 24 bits)		0	0 = not inverted
		2	Qint.7 Switchpoint mode	UInt		8 bits (Offset 16 bits)		1	0 = Deactivated 1 = Single point mode 2 = Window mode 3 = Two point mode
		3	Qint.7 Switchpoint hysteresis	UInt		16 bits (Offset 0 bits)		0	0 = Vendor specific default
16394	400A	0	Qint.8 SP1 / SP2	Record	yes	4 bytes	rw	-	
		1	Qint.8 SP1 sensing range	UInt		16 bits (Offset 16 bits)		device specific	0 ... 65535
		2	Qint.8 SP2 sensing range	UInt				device specific	0 ... 65535

ISDU			Name	Data type	Data repository	Length	Access	Default value	Value/range
Index		Sub-Index							
DEC	HEX								
16395	400B	0	**Qint.8 configuration**	Record	yes	4 bytes	rw	-	
		1	**Qint.8 Switchpoint logic**	UInt		8 bits (Offset 24 bits)		0	0 = **not inverted**
		2	**Qint.8 Switchpoint mode**	UInt		8 bits (Offset 16 bits)		1	0 = **Deactivated** 1 = **Single point mode** 2 = **Window** mode 3 = **Two point mode**
		3	**Qint.8 Switchpoint hysteresis**	UInt		16 bits (Offset 0 bits)		0	0 = **Vendor specific default**

NOTE
The index names of the WTT12LC device variant differ from the names shown here. The index numbers and function descriptions (if implemented, see IODD description of the respective WTT12LC device) nevertheless also apply to the WTT12LC.

The switching distance of the individual detection channels of the sensor can be set using **Qint.x SP1 sensing range** or **Qint.x SP2 sensing range** (in mm). The value range is restricted by the sensor's "max. sensing range" (see sensor data sheet for "max. sensing range").

Qint.x Switchpoint logic and **Qint.x Switchpoint hysteresis** are fixed parameters and cannot be changed.

Qint.x Switchpoint mode adjustments:

Deactivated = No function. The binary output state of Qint.x is set to "0", regardless of the current detection status.

Single point mode = The output state of Qint.x switches to "1" if the currently measured distance value between the sensor and object/background is less than or equal to the value set under **Qint.x SP1 sensing range.**

Window mode = The output state of Qint.x switches to "1" If the currently measured distance value between the sensor and object / background is between the set values of **Qint.x SP1 sensing range** and **Qint.x SP2 sensing range.**

Two point mode = If the distance measurement value is falling, the output state of Qint.x switches to "1" if the distance value between the sensor and object/background is less than or equal to the value set under **Qint.x SP2 sensing range.**
If the distance measurement value is rising, the output state of Qint.x switches to "0" if the currently measured distance value between the sensor and object/background is greater than or equal to the value set under **Qint.x SP1 sensing range.**

*Table 55: Teach-in/detection - **Measurement averaging***

ISDU			Name	Data type	Data repository	Length	Access	Default value	Value/range
Index		Sub-Index							
DEC	HEX								
89	59	-	**Measurement averaging**	UInt	yes	1 byte	rw	0	0 = 1 1 = 2 2 = 4 3 = 8 4 = 16 5 = 32 6 = 64 7 = 128 8 = 256 9 = 512

The **Measurement averaging** function results in a smoothing of the distance measurement value output in the process data and under **Distance to object** (index 229). A moving average filter is generated from a certain number of measured values. The number of measured values used for the **Measurement averaging** is set under this index.

*Table 56: Teach-in/detection - **Teach-in offset***

ISDU			Name	Data type	Data repository	Length	Access	Default value	Value/range
Index		Sub-Index							
DEC	HEX								
90	5A	-	Teach-in offset	Int	yes	2 bytes	rw	0	-200 ... +200

When this function is used, the defined detection point is corrected by the set value when a teach-in command is triggered (via the teach-in button on the sensor housing or via the system command **Single value teach SP1 / SP2** (index 2, value 65)).

This function can be used to increase detection reliability, especially for teach-in ongoing processes, by moving the detection point with the **Teach-in offset** "into the object", for example.

NOTE
Dependency:

Single value teach SP1 / SP2 system command (index 2, value 65/66)

NOTE
The **Teach-in offset** does not work with direct range adjustment via **Qint.x SP1 / SP2** (index 60/62/16384/16386/16388/16390/16390/16392/16394).

*Table 57: Teach-in/Detection - **Distance to object***

ISDU			Name	Data type	Data repository	Length	Access	Default value	Value/range
Index		Sub-Index							
DEC	HEX								
229	E5	0	Distance to object	Record	-	3 bytes	ro	-	
		1	Distance	UInt		16 bits (Offset 8)			0 ... 30000
		2	Distance qualifier	UInt		2 bits (Offset 0)			0 = Distance in range / valid 3 = No distance information / distance invalid

This parameter can be used to output the measured distance to the object or the background (if available and in sensing range) as a **Distance** in mm or 1/10 mm (depending on the device – see IODD of the respective device for details). If no measured value can be detected (e.g. because the sensor is facing empty space) or if the measured value is outside of the specified sensing range, the sensor delivers output value "30,000", which is to be interpreted as an invalid measurement.

Each measured value must be linked with the **Distance qualifier.** This value specifies whether the current output measured value is valid or not.

NOTE
Separate access to sub-index 1 or 2 is not possible.

8.8 Installation / Diagnostics

*Table 58: Teach-in/detection - **Standard command***

ISDU			Name	Data type	Data repository	Length	Access	Default value	Value/range
Index		Sub-index							
DEC	HEX								
2	02	-	Standard command	UInt	-	1 byte	wo	-	228 = Reset diagnostic parameter

The **Reset diagnostic parameter** system command resets all resettable diagnostic parameters in the device to the initial value or to zero.

NOTE
Dependency:

- **Operating hours since last reset** (Index 190, sub-index 2)

*Table 59: Installation/diagnostics - **Device Status***

ISDU			Name	Data type	Data repository	Length	Access	Default value	Value/Range
Index		Sub-index							
DEC	HEX								
36	24	-	Device Status	UInt	-	8 bits	ro	-	0 = Device is ok 1 = Maintenance required 2 = Outside the specifications 3 = Function check-out 4 = Error 5 – 255 = Reserved
37	25	-	Detailed Device Status	Array	-	device specific	ro	-	device specific

Device Status shows the current device status.

Detailed Device Status contains a rolling list of the most recent events.

*Table 60: Installation/Diagnostics - **Quality of teach***

ISDU			Name	Data type	Data repository	Length	Access	Default value	Value/range
Index		Sub-index							
DEC	HEX								
114	72	-	Quality of teach	UInt	-	1 byte	ro	-	0 to 100%

*Table 61: Installation/Diagnostics - **Quality of teach***

ISDU			Name	Data type	Data repository	Length	Access	Default value	Value/range
Index		Sub-index							
DEC	HEX								
114	72	-	Quality of teach	UInt	-	1 byte	ro	-	0 ... 100 %
		0	Quality of teach	RecordT		[sum of subindices]			0 ... 100 %
		1	Quality of teach Qint.1 SP1	UIntegerT		8 bits (Offset: see IODD)			0 ... 100 %
		2	Quality of teach Qint.1 SP2	UIntegerT		8 bits (Offset: see IODD)			0 ... 100 %
		3	Quality of teach Qint.2 SP1	UIntegerT		8 bits (Offset: see IODD)			0 ... 100 %
		4	Quality of teach Qint.2 SP2	UIntegerT		8 bits (Offset: see IODD)			0 ... 100 %
		5	Quality of teach Qint.3 SP1	UIntegerT		8 bits (Offset: see IODD)			0 ... 100 %
		6	Quality of teach Qint.3 SP2	UIntegerT		8 bits (Offset: see IODD)			0 ... 100 %
			...	...					0 ... 100 %
		x	Quality of teach Qint.n SP1	UIntegerT		8 bits (Offset: see IODD)			0 ... 100 %
		x+1	Quality of teach Qint.n SP2	UIntegerT		8 bits (Offset: see IODD)			0 ... 100 %

Quality of teach provides feedback regarding the quality of the last teach-in process performed.
The **Quality of teach** value is updated after each teach-in process.

For devices with several active setpoints, one **Quality of teach** value is output per setpoint. The number of sub-indices, the data length as well as the offset of the individual sub-indices are device specific and can be taken from the respective IODD.

*Table 62: Definition Q**uality of teach** for WTB, WTS and WTL devices*

Min. sensing range	≤	Teach-in sensing range	≤	Max. sensing range on black [1]	➜	Quality of teach = 100%
Max. sensing range on black [1]	<	Teach-in sensing range	≤	Max. sensing range on white [2]	➜	Quality of teach = 100 to 10%
				Teach-in error	➜	Quality of teach = 0%

1) 6% remission factor
2) 90% remission factor

*Table 63: Definition **Quality of teach** for WL, WLA, WLG, WE and WEO devices with teach-in*

Operating reserve after teach-in ≥ 3.75	➜	**Quality of teach** = 100%
3.75 > Operating reserve after teach-in > 1.0	➜	**Quality of teach** = 99% ... 1%
Operating reserve after teach-in ≤ 1.0	➜	**Quality of teach** = 0 %

NOTE

Dependency:

- **Standard command Single value teach** (Index 2, value 65)

*Table 64: Installation/Diagnostics - **Temperature***

ISDU			Name	Data type	Data repository	Length	Access	Default value	Value/range
Index		Sub-index							
DEC	HEX								
153	99	0	Temperature	Record	-	5 bytes	ro	-	
		1	Current temperature			8 bits (Offset 32 bits)			-127 ... 127 °C
		2	Max. temperature all time			8 bits (Offset 24 bits)			-127 ... 127 °C
		3	Min. temperature all time			8 bits (Offset 16 bits)			-127 ... 127 °C
		4	Max. temperature since last reset			8 bits (Offset 8 bits)			-127 ... 127 °C
		5	Min. temperature since last reset			8 bits (Offset 0 bits)			-127 ... 127 °C

Read out the operating temperature of the sensor. The values of **Max. temperature since last reset** and **Min. temperature since last reset** are deleted via the **Standard command Reset diagnostic parameters** (index 2, value 228).

*Table 65: Installation/Diagnostics - **Temperature zone***

ISDU			Name	Data type	Data repository	Length	Access	Default value	Value/range
Index		Sub-index							
DEC	HEX								
154	9A	-	Temperature zone	UInt	yes	1 byte	ro	-	0 = very cold 1 = cold 2 = ideal 3 = warm 4 = above specified limit

The **Temperature zone** parameter reports the interior device temperature.

*Table 66: Installation/Diagnostics - **Remaining sender lifetime***

ISDU			Name	Data type	Data repository	Length	Access	Default value	Value/range
Index		Sub-index							
DEC	HEX								
155	9B	0	Remaining sender lifetime	UInt	-	2 bytes	ro		0 ... 5000 65535

Shows the expected number of days until the sender unit will reach the end of its life cycle (the performance specified in the data sheet can no longer be guaranteed).

65535 = calculation not possible (e.g. because history is not available).

*Table 67: Installation/Diagnostics - **Quality of run***

ISDU			Name	Data type	Data repository	Length	Access	Default value	Value/range
Index		Sub-index							
DEC	HEX								
175	AF	-	Quality of run	UInt	-	1 byte	ro	-	0 to 255%
									0...254 %, 255 =not available
			Function reserve						0 to 99% 1)

1) Only for WE / WEO devices without teach-in

Quality of run provides continuous feedback on the current energy robustness of the object detection. Whenever a teach-in command is issued, the current light reception level of the receiver is set as the reference point and the **Quality of run** value is set to 100 %. The 0% threshold is automatically determined by the sensor. Should the energy at the receiver increase or decrease (e.g. due to contamination of the sensor's front screen or the reflector, or due to these elements being cleaned; excluding object detection), the **Quality of run** will change accordingly.

Function reserve (for WE/WEO devices without teach-in) shows the current operating reserve of the WE/WEO device in absolute terms.
The light reception level that reaches the limit between “object detected” and “object not detected” is defined as **Function reserve** = 1. If, for example, the amount of light energy received doubles, the **Function reserve**value increases to 2.

NOTE
Dependency:

- **Standard Command** (index 2) all device-specific teach-in commands.

*Table 68: Installation/Diagnostics - **Quality of run alarm threshold***

ISDU			Name	Data type	Data repository	Length	Access	Default value	Value/range
Index		Sub-index							
DEC	HEX								
176	B0	-	Quality of run alarm threshold	UInt	yes	1 byte	rw	50	0 ... 90%
			Function reserve alarm threshold					4	0 ... 99% [1]

1) Only for WE/WEO devices without teach-in

An alarm switching threshold can be defined for **Quality of run** or **Function reserve** via **Quality of run alarm threshold** or **Function reserve alarm threshold**.
If the value falls below this alarm switching threshold, the **Quality of run alarm output** (index 226, subindex 1) is activated. If the **Quality of run**or **Function reserve** value rises again, the alarm is deactivated as soon as the selected alarm switching threshold is exceeded by five percentage points (= hysteresis).
The alarm signal can also be output as a physical signal via pin 2 (**Pin 2 configuration** (Index 121)).

NOTE
Dependency:

- **Pin 2 configuration** (Index 121)
- **Quality of run alarm output** (Index 226, Subindex 1)

*Table 69: Installation/Diagnostics - **Quality of alignment***

ISDU			Name	Data type	Data repository	Length	Access	Default value	Value/range
Index		Sub-index							
DEC	HEX								
177	B1	-	Quality of alignment	UInt	yes	1 byte	ro	-	0 to 100%

Quality of alignment displays the energy currently received by the sensor, regardless of the reference signal or the teach-in command.
Quality of alignment is used to align the sensor with the reflector as accurately as possible (for WL, WLA and WLG devices) or to align the sender with the receiver (for WE/WEO devices).
On some devices, this information is also displayed on the alignment aid display (blue LEDs on the top of the sensor).

*Table 70: Installation/Diagnostics - **Maintenance prediction***

ISDU			Name	Data type	Data repository	Length	Access	Default value	Value/range
Index		Sub-index							
DEC	HEX								
178	B2	0	Maintenance prediction	UInt	-	2 bytes	ro		0 ... 5000 65535

Shows the expected number of days until maintenance is required. The maintenance prediction is calculated using the long-term trend of the **Quality of run** value. Suitable maintenance measures depend on the ambient conditions; typical measures include readjusting the sensor to the object or cleaning the sensor front panel.

65535 = calculation not possible (e.g. because history is not available).

*Table 71: Installation/Diagnostics - **Alarm thresholds for diagnostic parameters***

ISDU			Name	Data type	Data repository	Length	Access	Default value	Value/range
Index		Sub-index							
DEC	HEX								
179	B3	-	**Alarm thresholds for diagnostic parameters**	Record	yes	9 bytes	rw		
		Device-specific	**Upper temperature threshold** [1]	Sint		8 bits (Offset device specific)		80	-127 ... 127
		Device-specific	**Lower temperature threshold** [1]	Sint		8 bits (Offset device specific)		-30	-127 ... 127
		Device-specific	**Remaining sender lifetime threshold** [2]	UInt		16 bits (Offset device specific)		30	0 ... 5000
		Device-specific	**Maintenance prediction threshold** [3]	UInt		16 bits (Offset device specific)		30	0 ... 5000
		Device-specific	**Operating hours threshold** [4]	UInt		32 bits (Offset device specific)		40000	0 ... 1000000

1) In relation to index 153 dec, subindex 1 [° C]
2) In relation to index 155 dec [d]
3) In relation to index 178 dec [d]
4) In relation to index 190 dec, subindex 2 [h]

The **Parameter Alarm threshold for diagnostic parameters** offers the option of defining alarm thresholds for certain diagnostic values provided by the device. If these alarm thresholds are exceeded or not reached, a corresponding event is generated.

Future expansion to include additional sub-indices is possible.

NOTE
Dependency:

- **Current temperature** (Index 153, sub-index 1)
- **Remaining sender lifetime** (Index 155)
- **Maintenance prediction** (Index 178)
- **Operating hours since last reset** (Index 190, sub-index 2)

*Table 72: Installation/Diagnostics - **Operating hours***

ISDU			Name	Data type	Data repository	Length	Access	Default value	Value/range
Index		Sub-index							
DEC	HEX								
190	BE	0	**Operating hours**	Record	-	8 bytes	ro	-	
		1	**Total operating hours**	UInt		32 bits (Offset 32 bits)			0 ... 1000000
		2	**Operating hours since last reset**	UInt		32 bits (Offset 0 bits)			0 ... 1000000

The **Total operating hours** parameter displays how many total hours (h) the device has already been in operation. This value cannot be reset.

Parameter Operating hours since last reset displays how many hours (h) the device has been in operation since the last reset of the diagnostic parameters. The diagnostic parameters are reset using the **Reset diagnostic parameter** standard command (index 2, value 228).

NOTE
Dependency:

- **Reset diagnostics parameter** system command (index 2, value 228)
- **Operating hours threshold** (Index 179)

*Table 73: Installation/Diagnostics - **System state***

ISDU			Name	Data type	Data reposi-tory	Length	Access	Default value	Value/range	
Index		Sub-index								
DEC	HEX									
226	E2	0	**System state**	Record	-	1 byte	ro	-		
			Detection output Qint.1			1 bit (Offset 0 bit)			0x00 = **No object detected** 0x01 = **oObject detected**	
			Detection output Qint.2						1 bit (Offset 1 bit)	0x00 = **No object detected** 0x01 = **Object detected**
			Detection output Qint.3			1 bit (Offset 2 bits)			0x00 = **No object detected** 0x01 = **Object detected**	
			Detection output Qint.4			1 bit (Offset 3 bits)			0x00 = **No object detected** 0x01 = **Object detected**	
			Quality of run alarm out-put [alternatively: "Func-tion reserve alarm out-put"]			1 bit (Offset 6 bits)			0x00 = **Alarm not active** 0x01 = **Alarm active**	
			Input signal state Pin 2			1 bit (Offset 7 bits)			0x00 = **External input FALSE** 0x01 = **External input TRUE**	

System state can be used to request certain device statuses related to the current detection signal **Qint.1** and the **Quality of run alarm output**. The exact implementation may vary between the different device types.

Dependencies and interaction with:

- **Quality of run alarm threshold / Function reserve alarm threshold** (Index 176)

8.9 Smart Tasks

Smart Tasks process the various Smart Sensor signals for detection and measurement, linking them to binary switching signals from an external sensor if necessary. These signals can be imported via pin 2 (see Pin 2 configuration, ISDU 121). The Smart Task uses this data to generate the requisite process information – tailored to the task at hand in the plant. This saves time during data evaluation in the control, accelerates machine processes, and makes high-performance, cost-intensive additional hardware unnecessary.

- Decentralized signal analysis directly at the sensor
- Faster signal capture and processing
- Through Smart Tasks, Smart Sensors deliver the information that the plant process actually requires – no separate data preparation necessary in the control

8.9.1 Smart Task “Basic logic” (A00)

Logical principle of operation:

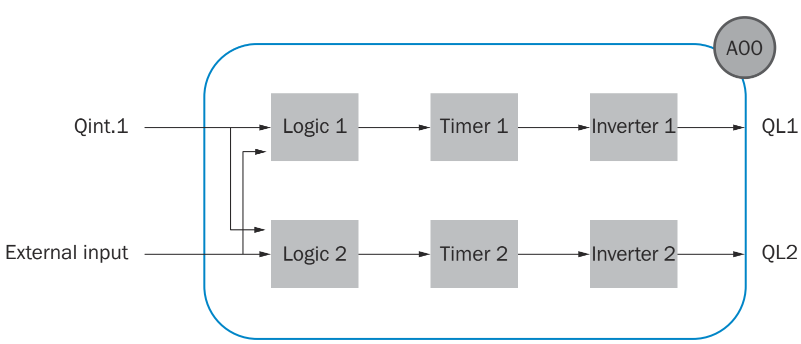


Figure 2: Logical principle of operation A00

*Table 74: Smart Tasks - **SLTI Version***

ISDU			Name	Data type	Data reposi-tory	Length	Access	Default value	Value/range
Index		Sub-index							
DEC	HEX								
1080	438	-	**SLTI Version**	String	-	8 bytes	ro	-	-

The **SLTI version** contains the version number for the Smart Task **Basic logic**.

*Table 75: Smart Tasks - **Logic***

ISDU			Name	Data type	Data repository	Length	Access	Default value	Value/range
Index		Sub-index							
DEC	HEX								
1083	43B	-	Logic 1	UInt	yes	1 byte	rw	0	0 = DIRECT 1 = AND 2 = OR 3 = Window Mode 4 = Hysteresis
1084	43C	-	Logic 2			1 byte			

The settings for **Logic 1** and **Logic 2** can be used to logically link the sensor-internal detection signal **Qint.1** to another sensor's switching signal imported via pin 2.
To do this, the **Pin 2 configuration** (index 121) must be set to **External input** .

Direct — For **Logic 1**:
Qint.1 signal is transferred without changes and without taking the external signal into account.
For **Logic 2**:
The external input signal is transferred without changes and without taking the **Qint.1** signal into account.

AND — Logical AND operation of **Qint.1** and **External input.**

OR — Logical OR linking of **Qint.1** and **External input.**

WINDOW MODE — See the following diagram

HYSTERESIS MODE — See the following diagram

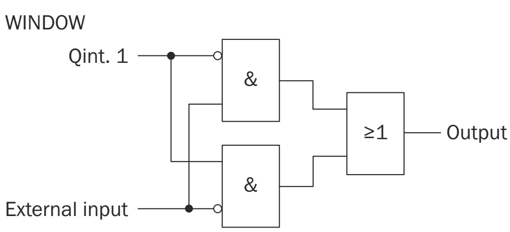


Figure 3: Window Mode

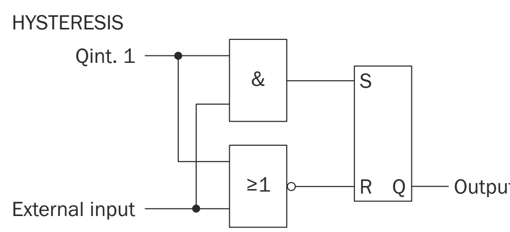


Figure 4: Hysteresis Mode

NOTE
If no physical signal is applied to the external input or if another function is selected for **Pin 2 configuration** (index 121), the status of the external input is interpreted as logical 0.

NOTE
Dependency:

- **Pin 2 configuration** (Index 121)

*Table 76: Smart Tasks - **Timer***

ISDU			Name	Data type	Data repository	Length	Access	Default value	Value/range
Index		Sub-index							
DEC	HEX								
1085	43D	-	Timer 1 mode	UInt	yes	1 byte	rw	0	0 = Deactivated 1 = T-on delay 2 = T-off delay 3 = T-on/T-off 4 = Impulse (one shot) 5 = T-on delay impulse[1]
1086	43E	-	Timer 2 mode			1 byte			
1087	43F	-	Time 1 setup			2 bytes		1	1 ... 30,000 ms
1088	440	-	Time 2 setup			2 bytes			
1091	443	-	Time 1.1 setup[1]			2 bytes			
1092	444	-	Time 2.1 setup[1]			2 bytes			

1 Optional functions, device-dependent. Implementation always common, index 1086 value 5, index 1091 and 1092.

Various delay modes can be selected via **Timer 1 mode** / **Timer 2 mode** .

The associated delay times are set via **Time 1 setup** / **Time 2 setup** and, depending on the device, also via **Time 1.1 setup** / **Time 2.1 setup** . See the table below for details:

	Index 1092/1093...		
	not implemented	implemented	
Timer mode	Time 1 setup / Time 2 setup	Time 1 setup / Time 2 setup	Time 1.1 setup / Time 2.1 setup
1 = T-on delay	T-on delay	T-on delay	-
2 = T-off delay	T-off delay	T-off delay	-
3 = T-on/T-off	T-on delay and T-off delay	T-on delay	T-off delay
4 = Impulse (one shot)	Impulse	Impulse	-
5 = T-on delay impulse	-	T-on delay	Impulse

See the following graphic for details on how the different modes work.

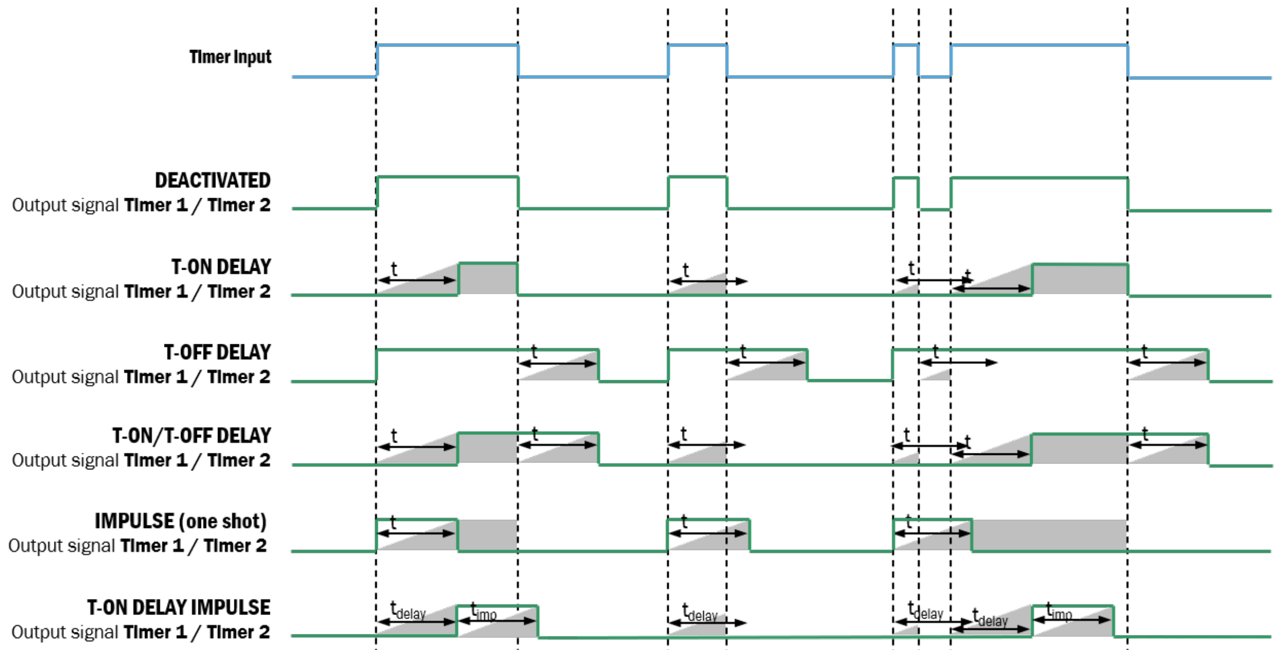


Figure 5: Timer 1 / Timer 2

*Table 77: Smart Tasks - **Inverter***

ISDU			Name	Data type	Data repository	Length	Access	Default value	Value/range
Index		Sub-index							
DEC	HEX								
1089	441	-	Inverter 1	UInt	yes	1 byte	rw	0 [1]	0 = Not inverted 1 = Inverted
1090	442	-	Inverter 2			1 byte			

[1] Default setting for WL, WLA, WLG, WE and WEO devices: 1 = Inverted

Inverter 1/2 inverts the logical status of the timer 1/2 output signal.

NOTE

Inverting the **Timer 1/2** output signal does not affect how the delay modes work.
Please note that by inverting the **Timer 1/2** output signal, a set switch-on delay can act as a switch-off delay, for example.

8.9.2 Smart task "Time measurement and debouncing" (A70)

Logical principle of operation:

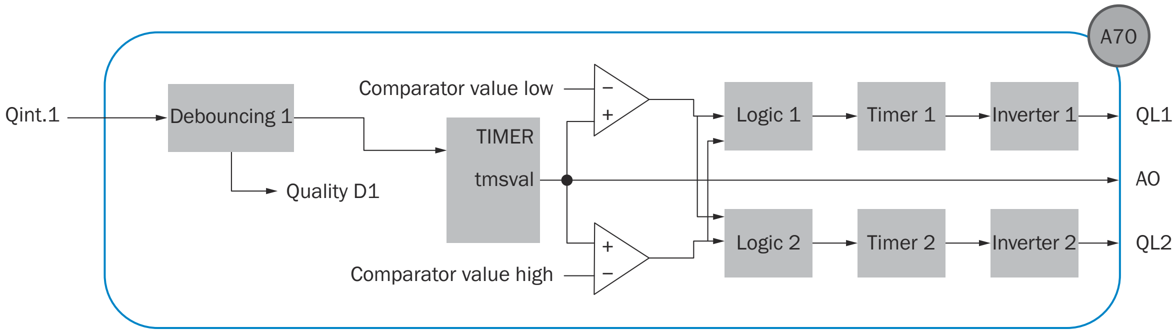


Figure 6: Logical principle of operation A70

*Table 78: Smart Task - **Time measurement version***

ISDU			Name	Data type	Data repository	Length	Access	Default value	Value/range
Index		Sub-index							
DEC	HEX								
1016	3F8	-	Time measurement version	String	-	8 bytes	ro	-	-

SLTI Version contains the version number of the Smart Task sub-function **Time measurement.**

*Table 79: Smart Task - **Time base***

ISDU			Name	Data type	Data repository	Length	Access	Default value	Value/range
Index		Sub-index							
DEC	HEX								
1017	3F9	-	Time base	UInt	yes	1 byte	rw	3	3= 1 ms 4= 10 ms 5= 100 ms

The time value **tmsval** is a 14-bit value and can therefore assume a value between 0 and 16383 (dec).

Time base is a factor by which the time measurement result is multiplied. This allows longer times to be measured. The resolution and measurement accuracy decrease accordingly.

*Table 80: Smart Task - **Measuring mode***

ISDU			Name	Data type	Data repository	Length	Access	Default value	Value/range
Index		Sub-index							
DEC	HEX								
1018	3FA	-	Measuring mode	UInt	yes	1 byte	rw	0	0 = target 1 = gap 2 = target, target + gap

Measuring mode determines which time measurement values are measured.

Target Time length measurement of the object passing the sensor.

Gap Time length measurement of the gap between two objects passing the sensor.

Target, Target + Gap The next time value emitted corresponds to the length of the object expressed as time. The next time value emitted then corresponds to the sum of the time-length measurement of the object and the subsequent gap to the next object.

*Table 81: Smart Task - **Comparator value***

ISDU			Name	Data type	Data repository	Length	Access	Default value	Value/range
Index		Sub-index							
DEC	HEX								
1019	3FB	-	Comparator value low	UInt	yes	2 bytes	rw	50	0 to 16383
1020	3FC	-	Comparator value high			2 bytes		100	

1) Time in ms, 10 ms, 100 ms - depending on the **Measuring mode setup**, index 1018 (see above)

Comparator value low and **Comparator value high** are two independent switching thresholds that refer to the measured time value.

If the measured time value exceeds the set switching thresholds, a logical 1 signal is applied to the output for the comparator in question.
If the measured time value reaches or falls below the selected switching thresholds, a logical 0 signal is applied to the output for the comparator in question.
These signals are transferred to the **Logic 1** and **Logic 2** modules.

*Table 82: Smart Task - **Debounce version***

ISDU			Name	Data type	Data repository	Length	Access	Default value	Value/range
Index		Sub-index							
DEC	HEX								
1032	408	-	Debounce version	String	-	8 bytes	ro	-	

Debounce version contains the version number of the Smart Task sub-function **Debouncing**.

*Table 83: Smart Task - **Debouncing***

ISDU			Name	Data type	Data repository	Length	Access	Default value	Value/range
Index		Sub-index							
DEC	HEX								
1033	409	-	Debounce time 1	UInt	yes	2 bytes	rw	0	0 ... 30,000 ms
1034	40A	-	Quality D1		-	2 bytes	ro	-	0 to 100%

Debounce time 1 can be used to suppress (debounce) short, interfering signals at the Smart Task's input.
The selected debounce time has the same effect as a switch-on or switch-off delay.
The measured time value **tmsval** is not affected when debouncing is active. **Quality D1** indicates the extent to which active debouncing is used. The higher the value, the more level changes that took place within the selected **Debounce time 1**.

Explanations for indices 1080, 1083, 1084, 1085, 1086, 1087, 1088, 1089, 1090: see "Smart Task "Basic logic" (A00)", page 42.

8.9.3 Smart task "Counter and debouncing" (A71)

Logical principle of operation:

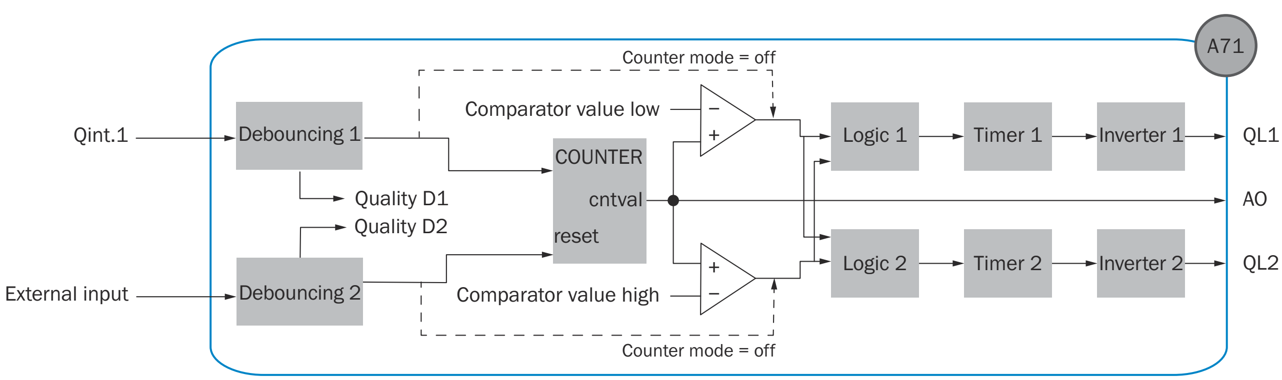


Figure 7: Logical principle of operation A71

*Table 84: Smart Task - **Standard command***

ISDU			Name	Data type	Data repository	Length	Access	Default value	Value/range
Index		Sub-index							
DEC	HEX								
2	2	-	Standard command	UInt	-	1 byte	wo	-	192 = Reset counter 193 = Preset counter

Reset counter resets the counter value **cntval** to 0.
The counter value can also be reset to 0 using a HIGH signal at the Smart Task's external input. To do this, the **Pin 2 configuration** (index 121) must be set to **External input.**
The current counter value **cntval** is set to the set value (index 1003) via **Standard command Preset counter Preset value** .

NOTE
Dependency:

- **Pin 2 configuration** (Index 121)
- **Preset value** (Index 1003)

*Table 85: Smart Task - **Counter version***

ISDU			Name	Data type	Data repository	Length	Access	Default value	Value/range
Index		Sub-index							
DEC	HEX								
1000	3E8	-	Counter version	String	-	8 bytes	ro	-	-

Counter version contains the version number for the Smart Task sub-function **Counter**.

*Table 86: Smart Task - **Counter mode***

ISDU			Name	Data type	Data repository	Length	Access	Default value	Value/range
Index		Sub-index							
DEC	HEX								
1001	3E9	-	Counter mode	UInt	yes	1 byte	rw	0	0 = Up 1 = Down 2 = OFF

Counter mode defines whether the counter value **cntval** is increased or decreased by one with each rising edge from **Debouncing 1 Modul** . When **Counter mode** = OFF: Signal pulses are routed past the counter and comparator module - see see figure 7, page 46; available from **Counter version** 1.2.0.
The counter value **cntval** is a 14-bit value and can therefore assume a value between 0 and 16383 (dec). Time pulses beyond these thresholds are ignored.

*Table 87: Smart Task - **Preset***

ISDU			Name	Data type	Data repository	Length	Access	Default value	Value/range
Index		Sub-index							
DEC	HEX								
1002	3EA	-	Preset mode	UInt	yes	1 byte	rw	0	0 = Preset internal disabled 1 = Preset internal enabled
1003	3EB	-	Preset value			2 bytes			0 to 16383

If the **Preset mode** is activated, the counter value **cntval** is set to **Preset value** (index 1003) if either the current counter value **cntval** exceeds the **Comparator value high** (index 1005) or if the **Standard command Preset counter** (index 2, value 193) is set.
The **Preset mode** is activated when, for example, the counter value **cntval** is automatically reset to a predefined value **Preset value** (index 1003) (typically “1”) when a certain counter value is reached. This allows the Smart Task to be used as a ring buffer.

NOTE
Dependency:

- **Preset value** (Index 1003)
- **Comparator value high** (Index 1005)
- **Standard command Preset counter** (Index 2, value 193)

*Table 88: Smart Task - **Comparator value / Counter value***

ISDU			Name	Data type	Data repository	Length	Access	Default value	Value/range
Index		Sub-index							
DEC	HEX								
1004	3EC	-	Comparator value low	UInt	yes	2 bytes	rw	10	0 to 16383
1005	3ED	-	Comparator value high			2 bytes		10	
1006	3EE	-	Counter value			2 bytes	ro	-	

The **Comparator value low** and the **Comparator value high** are two independent switching thresholds that refer to the **Counter value** .

If the **Counter value** exceeds the set switching thresholds, a logical 1 signal is applied to the output for the comparator in question.
If the **Counter value** reaches or falls below the set switching thresholds, a logical 1 signal is applied to the output for the comparator in question.
These signals are transferred to **Logic 1** and to the **Logic 2** module.

The **Counter value** shows the current meter reading.

NOTE
Dependency:

- **Preset mode** (Index 1002)
- **Preset value** (Index 1003)

*Table 89: Smart Task - **Debounce version***

ISDU			Name	Data type	Data reposi-tory	Length	Access	Default value	Value/range
Index		Sub-index							
DEC	HEX								
1032	408	-	Debounce version	String	-	8 bytes	ro	-	

The **Debounce version** contains the version number for the Smart Task sub-function **Debouncing**.

*Table 90: Smart Task - **Debouncing***

ISDU			Name	Data type	Data reposi-tory	Length	Access	Default value	Value/range
Index		Sub-index							
DEC	HEX								
1033	409	-	Debounce time 1	UInt	yes	2 bytes	rw	0	0 ... 30,000 ms
1034	40A		Quality D1		-		ro	-	0 to 100%
1035	40B		Debounce time 2		yes		rw	0	0 ... 30,000 ms
1036	40C		Quality D2		-		ro	-	0 to 100%

The **Debounce time 1/2** can be used to suppress (debounce) short, interfering signals at the Qint.1 input or **External input** of the Smart Task.
The set debounce time acts like a switch-on and switch-off delay.
Quality D1/D2 indicates how much debouncing is required. The higher the value, the more level changes that took place within the selected **Debounce time 1/2** .

Notes on ISDUs 1080, 1083, 1084, 1085, 1086, 1087, 1088, 1089, 1090, 1091, 1092: see "Smart Task “Basic logic” (A00)", page 42

8.9.4 Smart Task “Speed and length measurement” (A72)

Logical principle of operation:

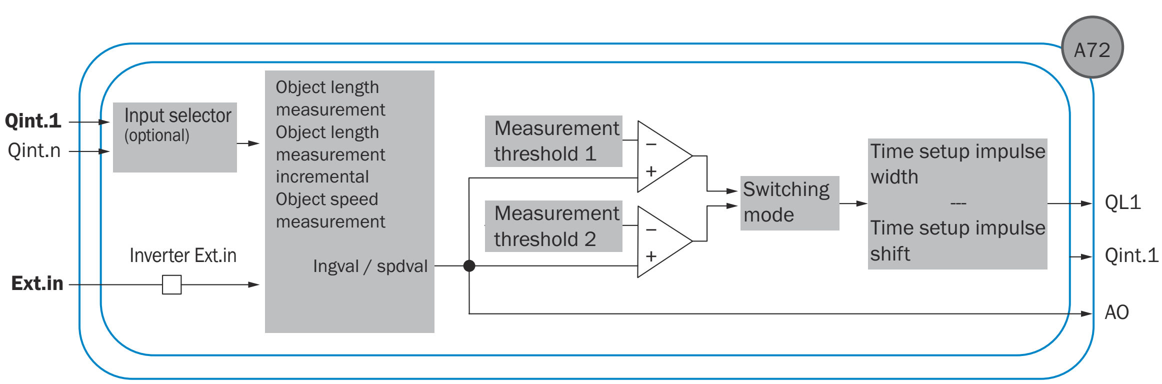


Figure 8: Logical principle of operation A72

The Smart Task “Speed and length measurement” (A72) can measure the length and speed of objects that pass the sensor on a conveyor belt, for example, and also determine the direction of movement. The Smart Task has three measurement modes for this purpose:

1 Measurement of the object length (**Length**)
2 Incremental measurement of the object length (**Length incremental**)
3 Measurement of the object speed (**Speed**)

The Smart Task A72 “Speed and length measurement” requires an additional external signal in each of the three measurement modes. This is supplied to the Smart Sensor via its Pin 2 / white wire.

In measuring mode **Length** and **Speed**, an additional binary switching sensor is required that detects the same measurement object shortly before or shortly after the A72 Smart Sensor, see see figure 9, page 50. To ensure the measurement accuracy specified in the sensor data sheet, it is recommended that the additional sensor has the same optical and detection properties as the A72 Smart Sensor used. In addition, the light beams of both sensors must be aligned exactly parallel.

For a correct length or speed measurement, it is crucial that the conveying speed of the measured object is constant. If, for example, the movement is accelerated, the sensor determines the average speed between the two measuring points and the measured object length is then too short.

To achieve a correct length measurement, even with accelerated or delayed movements, the measurement mode **Length incremental** must be used.

NOTE
The distance between the Smart Sensor and the additional sensor must be smaller than the smallest object to be measured. This means that the smallest object to be measured must be detected by both sensors simultaneously for a short moment.

NOTE
For easy connection of the additional sensor to the Smart Sensor, the Y-connector SYL-1204-G0M11-X1 (6055011, www.sick.com/6055011) or SYL-8204-G0M11-X2 (6055012, www.sick.com/6055012) can be used.

In measuring mode **Length incremental**, the A72 Smart Sensor requires the HTL signal from a connected incremental encoder (e.g. SICK DBS36, www.sick.com/dbs36), see see figure 10, page 50.

This measurement mode is particularly recommended if the object movement can be accelerated or decelerated during the measurement or if the object can come to a standstill during the measurement.

In order to ensure correct length measurement, the encoder must always rotate only in one direction during measurement. Detection of the movement direction of the object is not possible in this measurement mode.

NOTE
The A72 Smart Sensor can process a maximum of 1,000 encoder pulses per second.

NOTE
The Smart Sensor and the additional sensor or the additional encoder must be connected to the same electrical potential with their supply voltage.

The measured speed or length value and the direction of movement are provided via the process data, see see "Process data", page 11. Depending on the set measuring mode, either a length or a speed signal is output. The direction of movement is indicated by the sign of the measured value (only in measuring mode **Speed** and **Length**, not with **Length incremental**):

- • Positive sign: object travels into the measuring distance via the Smart Sensor
- • Negative sign: object travels into the measuring distance via the additional sensor

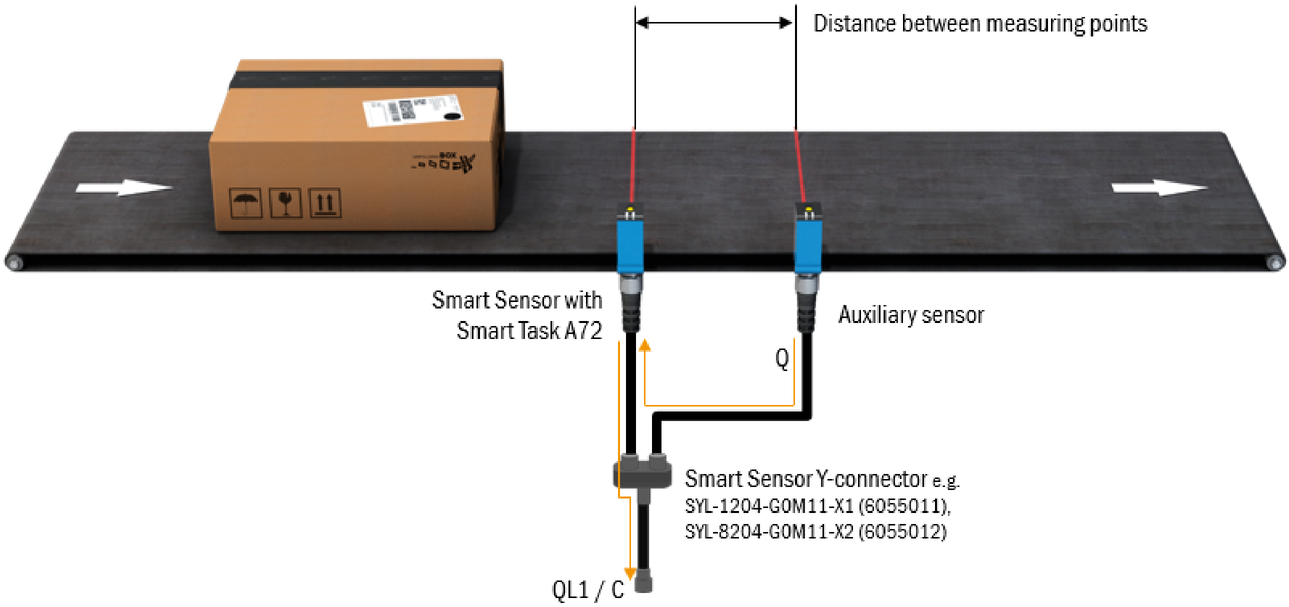


*Figure 9: Wiring example for measuring mode **Length** and **Speed***

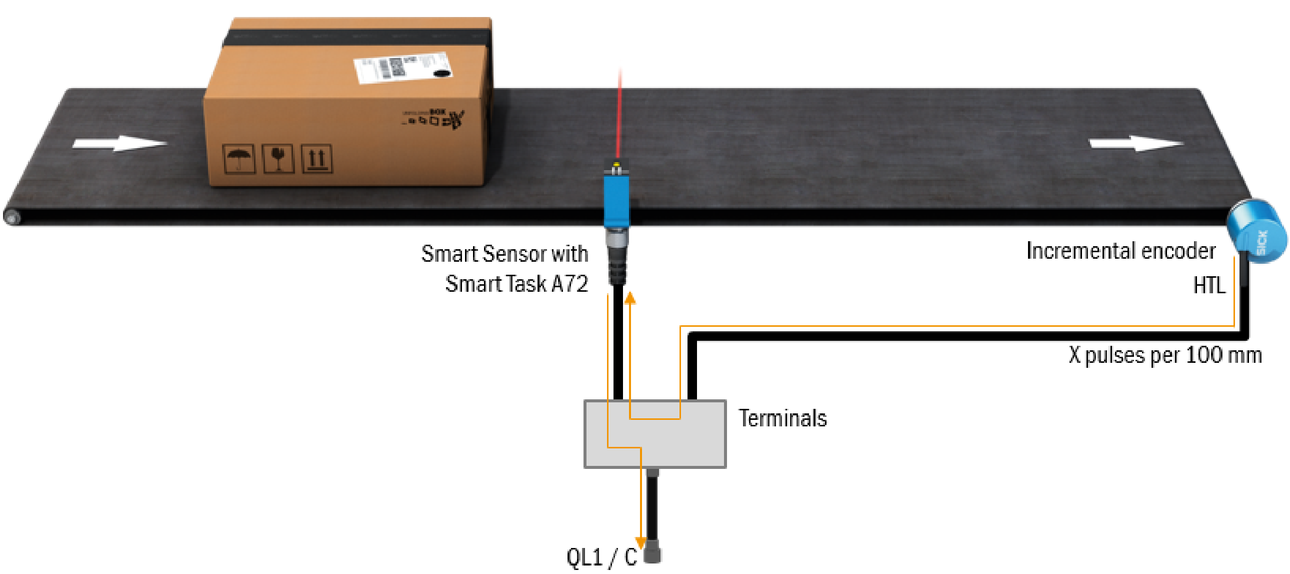


*Figure 10: Wiring example for measuring mode **Length incremental***

*Table 91: Smart Task – **Standard command***

ISDU			Name	Data type	Data repository	Length	Access	Default value	Value/range
Index		Sub-index							
DEC	HEX								
2	02	-	Standard command	UInt	-	1 byte	ro	-	201 = Start and stop reference run 202 = Zero setting for incremental length measurement value

As an alternative to directly entering the distance between the two measuring points (via index 1098 **Distance between measuring points**), this distance value can also be determined automatically: The command **Start and stop reference run** starts a recording function with which the parameter **Distance between measuring points** (index 1098) is automatically set by moving an object at a defined and constant speed through the detection area of the Smart Sensor and the additional sensor. Process:

- Input of the constant object speed during the reference run via **Object speed for reference run** (index 1105).
- Start the reference run via the command **Start and stop reference run** (index 2, value 201). **Smart Task operating state** (Index 1109) goes from **Operate** to **Reference run**.

- Within the next 20 seconds, an object must be moved through the detection area of the Smart Sensor and the additional sensor at exactly the previously entered and constant speed.
- The parameter **Distance between measuring points** (index 1098) is overwritten with the new value as soon as the object has entered the detection area of the second sensor. The status goes back to **Operate** (Index 1109).
- If no object moves through the detection areas of the sensors within 20 seconds of the reference run being activated, the reference run is aborted. The sensor returns to the status **Operate** (index 1109), the previous value of **Distance between measuring points** (index 1098) remains unchanged. The same happens if the command **Start and stop reference run** (index 2, value 201) is sent again within the 20 seconds.

The command **Start and stop reference run** is only executed by the sensor if the **Measurement Mode** (index 1097) is set to **Speed** or **Length** .

NOTE

Dependency:

- **Measurement mode** (Index 1097)
- **Distance between measuring points** (Index 1098)
- **Object speed for reference run** (Index 1105)
- **Smart Task operating state** (Index 1109)

The command **Zero setting for incremental length measurement value** resets the current measured value of the Smart Task, output via the process data or via the parameter **Length measurement value** (index 1106), to zero. This is necessary, for example, if a measurement is only to start after the measurement object has already entered the detection area of the A72 Smart Sensor.

The command **Zero setting for incremental length measurement value** is only executed by the sensor if the **Measurement Mode** (index 1097) is set to **Length incremental** .

*Table 92: Smart Task – **Speed and Length Measurement version***

ISDU			Name	Data type	Data repository	Length	Access	Default value	Value/range
Index		Sub-index							
DEC	HEX								
1096	448	-	Speed and Length Measurement version	String	-	8 bytes	ro	-	-

Speed and Length Measurement version specifies the version of the Smart Task "Speed and length measurement".

*Table 93: Smart Task - **Input selector***

ISDU			Name	Data type	Data repository	Length	Access	Default value	Value/range
Index		Sub-index							
DEC	HEX								
1081	439	-	Input selector	Index	yes	1 byte	rw	0	0 = Qint.1 1 = Qint.2 2 = Qint.3 3 = Qint.4 4 = Qint.5 5 = Qint.6 6 = ...

The **Input selector** defines which Qint.x detection signal is used for speed and length measurement.

NOTE

This function is only available if the Smart Sensor has more than one Qint.x. The actual scope of the value range is device specific. For details, see the respective device IODD.

*Table 94: Smart Task - **Inverter external input***

ISDU			Name	Data type	Data repository	Length	Access	Default value	Value/range
Index		Sub-index							
DEC	HEX								
1093	445	-	Inverter Ext.input	UInt	yes	1 byte	rw	0	0 = Not inverted 1 = Inverted

The Smart Task A72 speed and length measurement always expects a HIGH signal at the external input (pin 2 or white wire) when the additional sensor detects an object. If the connected additional sensor supplies a LOW signal when an object is detected (typical for retro-reflective or through-beam photoelectric sensors), the **Inverter Ext.input** must be set to **1 = inverted** . If the inverter is set incorrectly, the measurement will not work.

NOTE
This function is only relevant in the measurement modes **Speed** and **Length** of the parameter **Measurement mode** (index 1097).

*Table 95: Smart Task - **Measurement mode***

ISDU			Name	Data type	Data reposi-tory	Length	Access	Default value	Value/range
Index		Sub-index							
DEC	HEX								
1097	449	-	Measurement mode	UInt	yes	1 byte	rw	0	0 = Length [mm] 1 = Length incremental [mm] 2 = Speed [mm/s]

Measurement mode defines which primary measuring task is performed by the Smart Task:

Length
The length of objects passing by the Smart Sensor and additional sensor is measured. The measurement result is output in the process data as a millimeter value. The sign of the measured value indicates the direction of movement of the object:

- Positive sign: object travels into the measuring distance via the Smart Sensor
- Negative sign: object travels into the measuring distance via the additional sensor

The measurement only provides correct values if the parameter **Distance between measuring points** (index 1098) is set correctly.

Length incremental
The length of objects passing by the Smart Sensor is measured. The measurement result is output in the process data as a millimeter value. The sign of the measured value is always positive. It is not possible to make a statement about the direction of movement of the object in this mode. The measurement only provides correct values if the parameter **Pulses per 100 millimeter** (index 1099) is set correctly.

Speed
The speed of objects passing the Smart Sensor and additional sensor is measured. The measurement result is output in the process data in millimeters per second. The sign of the measured value indicates the direction of movement of the object:

- Positive sign: object travels into the measuring distance via the Smart Sensor
- Negative sign: object travels into the measuring distance via the additional sensor

The measurement only provides correct values if the parameter **Distance between measuring points** (index 1098) is set correctly.

The lengths and speeds measured by the sensor are also output via the parameters **Length measurement value** (index 1106) and **Speed measurement value** (index 1107).

NOTE
Dependency:

- **Distance between measuring points** (Index 1098)
- **Pulses per 100 millimeter** (Index 1099)

*Table 96: Smart Task – **Distance between measuring points***

ISDU			Name	Data type	Data reposi-tory	Length	Access	Default value	Value/range
Index		Sub-index							
DEC	HEX								
1098	44A	-	Distance between measuring points [in 100 µm]	UInt	yes	2 bytes	rw	1000	1 ... 65,535 [x 100 µm]

To ensure that the length or speed measurement (**Measurement mode Length** or **Speed**, index 1097) is carried out correctly, the parameter **Distance between measuring points** must be set as precisely as possible. This is the physical distance between the detection point of the A72 Smart Sensor and the detection point of the additional sensor. The distance is specified in 100 µm (corresponds to 1/10 mm) to increase the measurement accuracy of the Smart Task.

Example: For a measured distance between the detection points of 150.0 mm, the value “1500” must be entered.

NOTE
Dependency:

- **Measurement mode** (Index 1097)

*Table 97: Smart Task – **Pulses per 100 millimeter***

ISDU			Name	Data type	Data repository	Length	Access	Default value	Value/range
Index		Sub-index							
DEC	HEX								
1099	44B	-	Pulses per 100 millimeter	UInt	yes	2 bytes	rw	100	1 ... 1000

To ensure that the incremental length measurement (**Measurement mode Length incremental**, index 1097) is carried out correctly, the parameter **Pulses per 100 millimeter** must be set as precisely as possible. This is the number of HTL signal pulses that the incremental encoder sends to the Smart Sensor while the conveyor belt on which the measurement object is conveyed and to which the encoder is coupled travels 100 mm. The value depends on the number of pulses per revolution of the encoder, the diameter of the measuring wheel or the conveyor roller and, if applicable, the thickness of the conveyor belt.

The parameter is only included in the Smart Task calculations in **Measurement mode Length incremental** (index 1097).

NOTE
Dependency:

- **Measurement mode** (Index 1097)

*Table 98: Smart Task - **Measurement threshold***

ISDU			Name	Data type	Data repository	Length	Access	Default value	Value/range
Index		Sub-index							
DEC	HEX								
1100	44C	-	Measurement threshold 1	Int	yes	2 bytes	rw	100	- 8191 ... +8191
1101	44D	-	Measurement threshold 2	Int	yes	2 bytes	rw	50	- 8191 ... +8191
1102	44E	-	Switching mode	UInt	yes	1 bytes	rw	0	0 = Within time window 1 = Out of time window
1103	44F	-	Time setup impulse width	UInt	yes	2 bytes	rw	500	1 ... 30,000 ms
1104	450	-	Time setup impulse shift	UInt	yes	2 bytes	rw	0	0 ... 30,000 ms

The **Measurement threshold 1** and **Measurement threshold 2** are switching thresholds that are based on the measured length and the measured speed. The two switching thresholds form a switching window, with the larger value forming the upper switching threshold and the smaller value the lower switching threshold. Depending on the setting of **Switching mode** , a logical HIGH signal is generated:

- **Within time window:**
  HIGH signal when the lower switching threshold < measured value ≤ upper switching threshold
- **Out of time window:**
  HIGH signal when measured value ≤ lower switching threshold; or when the measured value > upper switching threshold

The HIGH signal is output as switching pulse **QL1**. The width of the switching pulse can be adjusted via **Time setup impulse width.** Output of the switching pulse can be delayed via **Time setup impulse shift.**

NOTE
The selected pulse width (**Time setup impulse width**) must always be smaller than the distance in time to the next measurement object.

NOTE
Dependency:

- **Impulse buffer state** (Index 1123)

*Table 99: Smart Task- **Object speed for reference run***

ISDU			Name	Data type	Data repository	Length	Access	Default value	Value/range
Index		Sub-index							
DEC	HEX								
1105	451	-	Object speed for reference run	UInt	yes	2 bytes	rw	100	10 ... 500 mm/s

As an alternative to directly entering the distance between the two measuring points (via index 1098 **Distance between measuring points**), this distance value can also be determined automatically: The command **Start and stop reference run** starts a recording function with which the parameter **Distance between measuring points** (index 1098) is automatically set by moving an object at a defined and constant speed through the detection area of the Smart Sensor and the additional sensor. Process:

- Input of the constant object speed during the reference run via **Object speed for reference run** (index 1105).
- Start the reference run via the command **Start and stop reference run** (index 2, value 201). **Smart Task operating state** (Index 1109) goes from **Operate** to **Reference run**.
- Within the next 20 seconds, an object must be moved through the detection area of the Smart Sensor and the additional sensor at exactly the previously entered and constant speed.
- The parameter **Distance between measuring points** (index 1098) is overwritten with the new value as soon as the object has entered the detection area of the second sensor. The status goes back to **Operate** (Index 1109).
- If no object moves through the detection areas of the sensors within 20 seconds of the reference run being activated, the reference run is aborted. The sensor returns to the status **Operate** (index 1109), the previous value of **Distance between measuring points** (index 1098) remains unchanged. The same happens if the command **Start and stop reference run** (index 2, value 201) is sent again within the 20 seconds.

The command **Start and stop reference run** is only executed by the sensor if the **Measurement Mode** (index 1097) is set to **Speed** or **Length** .

NOTE
Dependency:
- **Measurement mode** (Index 1097)
- **Distance between measuring points** (Index 1098)
- **Object speed for reference run** (Index 1105)
- **Smart Task operating state** (Index 1109)

The command **Zero setting for incremental length measurement value** resets the current measured value of the Smart Task, output via the process data or via the parameter **Length measurement value** (index 1106), to zero. This is necessary, for example, if a measurement is only to start after the measurement object has already entered the detection area of the A72 Smart Sensor.

The command **Zero setting for incremental length measurement value** is only executed by the sensor if the **Measurement Mode** (index 1097) is set to **Length incremental** .

NOTE
Dependency:

- **Standard command Start and stop reference run** (Index 2, value 201)

*Table 100: Smart Task - **Length measurement value***

ISDU			Name	Data type	Data repository	Length	Access	Default value	Value/range
Index		Sub-index							
DEC	HEX								
1106	452	-	Length measurement value	Int	-	2 bytes	ro	-	- 8,191 ... + 8,191 mm

Provision of the last measured length value.

*Table 101: Smart Task - **Speed measurement value***

ISDU			Name	Data type	Data repository	Length	Access	Default	Value/range
Index		Sub-index							
DEC	HEX								
1107	453	-	Speed measurement value	Int	-	2 bytes	ro	-	- 8,191 ... + 8,191 mm/s

Provision of the last measured speed value.

*Table 102: Smart Task - **Smart Task operating state***

ISDU			Name	Data type	Data repository	Length	Access	Default value	Value/range
Index		Sub-index							
DEC	HEX								
1109	455	-	Smart Task operating state	UInt	-	1 byte	ro	-	0 = Operate 1 = Reference run

As an alternative to directly entering the distance between the two measuring points (via index 1098 **Distance between measuring points**), this distance value can also be determined automatically: The command **Start and stop reference run** starts a recording function with which the parameter **Distance between measuring points** (index 1098) is automatically set by moving an object at a defined and constant speed through the detection area of the Smart Sensor and the additional sensor. Process:

- Input of the constant object speed during the reference run via **Object speed for reference run** (index 1105).
- Start the reference run via the command **Start and stop reference run** (index 2, value 201). **Smart Task operating state** (Index 1109) goes from **Operate** to **Reference run**.
- Within the next 20 seconds, an object must be moved through the detection area of the Smart Sensor and the additional sensor at exactly the previously entered and constant speed.
- The parameter **Distance between measuring points** (index 1098) is overwritten with the new value as soon as the object has entered the detection area of the second sensor. The status goes back to **Operate** (Index 1109).
- If no object moves through the detection areas of the sensors within 20 seconds of the reference run being activated, the reference run is aborted. The sensor returns to the status **Operate** (index 1109), the previous value of **Distance between measuring points** (index 1098) remains unchanged. The same happens if the command **Start and stop reference run** (index 2, value 201) is sent again within the 20 seconds.

The command **Start and stop reference run** is only executed by the sensor if the **Measurement Mode** (index 1097) is set to **Speed** or **Length** .

NOTE

Dependency:

- **Measurement mode** (Index 1097)
- **Distance between measuring points** (Index 1098)
- **Object speed for reference run** (Index 1105)
- **Smart Task operating state** (Index 1109)

The command **Zero setting for incremental length measurement value** resets the current measured value of the Smart Task, output via the process data or via the parameter **Length measurement value** (index 1106), to zero. This is necessary, for example, if a measurement is only to start after the measurement object has already entered the detection area of the A72 Smart Sensor.

The command **Zero setting for incremental length measurement value** is only executed by the sensor if the **Measurement Mode** (index 1097) is set to **Length incremental** .

NOTE
Dependency:

- **Standard command Start and stop reference run** (Index 2, value 201)

*Table 103: Smart Task - **Impulse buffer state***

ISDU			Name	Data type	Data repository	Length	Access	Default value	Value/range
Index		Sub-index							
DEC	HEX								
1123	463	-	**Impulse buffer state**	UInt	-	1 byte	ro	-	0 = **Green: Buffer OK** 1 = **Yellow: Buffer almost full** 2 = **Red: Buffer overflow**

If a pulse delay is set via **Time setup impulse shift** (index 1104), further switching pulses may be generated while the delay time of a previous switching pulse is still running. In such a case, up to 16 switching pulses are temporarily stored and successively output via **QL1** .

The **Impulse buffer state** indicates how full the buffer tank is:

Green:	**Buffer OK:**	0 ... 12 QL1 pulses in the buffer
Yellow:	**Buffer almost full:**	13 ... 16 QL1 pulses in the buffer
Red:	**Buffer overflow:**	Buffer is full. New QL1 pulses will be discarded.

NOTE
Dependency:

- **Time setup impulse shift** (Index 1104)

8.9.5 Smart Tasks “Object and gap monitor” (A73)

Logical principle of operation:

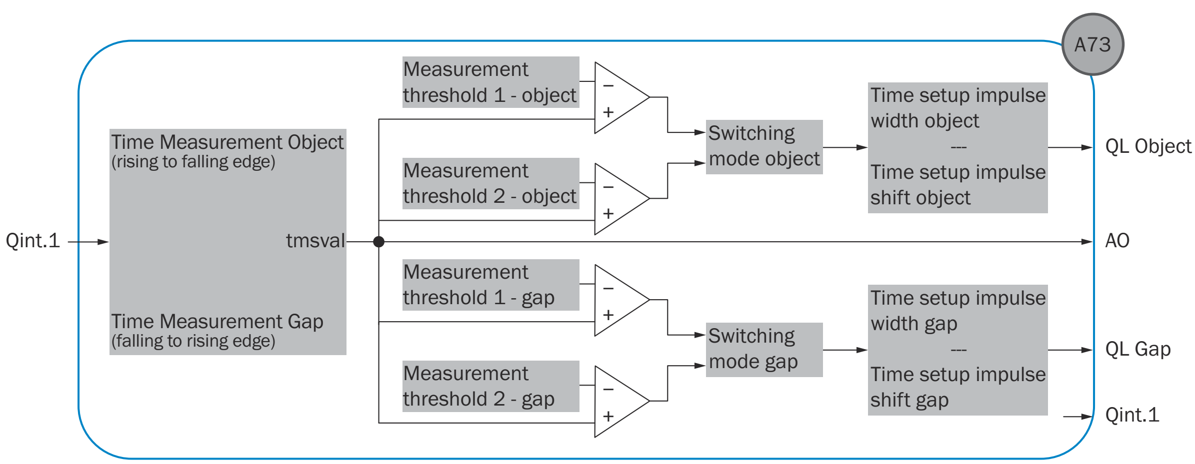


Figure 11: Logical principle of operation A73

The Smart Task “Object and gap monitor” measures the length of the objects that pass the sensor followed by the gap to the next detection object. In this case, the time between the rising signal edge and the falling signal edge of the Qint.1 detection signal corresponds to the object length and the time between the falling signal edge and the rising signal edge of the Qint.1 detection signal corresponds to the length of the gap. The measured time value for objects and gaps is always output in the sensor’s process data element. The measurement is recorded in milliseconds (see "Process data", page 11).

NOTE
The measured length value depends on the object’s speed of transportation. If the speed of transportation increases, the measured time value decreases and vice versa.

*Table 104: Smart Task - **Object + Gap Monitor version***

ISDU			Name	Data type	Data repository	Length	Access	Default value	Value/range
Index		Sub-index							
DEC	HEX								
1112	458	-	**Object + Gap Monitor version**	String	-	8 bytes	ro	-	-

Object + Gap Monitor version specifies the version present in the Smart Task sub-function “Object and gap monitor”.

*Table 105: Smart Task - **Measurement threshold - object***

ISDU			Name	Data type	Data repository	Length	Access	Default value	Value/range
Index		Sub-index							
DEC	HEX								
1113	459	-	**Measurement threshold 1 - object**	UInt	yes	2 bytes	rw	200	1 ... 8,190 ms
1114	45A	-	**Measurement threshold 2 - object**	UInt	yes	2 bytes	rw	150	1 ... 8,189 ms
1115	45B	-	**Switching mode object**	UInt	yes	1 byte	rw	0	0 = **Object within time window** 1 = **Object out of time window**
1116	45C	-	**Time setup impulse width object**	UInt	yes	2 bytes	rw	50	1 ... 30,000 ms
1117	45D	-	**Time setup impulse shift object**	UInt	yes	2 bytes	rw	0	0 ... 30,000 ms

Measurement threshold 1 – object and **Measurement threshold 2 – object** are thresholds that are placed on the measured time between the rising signal edge and falling signal edge of the detection signal **Qint.1**(= Object detection). Together, the two thresholds form a time window, whereby the larger value is the upper threshold and the smaller value is the lower threshold. A HIGH signal is generated depending on the settings for **Switching mode object**:

- **Object within time window:**
  HIGH signal, when the lower switching threshold < Object time value ≤ Upper switching threshold
- **Object out of time window:**
  HIGH signal when the object time value ≤ lower switching threshold or when the object time value > upper switching threshold

The HIGH signal can be emitted as a switching pulse: **QL Object**. The width of the switching pulse can be adjusted under **Time setup impulse width object. Time setup impulse shift object** can be used to delay the output of the switching pulse.

NOTE
The selected pulse width (**Time setup impulse width object**) must always be smaller than the smallest time distance to the next object.

*Table 106: Smart Task - **Measurement threshold - gap***

ISDU			Name	Data type	Data repository	Length	Access	Default value	Value/range
Index		Sub-index							
DEC	HEX								
1118	45E	-	**Measurement threshold 1 - gap**	UInt	yes	2 bytes	rw	200	1 ... 8,190 ms
1119	45F	-	**Measurement threshold 2 - gap**	UInt	yes	2 bytes	rw	150	1 ... 8,189 ms
1120	460	-	**Switching mode gap**	UInt	yes	1 byte	rw	0	0 = **Gap within time window** 1 = **Gap out of time window**
1121	461	-	**Time setup impulse width gap**	UInt	yes	2 bytes	rw	50	1 ... 30,000 ms
1122	462	-	**Time setup impulse shift gap**	UInt	yes	2 bytes	rw	0	0 ... 30,000 ms

Measurement threshold 1 – gap and **Measurement threshold 2 – gap** are thresholds that are placed on the measured time between the falling signal edge and rising signal edge of the detection signal **Qint.1**(= Gap detection). Together, the two thresholds form a time window, whereby the larger value is the upper threshold and the smaller value is the lower threshold. A HIGH signal is generated depending on the settings for **Switching mode gap**:

- **Gap within time window:**
  HIGH signal, when the lower switching threshold < Gap time value ≤ Upper switching threshold
- **Gap out of time window:**
  HIGH signal when the gap time value ≤ lower switching threshold or when the gap time value > upper switching threshold

The HIGH signal can be emitted as a switching pulse: **QL Gap**. The width of the switching pulse can be adjusted under **Time setup impulse width gap**. **Time setup impulse shift gap** can be used to delay the output of the switching pulse.

NOTE
The selected pulse width (**Time setup impulse width gap**) must always be smaller than the smallest time interval to the next gap.

*Table 107: Smart Task - **Impulse buffer state***

ISDU			Name	Data type	Data repository	Length	Access	Default value	Value/range
Index		Sub-index							
DEC	HEX								
1123	463	-	Impulse buffer state	UInt	-	1 byte	ro	-	0 = Green: Buffer OK 1 = Yellow: Buffer almost full 2 = Red: Buffer overflow

When a pulse delay is selected using **Time setup impulse shift object** (index 1117) and/or **Time setup impulse shift gap** (index 1122), further switching pulses may be generated while the delay time of a previous switching pulse is still running. In this case, up to 16 switching pulses are temporarily stored and successively output via **QL Object** and **QL Gap** .

Impulse buffer state indicates how full the buffer is:

Green:	**Buffer OK:**	0 to 12 **QL Object**- / **QL Gap** pulses in the buffer
Yellow:	**Buffer almost full:**	13 to 16 **QL Object**- / **QL Gap** pulses in the buffer
Red:	**Buffer overflow:**	Buffer is full. New **QL Object**- / **QL Gap** pulses will be discarded

8.10 System-specific ISDUs

*Table 108: System-specific ISDUs - **Profile characteristic***

ISDU			Name	Data type	Data repository	Length	Access	Default value	Value/range
Index		Sub-index							
DEC	HEX								
13	D	-	Profile characteristic	Array	-	device specific	ro	-	-

Profile characteristic indicates which standardized profiles and functionalities the sensor supports.
The values are emitted in five 16-bit blocks.
At most, the following profiles / functionalities are supported:

1 PID (**Profile Identifier**) "Smart Sensor Profile".

32768 **Device Identification**
The sensor supports enhanced identification options, see Identification section.

32769 **Binary Data Channel**
The sensor generates a switching signal from measured analog values and makes this available in a specified manner (see indices 60/61 and 62/63).

32770 **Process Data Variables**
The sensor provides the measured analog value as process data.

32771 **Diagnostics**
The sensor provides standardized diagnostic information.

32772 The sensor supports teach-in methods to teach-in the sensor via the IO-Link interface.

*Table 109: System-specific ISDUs - **PD-Descriptor***

ISDU			Name	Data type	Data repository	Length	Access	Default value	Value/range [1)]
Index		Sub-index							
DEC	HEX								
14	0E	-	PDInput Descriptor	Array	-	device specific	ro	-	Octet String [2]
15	0F	-	PDOutput Descriptor	Array	-	device specific	ro	-	Octet String [1]

1) Description of the process data

The **PDInput Descriptor** (index 14) and the **PDOutput Descriptor** (index 15) provide information on the data structure of the process data (input and output). The coding is described in the specification of **Smart-Sensor-Profils** .

Each part of the process data is described with 3 bytes.

Byte 1 Data type:
0: **OctetStringT**
1: **Set of BoolT**
2: **UIntegerT**
3: **IntegerT**
4: **Float32T.**

Byte 2 Length of the data in bits.

Byte 3 Bit offset of the corresponding process data variables in the process data.

*Table 110: System-specific ISDUs - **SICK Profile Version***

ISDU			Name	Data type	Data repository	Length	Access	Default value	Value/range
Index		Sub-index							
DEC	HEX								
205	0E	-	**SICK Profile Version**	String	-	4 bytes	ro	-	-

SICK sensors do not just fulfill the requirements of the IO-Link specification and the IO-Link Smart Sensor profile specification, but also the requirements of in-house profiles so as to ensure that all sensors of SICK can be operated in a similar manner. This index indicates the version of the SICK profile used.

*Table 111: System-specific ISDUs - **Process Data Input***

ISDU			Name	Data type	Data repository	Length	Access	Default value	Value/range
Index		Sub-index							
DEC	HEX								
40	28	-	**Process Data Input**	PD in	-	device specific	ro	-	-

The current process data is made available as an index in this index.
For further information see "Process data", page 11.

9 Sensor replacement/data storage

All **IO-Link Device** have a backup and restore functionality - **Data Storage (DS)**. The IO-Link **Data Storage** function can be used to save previous parameters and transfer them to the replacement device, eliminating the need to re-parameterize the replacement device.

In the world of automation, there are several names for the same function:

- Data storage
- Backup and restore
- Parameter server
- Device replacement

NOTE
The **DS**function was introduced with the IO-Link specification V1.1.

It is therefore possible that devices older than 2013 were programmed according to the IO-Link specification V1.0 and do not support the entire feature.

Replacing a **IO-Link Device** requires the replacement hardware and the application-specific parameterization of the device.
When data storage is activated, the **IO-Link Master** always saves the last valid setting parameters of all connected **IO-Link Device** in its local memory. If one of the connected **IO-Link Devices** is replaced with a functionally compatible replacement device, the **IO-Link Master** automatically transfers the last valid parameter set of the predecessor sensor to the new **IO-Link Device**.

When activating the new **IO-Link Device** in the **IO-Link Master**, you can choose between different **IO-Link Master** behaviors:

- NONE: No backup of the device parameters is made in the **IO-Link Master** .
- BACKUP/RESTORE: The **IO-Link Master** saves the parameterization of the connected **IO-Link Devices** (initially automatically) and is ready to restore it in the event of a device replacement.
- RESTORE: No automatic backup of the device parameters is performed in the **IO-Link Master** . Manually initiated backups are possible. The **IO-Link Master** monitors the port and restores the parameterization when a replacement device is detected.

NOTE

- To be able to use data storage, it must be activated in the **IO-Link Master** .
- If the changeover of one or more sensor parameters is initiated via the control unit, the control unit must activate the so-called **Data Storage Upload Request-Flag** as the final command in the sensor. Only this initiates the data repository.
- Depending on the data volume and the **IO-Link Master** used, the upload/download of sensor parameters via the data storage function can take between a few hundred milliseconds and up to three seconds (typical values; values may vary in individual cases).
- For details on using the data repository, see IO-Link Interface and System Specification, V1.1.2, section 10.4 Data Storage (DS) at www.io-link.com, Downloads menu item.
- Parameters that do not participate in data storage are marked in the IODD overview.

NOTE
To set the **DS**function, read the manufacturer-specific instructions for the **IO-Link Master**.

10 Device Backward Compatibility (DBC)

IO-Link sensors typically offer extensive parameterization options to optimally adjust the device functionality to the requirements of the individual applications and to be able to operate the system reliably for many years. If such an IO-Link sensor is nevertheless defective, it is important for the replacement device to be compatible with the original device not only in terms of its sensor characteristics, but also with regard to the configurable IO-Link parameters and the IO-Link communication properties. This applies in particular if the defective device type is no longer available, e.g., due to a generation change, and a successor device needs to be used.

IO-Link-capable sensors from SICK are generally backwards-compatible with their respective IO-Link-capable predecessor devices (if such predecessor devices exist) in terms of their communication properties and IO-Link functionality. They use the DBC mechanism (DBC = **Device Backward Compatibility**) standardized by the IO-Link Consortium.

DBC is based on the fact that an **IO-Link device** not only supports its current communication-related and functional IO-Link parameter set, but also the parameter set(s) of one or more predecessor devices. Each of these parameter sets is represented by its own **device ID**. Accordingly, a backwards-compatible IO-Link device supports multiple **device IDs**. Depending on the requirements, the device can be operated with its latest (default) **device ID** or with one of the supported predecessor **device IDs.**

Ideally, the sensor is automatically set to the **device ID** required in the respective application during start-up via DBC. Such an automatic **device ID** setting works if the **IO-Link master** supports DBC and the relevant IO-Link master ports are configured so that when IO-Link communication with the connected IO-Link device starts up, its identity is checked using the **vendor** and **device ID** (often found under the keyword “validation”). If the DBC-capable IO-Link device supports the **vendor** and **device ID** expected by the **IO-Link master**, the IO-Link device sets itself accordingly and starts up with this **device ID** requested by the master.

To utilize the full potential of DBC, the data repository function (section 9) should also be used for the relevant IO-Link devices. This ensures that the respective IO-Link device automatically adopts the last active parameter settings from the predecessor device in addition to the correct **device ID**.

Together with the data repository function, DBC thus enables plug & play device exchange even across device generations.

If the requirements for automatic **device ID** switching via DBC are not met in an existing system, most DBC-capable IO-Link sensors from SICK allow manual switching of the **device ID** via index 16000 (**Device ID setup**), see table 23, page 18.

11 Events

IO-Link events

With **Events** (events), an **IO-Link Device** reports events to the **IO-Link Master** without being prompted to do so by the **IO-Link Master.**

Events are the only way for an **IO-Link Device** to report a sporadic event, information or problem. An **IO-Link Master** can use events to inform about port-specific events, e.g. the disconnection of an **IO-Link Device** from the **IO-Link Master.**

NOTE
Not all **IO-Link Master** support the event mechanism, especially older ones. You can deactivate the generation of events on the device page in "**Notification handling** (ISDU 227)".

An event consists of:

- **Event Qualifier:** Specification of information about:
  - **Instance** (event instance)
  - **Source** (event source)
  - **Type** (event type)
  - **Mode** (event mode)
- **Event Code:** Details of the event content

11.1 Event Qualifier

The **Event Qualifier** (event qualifier) is a byte that contains some important information about the event.

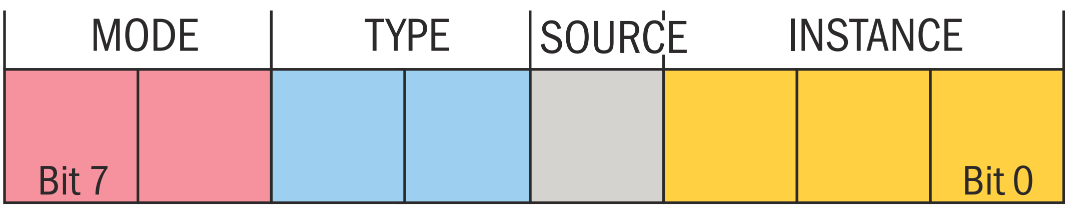


Figure 12: Structure of an ***Event Qualifier***

Instance

As a rule, all events come from the application layer.

Table 112: ***Instance***

Value	Definition
0	Unknown
1-3	Reserved
4	Application
5-7	Reserved

Source

This bit decides whether the event comes from the **IO-Link Master** / **Port** (e.g. "**No Device (communication)**") or from the connected **IO-Link Device** (e.g. "**Teach-in successful**").

Table 113: ***Source***

Value	Definition
0	**IO-Link Device**
1	**IO-Link Master** / **Port**

Type

Type (event type) are classified as follows:

*Table 114: **Type***

Value	Definition	Description	Event mode
0	Reserved	-	-
1	Note	For information purposes only; the system is not restricted.	**Event single shot**
2	Warning	System is still functional, but impaired in some way. You must rectify the problem as quickly as possible by taking appropriate measures.	Event appears/disappears
3	Error	The system is no longer functional. Depending on the cause of the error, it may be possible to restore the function.	Event appears/disappears

Mode

There are upcoming, outgoing and individual events (e.g. a note).

*Table 115: **Mode** (event mode)*

Value	Definition
0	Reserved
1	**Event single shot**
2	Event disappears
3	Event appears

11.2 Event Code

An event outputs a 2-byte long **Event Code** that contains the cause for the occurrence of the event.

The information on the event source from **Event Qualifier** can be used to differentiate where the event comes from.

11.2.1 Device-specific events

Common **Event Codes** are defined in the IO-Link interface specification (Table D.1):

*Table 116: **Event Codes** for devices*[2)]

Event Code ID	Definition and recommended maintenance action	DeviceStatus Value	Type
0x0000	No malfunction	0	**Notification**
0x1000	**General malfunction – unknown error**	4	**Error**
0x1001 to 0x17FF	Reserved		
0x1800 to 0x18FF	**Vendor specific**		
0x1900 to 0x3FF	Reserved		
0x4000	**Temperature fault – Overload**	4	**Error**

2) Source: IO-Link Interface Specification V1.1.3, June 2019; Table D.1 - EventCodes for Devices

Event Code ID	Definition and recommended maintenance action	DeviceStatus Value	Type
0x4001 to 0x420F	Reserved		
0x4210	Device temperature overrun – Clear source of heat	2	Warning
0x4211 to 0x421F	Reserved		
0x4220	Device temperature underrun – Insulate Device	2	Warning
0x4221 to 0x4FFF	Reserved		
0x5000	Device hardware fault – Device exchange	4	Error
0x5001 to 0x500F	Reserved		
0x5010	Component malfunction – Repair or exchange	4	Error
0x5011	Non volatile memory loss – Check batteries	4	Error
0x5012	Batteries low – Exchange batteries	2	Warning
0x5013 to 0x50FF	Reserved		
0x5100	General power supply fault – Check availability	4	Error
0x5101	Fuse blown/open – Exchange fuse	4	Error
0x5102 to 0x510F	Reserved		
0x5110	Primary supply voltage overrun – Check tolerance	2	Warning
0x5111	Primary supply voltage underrun – Check tolerance	2	Warning
0x5112	Secondary supply voltage fault (Port Class B) – Check tolerance	2	Warning
0x5113 to 0x5FFF	Reserved		
0x6000	Device software fault – Check firmware revision	4	Error
0x6001 to 0x631F	Reserved		
0x6320	Parameter error – Check data sheet and values	4	Error
0x6321	Parameter missing – Check data sheet	4	Error
0x6322 to 0x634F	Reserved		
0x6350	Reserved		
0x6351 to 0x76FF	Reserved		
0x7700	Wire break of a subordinate device – Check installation	4	Error
0x7701 to 0x770F	Wire break of subordinate device 1 ...device 15 – Check installation	4	Error
0x7710	Short circuit – Check installation	4	Error
0x7711	Ground fault – Check installation	4	Error
0x7712 to 0x8BFF	Reserved		
0x8C00	Technology specific application fault – Reset Device	4	Error
0x8C01	Simulation active – Check operational mode	3	Warning
0x8C02 to 0x8C0F	Reserved		

Event Code ID	Definition and recommended maintenance action	DeviceStatus Value	Type
0x8C10	**Process variable range overrun – Process Data uncertain**	2	**Warning**
0x8C11 to 0x8C1F	Reserved		
0x8C20	**Measurement range exceeded – Check application**	4	**Error**
0x8C21 to 0x8C2F	Reserved		
0x8C30	**Process variable range underrun – Process Data uncertain**	2	**Warning**
0x8C31 to 0x8C3F	Reserved		
0x8C40	**Maintenance required – Cleaning**	1	**Warning**
0x8C41	**Maintenance required – Refill**	1	**Warning**
0x8C42	**Maintenance required – Exchange wear and tear parts**	1	**Warning**
0x8C43 to 0x8C9F	Reserved		
0x8CA0 to 0x8DFF	**Vendor specific**		
0x8E00 to 0xAFFF	Reserved		
0xB000 to 0xB0FF	Reserved for Safety extensions		
0xB100 to 0xBFFF	Reserved for profiles		
0xC000 to 0xFF90	Reserved		
0xFF91	**Data Storage upload request ("DS_UPLOAD_REQ") – internal, not visible to user**	0	**Notification (single shot)**
0xFF92 to 0xFFAF	Reserved		
0xFFB0 to 0xFFB7	**Reserved for Wireless extensions**		
0xFFB8 to 0xFFFF	Reserved		

In addition, **IO-Link Devices** support manufacturer-specific **Event Codes**, which must be described in the documentation belonging to the IO-Link device.

Manufacturer-specific events

IO-Link communication is a **IO-Link Master/IO-Link Device** communication system.
With **Events**, an IO-Link device reports events to the IO-Link Master (without being prompted by the IO-Link Master).
Device-specific events are classified as follows:

Table 117: Device-specific events

Notification	For information purposes only; system is not restricted.
Warning	System is still functional, but is impaired in some way. You must rectify this with suitable measures as soon as possible.
Error	System is no longer functional. Depending on the cause of the error, it may be possible to restore functionality.

An **Event** issues an event code, which contains the cause of the occurrence of the **Event**.

NOTE
Not all IO-Link masters support the event mechanism.
In **Notification Handling** (Index 227), the generation of events can be deactivated on the device side.

The following events are supported:

*Table 118: **Events***

Code		Name	Type	Description	Action
Dec	Hex				
30480	0x7710	Short circuit	Error	Triggered in the event of a short circuit on at least one digital output. Overcurrent detection.	Check device connection.
36000	0x8CA0	Short circuit on Qx	Warning	Triggered in the event of a short circuit on at least one digital output. Overcurrent detection.	Check device connection.
36001	0x8CA1	New parameters	Notification	Parameters have been amended (only when changing the sensing range using control elements on the sensor housing or using the external teach-in via pin 2).	None
36004	0x8CA4	Quality of run alarm	Warning	Operational safety alarm	Clean the optical surfaces (sensor and reflector).
36005	0x8CA5	Teach / value out of specified range	Notification	Teach/distance value outside the specified range (too close, too far, no signal).	Readjust sensor or detection object. Teach in again.
36006	0x8CA6	Value out of specified range	Notification	Set value is outside the permissible range.	Correct adjustment value.
36007	0x8CA7	Teach-in necessary or teach-in error	Warning	Teach-in required Teach-in error	Teach in again.
36008	0x8CA8	Alarm upper temperature threshold	Warning	Upper temperature threshold has been exceeded.	Cool down sensor.
36009	0x8CA9	Alarm sender lifetime threshold	Warning	Alarm threshold for sender LED monitoring reached.	Prepare device exchange.
36010	0x8CAA	Alarm maintenance prediction	Warning	Alarm threshold for maintenance request reached.	Prepare on-site service.
36011	0x8CAB	Alarm operating hours	Warning	Alarm threshold for operating hours reached	Prepare on-site service or device exchange.
36015	0x8CAF	Alarm lower temperature threshold	Warning	Lower temperature threshold has been exceeded.	Warm up sensor.

Example of common Event Code

The SLG-2 from SICK transmits the event of an occurring "short-circuit" error:

LastEvent_Type	'Error'	{...}		STRING
LastEvent_Source	'Device'	{...}		STRING
LastEvent_Qualifier	16#f4		Hex	SINT
LastEvent_Mode	'Event appears'	{...}		STRING
LastEvent_Instance	'Application'	{...}		STRING
LastEvent_Code	16#7710		Hex	INT

Figure 13: Source: Logix Designer, Studio 5000 using SIG350 as IO-Link Master

Example of manufacturer-specific Event Code

The KTS from SICK sends the event "Successful teach-in":

LastEvent_Type	'Notification'	{...}		STRING
LastEvent_Source	'Device'	{...}		STRING
LastEvent_Qualifier	16#54		Hex	SINT
LastEvent_Mode	'Event single shot'	{...}		STRING
LastEvent_Instance	'Application'	{...}		STRING
LastEvent_Code	16#1801		Hex	INT

Figure 14: Source: Logix Designer, Studio 5000 using SIG350 as IO-Link Master

11.2.2 Port-specific events

Port-specific events are events that are output by the **IO-Link-Master**. The reason for their occurrence has something to do with the port to which a device is connected.

Here too, a distinction is made between common **Event Codes** events that are specified in the IO-Link interface specification (Table D.2) and events that are specific to the IO-Link master:

*Table 119: **EventCodes** for ports [3)]*

EventCode ID	Definition and recommended maintenance action	Type
0x0000 to 0x17FF	Reserved	
0x1800	No Device (communication) Trigger: SMI_PortEvent (0x1800) by SM_PortMode (COMLOST)	Error
0x1801	Startup parametrization error – check parameter	Error
0x1802	Incorrect VendorID – Inspection Level mismatch Trigger: SM_PortMode (COMP_FAULT)	Error
0x1803	Incorrect DeviceID – Inspection Level mismatch Trigger: SM_PortMode (COMP_FAULT)	Error
0x1804	Short circuit at C/Q – check wire connection	Error
0x1805	PHY overtemperature – check Master temperature and load	Error
0x1806	Short circuit at L+ – check wire connection	Error
0x1807	Overcurrent at L+ – check power supply (e.g. L1+)	Error
0x1808	Device Event overflow	Error
0x1809	Backup inconsistency – memory out of range (2048 octets) Trigger: SMI_PortEvent (0x1809) by DS_Fault (SizeCheck_Fault)	Error
0x180A	Backup inconsistency – identity fault Trigger: SMI_PortEvent (0x180A) by DS_Fault (Identification_Fault)	Error
0x180B	Backup inconsistency – Data Storage unspecific error Trigger: SMI_PortEvent (0x180B) by DS_Fault (All other incidents)	Error
0x180C	Backup inconsistency – upload fault	Error
0x180D	Parameter inconsistency – download fault	Error
0x180E	P24 (Class B) missing or undervoltage	Error
0x180F	Short circuit at P24 (Class B) – check wire connection (e.g. L2+)	Error
0x1810	Short circuit at I/Q – check wiring	Error
0x1811	Short circuit at C/Q (if digital output) – check wiring	Error
0x1812	Overcurrent at I/Q – check load	Error
0x1813	Overcurrent at C/Q (if digital output) – check load	Error
0x1814 to 0x1EFF	Reserved	
0x1F00 to 0x1FFF	Vendor specific	
0x2000 to 0x2FFF	Safety extensions	
0x3000 to 0x3FFF	Wireless extensions	
0x4000 to 0x5FFF	Reserved	
0x6000	Invalid cycle time Trigger: SM_PortMode (CYCTIME_FAULT)	Error

3) Source: IO-Link Interface Specification V1.1.3, June 2019, Table D.2 - EventCodes for Ports

EventCode ID	Definition and recommended maintenance action	Type
0x6001	**Revision fault – incompatible protocol version Trigger: SM_PortMode (REVISION_FAULT)**	**Error**
0x6002	**ISDU batch failed – parameter inconsistency?**	**Error**
0x6003 to 0xFF20	Reserved	
0xFF21[a)]	**DL: Device plugged in ("NEW_SLAVE") – PD stop Trigger: SM_Port-Mode (COMREADY); see Figure 71 (T10)**	**Notification**
0xFF22[a)]	**Device communication lost ("DEV_COM_LOST") Trigger: see Figure 101 (T9)**	**Notification**
0xFF23[a)]	**Data Storage identification mismatch ("DS_IDENT_MISMATCH") Trigger: see Figure 104 (T15)**	**Notification**
0xFF24[a)]	**Data Storage buffer overflow ("DS_BUFFER_OVERFLOW") Trigger: see Figure 104 (T17)**	**Notification**
0xFF25[a)]	**Data Storage parameter access denied ("DS_ACCESS_DENIED") Trigger: see Figure 104 (T29), Figure 105 (T32), Figure 107 (T39)**	**Notification**
0xFF26	**Port status changed – Use "SMI_PortStatus" service for port status in detail Trigger: see Figure 101 (T12)**	**Notification**
0xFF27	**Data Storage upload completed and new data object available Trigger: see Figure 104 (T26)**	**Notification**
0xFF28 to 0xFF30	Reserved	
0xFF31[a)]	**DL: Incorrect Event signalling ("EVENT") Trigger: none**	**Notification**
0xFF32 to 0xFFFF	Reserved	

a) No more required due to SMI Event concept. Not recommended for new implementations.

Example of common port-specific Event Code

SIG350 sends the port event of a disappearing 'No Device (communication)' error:

LastEvent_Type	'Error'	{...}		STRING
LastEvent_Source	'Master'	{...}		STRING
LastEvent_Qualifier	16#bc		Hex	SINT
LastEvent_Mode	'Event disappears'	{...}		STRING
LastEvent_Instance	'Application'	{...}		STRING
LastEvent_Code	16#1800		Hex	INT

Figure 15: Source: Logix Designer, Studio 5000 using SIG350 as IO-Link Master

Technical principle of operation in detail

An IO-Link device manufacturer can choose from various **Frame Types**, depending on the amount of process and service data required for the respective device.

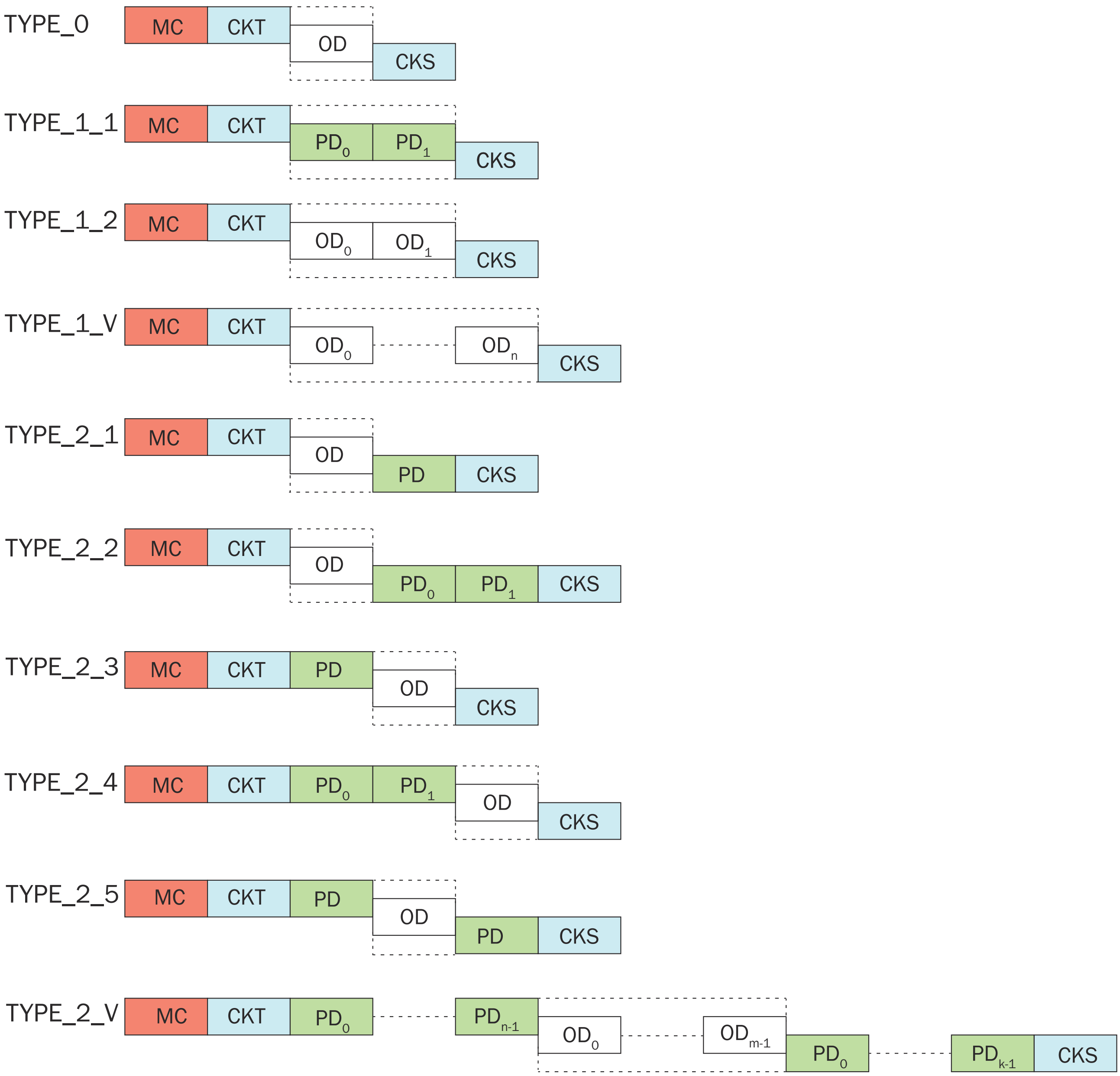


*Figure 16: **Frame Types**, source: IO-Link Interface Specification V1.1.3, June 2019*

The figure above shows the available **Frame Types.** Each block represents one byte.

What they all have in common is that the **Frame** begins with **MC (Master-Sequence-Control)**, followed by **CKT (Checksum / M-Sequence-Type).** In addition, all **Frames** end with **CKS (Checksum / Status).**

It is precisely this CKS byte that is decisive for the event mechanism:

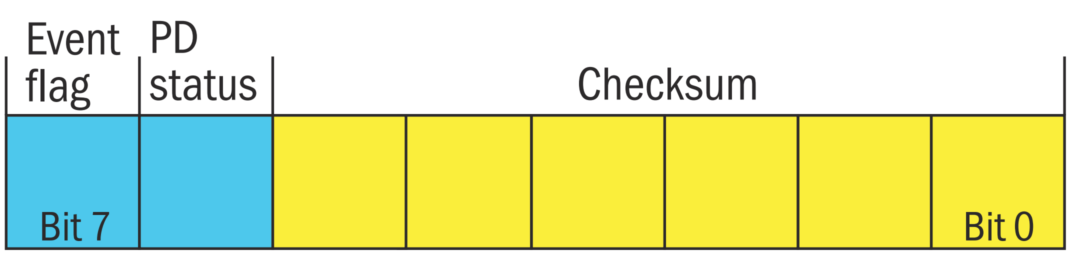


Figure 17: CKS byte, source: IO-Link Interface Specification V1.1.3, June 2019

The CKS byte is the last part of the response message from the **Device** to the master. It consists of a 6-bit checksum (to check the integrity of the response message from the device to the master), a **Flag** to display valid or invalid process data and the **Eventflag**.

This **Eventflag** indicates that an event has occurred on the device side. As soon as the master recognizes the activated **Eventflag**, it starts the procedure for reading the event details (**Event Qualifier** and **Event Code**).

An **IO-Link-Master** will then propagate the event and its content to its gateway application and thus make the event available on its fieldbus and/or cloud interface.

How the event and its information are then processed further depends heavily on the protocol of the interface used at the next level.

You can find some examples in section 11.3.

11.3 Event processing using the example of EtherNet/IP (Rockwell Logix Designer, Studio 5000)

The following example: The program (SIG350_EventExample.ACD) shows how events of a SIG350 are read using an Ethernet/IP interface.

- PLC: Allen Bradly, L30ER
- IO-Link master: SIG350
- Rockwell Logix Designer, Studio 5000

1. Check whether events are pending

Input Assembly with process data

Table 14: Assem101 T2O - Input Data - 32 bytes per IO-Link Port

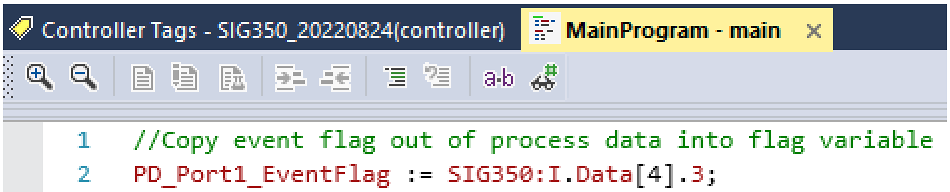
Byte	Designa-tion		Data length	Data type	Description
0	DI Status		1 byte	USINT	
1	Reserved		7 byte	ARRAY	
2... 3	DI Status		2 bytes	USINT	see table 15, page 38
4	S1 port	IOL status	1 byte	USINT	see table 17, page 38
5		Reserved	1 byte	USINT	-
6 ... 37		IOL data	32 byte	ARRAY	Process data of the device
38	S2 port	IOL status	1 byte	USINT	see table 17, page 38
39		Reserved	1 byte	USINT	-
40 ... 71		IOL data	32 byte	ARRAY	Process data of the device
72	S3 port	IOL status	1 byte	USINT	see table 17, page 38
73		Reserved	1 byte	USINT	-
74 ... 105		IOL data	32 byte	ARRAY	Process data of the device

The Ethernet/IP input process data of SIG350 contains an IOL status byte with the following coding. With bit 3, the IO-Link master reports whether events are currently pending or not.

Table 17: IOL Status

Bit	Description
Bit 7	Validity of the device process data (PQ) 0 = Invalid IO process data from device 1 = Valid IO process data from device
Bit 6	Display of a port/device error (DevErr) 0 = No error/no warning 1 = Error/warning for device or port
Bit 5	Device communication (DevCom) 0 = No device available 1 = Device detected and in PREOPERATE or OPERATE state
Bit 4	Reserved always “0”
Bit 3	IO-Link event 0 = No pending device event 1 = Connected device has reported an event
Bit 2	Reserved always “0”
Bit 1	Reserved always “0”

The first line in the main program copies the flag into a variable.



Source: Rockwell Logix Designer, Studio 5000

2. Read out event details

   There is a CIP object for reading out details (**Event Qualifier**, **Event Code**) that provides access to all information. To receive the event details, the CIP Explicit Messaging System (CIP messaging system) must be used.

8 CIP Event Log Object (Class Code 0x41)

The Event Log Object can be used to get information about IO-Link events.

This object is officially defined by the ODVA (see CIP Volume 1).

The following table shows the mapping of CIP instances to the IO-Link ports. (CIP instance 1 to 99 do not exist)

IO-Link Port	CIP Instance
1	100
2	101
3	102
4	103
...	...

8.2.2.5 Attribute #22 - Sequential Event/Data Access

The Sequential Event/Data Access attribute provides the means for simple sequential access to members of the Event/Data Log.
The form of the data in this attribute is identical to the form of the data contained within individual member(s) of the Event/Data Log (attribute #14).

The Get_Attribute_Single service, when directed to the Sequential Event/Data Access attribute, will return the contents of the oldest Event/Data Log entry (attribute 14) and will remove that entry from the list afterwards.

Note: Reading attribute 22 using the Get_Attribute_Single service is the same as sending the Remove_Member service (0x1B) to instance attribute #14 and addressing member 1.

Source: netPROXY System Development

The easiest access is provided by attribute 22.

The response of the explicit message is the oldest pending event on the respective port. Reading the event automatically deletes this event from the queue in the IO-Link master. As soon as all pending events have been read/deleted, the **Event Flag** is deleted from the Ethernet/IP process data.

Explicit Message

- Service code: 0x0E
- Class code: 0x41
- Instance: 100...107
- Attributes: 0x16

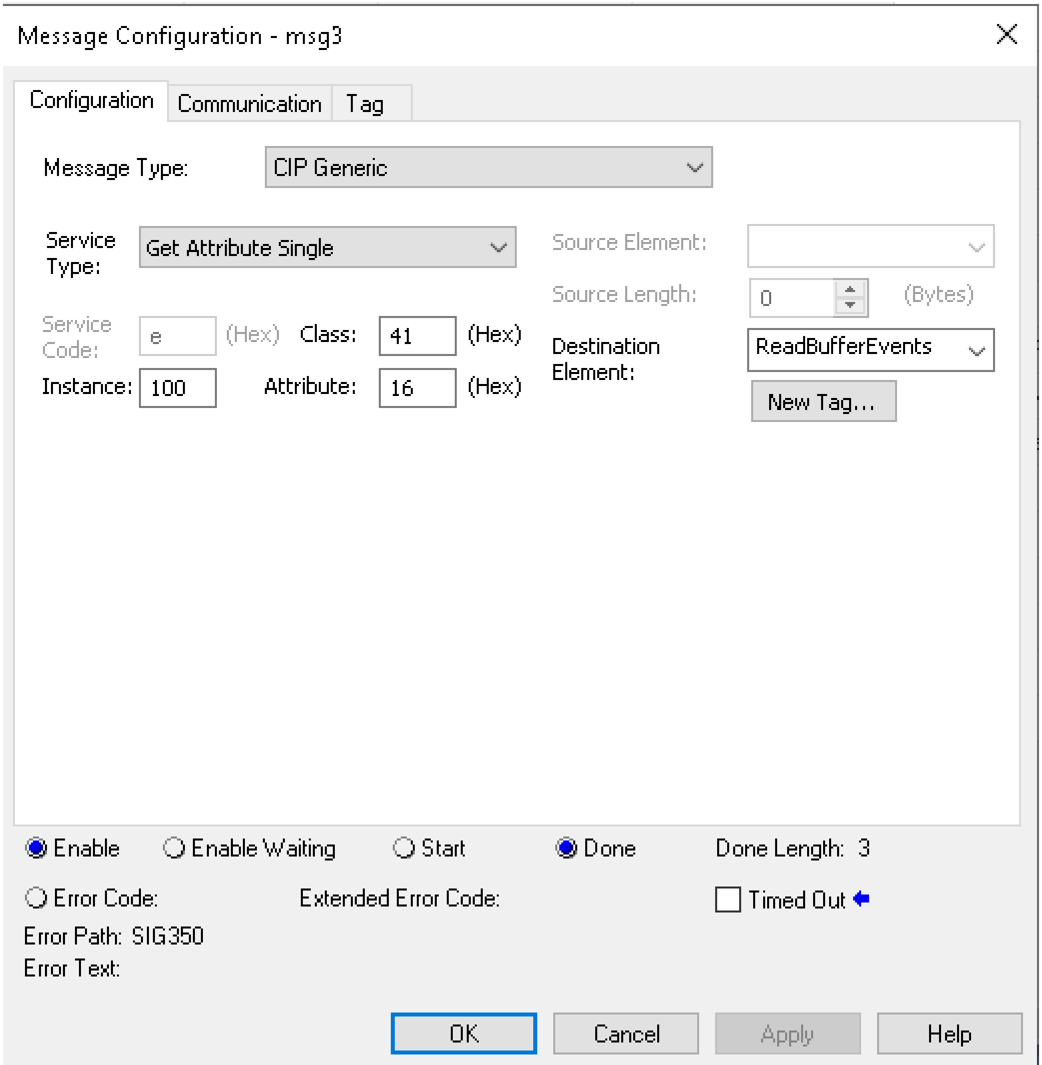


Figure 18: Rockwell Logix Designer, Studio 5000

3. Interpretation of the event details

The example program shown contains an implementation of how an event could be interpreted.

```
10:
    //ReadOldestEventAndRemove
    msg3.Attribute := 22;
    MSG(msg3);
    step := 11;

11:
    //Transform EventCode
    if NOT(msg3.ST) & msg3.DN then
        COP(ReadBufferEvents, LastEvent_Qualifier,1);

        transform.Source := ReadBufferEvents;
        transform.SourceBit := 8;
        transform.Length := 16;
        transform.DestBit := 0;
        transform.Target := 0;
        BTDT(transform);
        LastEvent_Code := transform.Dest;

        step := 12;
    end_if;

12:
    //***INTERPRET EVENT
    //Instance
    if NOT(LastEvent_Qualifier.0) & NOT(LastEvent_Qualifier.1) & NOT(LastEvent_Qualifier.2) then
        COP(Instance_Unkn, LastEvent_Instance, 1);
    end_if;

    if NOT(LastEvent_Qualifier.0) & NOT(LastEvent_Qualifier.1) & LastEvent_Qualifier.2 then
        COP(Instance_Appl, LastEvent_Instance, 1);
    else
        COP(Instance_Res, LastEvent_Instance, 1);
    end_if;

    //SOURCE
    if LastEvent_Qualifier.3 then
        COP(Source_Master, LastEvent_Source, 1);
```

Source: Rockwell Logix Designer, Studio 5000

The interpreted event is located in the controller tags of the example program.

LastEvent_Type	'Notification'	{...}		STRING
LastEvent_Source	'Device'	{...}		STRING
LastEvent_Qualifier	16#54		Hex	SINT
LastEvent_Mode	'Event single shot'	{...}		STRING
LastEvent_Instance	'Application'	{...}		STRING
LastEvent_Code	16#1801		Hex	INT

Source: Rockwell Logix Designer, Studio 5000

12 Technical data

Table 120: Mechanics/Electronics

Cable length of IO-Link master and IO-Link device	max. 20 m
IO-Link specification	V1.1

13 List of abbreviations

Table 121: List of abbreviations

IODD	IO Device Description	Device description file of an IO-Link device
ISDU	Indexed Service Data Unit	Service data object in IO-Link
COM1 COM2 COM3	SDCI communication mode	COM1 = 4.8 kbit/s COM2 = 38.4 kbit/s COM3 = 230.4 kbit/s
SDCI	Single-drop digital interface	Official (specification) name for IO-Link technology
SDD	SOPAS ET Device Description	Device description file / driver for SICK SOPAS ET software

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