Software manual

SCHUNK Monitoring System with IO-Link

VERO-S AFS3 IOL 99, VERO-S AFS3 IOL 138, VERO-S AFS3 IOL 100-75, VERO-S AFS3 IOL 176, VERO-S AFS3-R IOL 138

Hand in hand for tomorrow

Imprint

Technical changes:
We reserve the right to make alterations for the purpose of technical improvement.

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Dear Customer,

Thank you for trusting our products and our family-owned company, the leading technology supplier of robots and production machines.

Our team is always available to answer any questions on this product and other solutions. Ask us questions and challenge us. We will find a solution!

Best regards,

Your SCHUNK team

Customer Management

Tel. +49-7572-7614-1300
Fax +49-7572-7614-1039

customercentermengen@de.schunk.com

Please read the software manual in full and keep it close to the product.

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1 General

1.1 Validity

This version of the software manual for the AFS3 IOL 99, AFS3 IOL 138, AFS3 IOL 100-75, AFS3 IOL 176 and AFS3-R IOL 138 describes the functions of firmware versions with the main version number 1.0.0. The firmware version can be read. Information on the corresponding parameter can be found in section 3.1 Identification data ▸ 3 [🗋 9].

1.2 Applicable documents

- General Terms and Conditions *
- Operating manual of the products used *

The documents labeled with an asterisk (*) can be downloaded from **www.schunk.com**.

1.3 IO-Link Basics

Fieldbus-independent interface

IO-Link is a point-to-point interface for connecting a SCHUNK product (IO-Link device) to a control system (IO-Link master). Via this interface it is possible to transfer parameters, process data and diagnostic data. Parameter data are transfered to the IO-Link device from the master (actuator or sensors). In the opposite direction, the master receives cyclical process data and, if required, service and diagnostic data.

Further information on IO-Link can be found at www.io-link.com.

1.4 Data exchange

Cyclical data exchange

To exchange cyclic process data between an IO-Link device and a controller, the IO-Link data is transferred from the IO-Link master to the previously set address ranges. The user program of the controller accesses the process values via these addresses and processes them. Conversely, the cyclic data exchange is performed from the controller to the IO-Link device.

Acyclical data exchange

The exchange of acyclic data, such as parameters or events, takes place over a specified index and sub-index range. Using the index and sub-index range, targeted access of the device data is possible (e.g. for reparameterization of the device or master during ongoing operation).

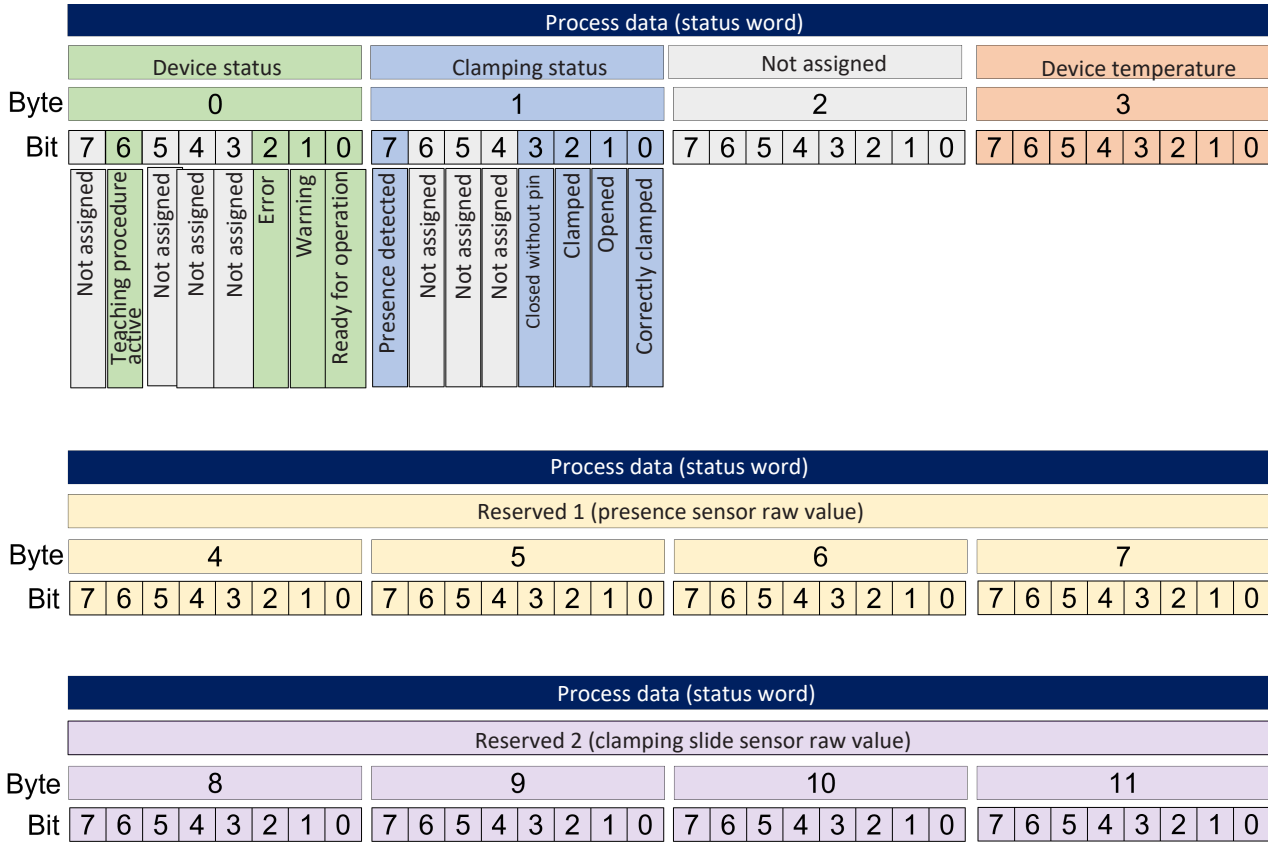
1.5 Data types

The data types mentioned in this version of the software manual are designated according to the "IO-Link Interface and System Specification", Annex F, Version 1.1.9, which is available at www.io-link.com. The corresponding designation according to IEC 61131-3 (PLC standard) can be found in the following table:

Description	IO-Link standard	PLC standard IEC 61131-3	Bit length
Logical value	BooleanT	BOOL	1 bit
Integer	IntegerT (8)	SINT	8 bit
	IntegerT (16)	INT	16 bit
	IntegerT (32)	DINT	32 bit
	IntegerT (64)	LINT	64 bit
Natural number	UIntegerT (8)	USINT	8 bit
	UIntegerT (16)	UINT	16 bit
	UIntegerT (32)	UDINT	32 bit
	UIntegerT (64)	ULINT	64 bit
Floating-point numbers	Float32T	REAL	32 bit
	Float64T	LREAL	64 bit
Characters	StringT (x)	STRING	x bit

2 Incoming process data

To determine the current device status and clamping status, as well as the current device temperature and raw sensor values, the following cyclic data is received by the query system (device) and subsequently made available:



2.1 Device status – byte 0

The current status of the device is displayed. Further information is provided via the acyclic device data ▶ 3 [🗋 9].

Bit	Sub-index	Bit offset	Data type	[Values]	Description
0	1	120	BooleanT	[true]	ready for operation
				[false]	otherwise
1	2	121	BooleanT	[true]	warning
				[false]	otherwise
2	3	122	BooleanT	[true]	error
				[false]	otherwise
6	7	126	BooleanT	[true]	teaching procedure active
				[false]	otherwise

2.2 Clamping status – byte 1

The sensors detect the following conditions:

Clamping slide sensor	Presence sensor
• Opened • Clamped • Closed without clamping pin	• Presence detected • Presence not detected

The current clamping state determined via the sensor system of the monitoring system is displayed.

Bit	Subindex	Bit offset	Data type	[Value]	Description
0	9	112	BooleanT	[true]	correctly clamped
				[false]	otherwise
1	10	113	BooleanT	[true]	open
				[false]	otherwise
2	11	114	BooleanT	[true]	clamped
				[false]	otherwise
3	12	115	BooleanT	[true]	closed without clamping pin
				[false]	otherwise
7	16	119	BooleanT	[true]	presence detected
				[false]	otherwise

The clamping status 'Correctly clamped' is represented by the Boolean value of bit 0 and is a logical combination of the status *clamped* (bit 2) and *pallet detected* (bit 7).

The Boolean value of bit 1 reflects the clamping status *Open*.

The Boolean value of bit 2 indicates the clamping status *Clamped*.

The Boolean value of bit 3 indicates the clamping status *Closed without clamping pin*.

The above points for the clamping states and pallet presence can be taught automatically using acyclic parameters. ▶ 6 [🗋 16]

2.3 Device temperature – byte 3

The current device temperature of the device is displayed in units of (°C).

Bit	Sub-index	Bit offset	Data type	[Values]	Description
0–7	25	96	IntegerT (8)	[0...255]	Current temperature (°C)

2.4 Reserved 1 (presence sensor raw value) byte 4 –7

The raw value of the presence sensor is displayed in units of (MHz).

Bit	Sub-index	Bit offset	Data type	Description
	26	64	Float32T	Raw value presence sensor (MHz)

2.5 Reserved 2 (clamping slide sensor raw value) byte 8 – 11

The raw value of the clamping slide sensor is displayed in units of (MHz).

Bit	Subin dex	Bit offset	Data type	Description
	27	32	Float32T	Raw value clamping slide sensor (MHz)

NOTE

Byte 2 and bytes 12–15 are not assigned. Their bit values are set as zero [false].

3 Acyclical data

Identification data, monitoring values, parameters and diagnostic information including events and error messages are transmitted acyclically from the IO-Link master on request and can be changed depending on the applicable access rights.

3.1 Identification data

The following acyclic data is provided for identification:

Index	Name	Data type	Access rights *	[Values] description
16	Manufacturer name	StringT (64)	ro	[SCHUNK GmbH & Co. KG]
17	Manufacturer text	StringT (64)	ro	[schunk.com]
18	Product name	StringT (64)	ro	{Produkt name e.g.: AFS3 IOL 138}
19	Product ID	StringT (64)	ro	{Identnummer}
20	Product text	StringT (64)	ro	[VERO-S Monitoring System]
21	Serial number	StringT (16)	ro	{Alphanumeric serial number of the device}
22	Hardware version	StringT (64)	ro	[HW-V {*major.minor.fix*}]
23	Firmware version	StringT (64)	ro	[FW-V {*major.minor.fix*}]
24	Application-specific marking	StringT (32)	rw	{empty textfield for usage specific identification}
25	Function tag	StringT (32)	rw	
26	Location tag	StringT (32)	rw	

* ro (read only), rw (read and write), wo (write only)

3.2 Parameter

The following acyclic data is provided for setting generally accessible parameters:

Index	Name	Data type	Access rights *	[Values] description
presence sensor				
100	Presence sensor value compensated	Float32T	ro	Temperature-compensated raw value of the presence sensor in MHz
101	Threshold → Present	Float32T	rw	Threshold value for process data clamping state bit 7 – "Presence detected" in MHz
102	Threshold factory settings	Float32T	ro	Factory setting for index 101 in MHz
103	Teach command	UInteger(T) 8	wo	[0] no command [1] start teach process position absent [2] start teach process position present [255] load factory settings
104	Presence sensor teach response	UInteger(T) 8	ro	[0] No message [1] Teaching active [3] Teaching successful [4] Error
153	Device temperature presence teaching	Float32T	ro	Device temperature in °C at the last execution of the presence teaching process

* ro (read only), rw (read and write), wo (write only)

Index	Name	Data type	Access rights *	Description
Clamping slide sensor				
110	Clamping slide sensor value compensated	Float32T	ro	Temperature-compensated raw value of the clamping slide sensor in MHz
111	Threshold value 1 open → undefined	Float32T	rw	Threshold value for process data clamping state bit 1 – "Opened" in MHz
112	Threshold value 2 open → clamped	Float32T	rw	Threshold value for process data clamping state bit 2 – "Clamped" in MHz
113	Threshold value 3 clamped → without pin	Float32T	rw	Threshold value for process data clamping state bit 3 – "Closed without clamping pin" in MHz
115	Threshold value 1 factory settings	Float32T	ro	Factory settings for index 111 in MHz
116	Threshold value 2 factory settings	Float32T	ro	Factory settings for index 112 in MHz
117	Threshold value 3 factory settings	Float32T	ro	Factory settings for index 113 in MHz
119	Teach command	UInteger(T) 8	wo	[0] no command [1] start teaching process position open [3] start teaching process position clamped [4] start teaching process position without pin [255] load factory settings
120	Clamping slide sensor teach response	UInteger(T) 8	ro	[0] No message [1] Teaching active [3] Teaching successful [4] Error
154	Device temperature teaching clamping slide	Float32T	ro	Device temperature in °C at the last execution of the clamping slide teaching process

* ro (read only), rw (read and write), wo (write only)

3.3 Diagnostics

The following acyclic data is provided for diagnosis:

Index	Name	Data type	Access rights *	Description
Device temperature				
150	Device temperature current value	Float32T	ro	Device temperature in °C
151	Device temperature maximum value	Float32T	ro	Maximum device temperature in °C
152	Device temperature minimum value	Float32T	ro	Minimum device temperature in °C
Service data				
036	Device status	UInteger(T) 8	ro	[0] Device is OK [1] Maintenance required [2] Out of specification [3] Function check [4] Error
032	Error counter	UInteger(T) 8	ro	
162	Last error code	UInteger(T) 32	ro	[0] no error] [30] Hardware defect (E30) [31] Hardware defect (E31) [32] Hardware defect (E32) [33] Hardware defect (E33) [34] Hardware defect (E34) [41] Measured value invalid (E41) [42] Measured value invalid (E42) [43] Measured value invalid (E44) [50] Teach values too close together (E50)
160	Cycle counter total number of clamping procedures	UInteger(T) 32	ro	

* ro (read only), rw (read and write), wo (write only)

3.4 Events and error messages

IO-Link generates acyclic EventCodes (events).
These codes are divided as follows:

IO-Link event code	Error code (command 162)	Designation	Action	Error level
0x4210	20	Device temperature too high	Determine heat source	Warning
0x4220	21	Device temperature too low	Possibly insulate device	Warning
0x8C40	22	High wear level	Servicing required	
0x1817	23	Teaching in progress	Execute teach command for all teaching products	Notification
0x1000	unknown	General failure	Replace device and contact service	
0x181E	30	Hardware defect E30 (Eeprom HW error)	Replace device and contact service	Fatal
0x181F	31	Hardware defect E31 (temp. sensor HW error)	Replace device and contact service	Fatal
0x1820	32	Hardware defect E32 (ADC HW error)	Replace device and contact service	
0x1821	33	Hardware defect E33 (LDC1 HW error)	Replace device and contact service	Fatal
0x1822	34	Hardware defect E34 (LDC2 HW error)	Replace device and contact service	
0x1829	41	Measured value invalid E41 (temp. implausible)	Replace device and contact service	Fatal
0x182A	42	Measured value invalid E42 (DMS implausible)	Replace device and contact service	
0x182B	43	Measured value invalid E43 (LDC1 implausible)	Replace device and contact service	Fatal
0x182C	44	Measured value invalid E44 (LDC2 implausible)	Replace device and contact service	Fatal
0x1832	50	Insufficient difference of teach values with and without pin E50	Servicing required or contact service	Warning
0x5011	67	Product data not readable, memory error	Replace device and contact service	Fatal
n.a.	n.a.	Clamping slide is in undefined state		n.a.
n.a.	n.a.	Clamping slide is in undefined state		n.a.

4 Clamping state detection

The clamping states are detected via position detection of the clamping slide with respect to the threshold values set during teaching.

NOTE

If the clamping module is in an undefined clamping state and no clamping slide movement is detected, a warning is initially signaled via device status byte 0 and an error is signaled after 15 seconds.

5 LED status

In addition to the device status byte and the clamping state byte of the process data (Link Abdeckbleche entfernen, Link Abdeckbleche entfernen), the LED on the side of the monitoring system indicates the following clamping states and device statuses by the corresponding light behavior:

LED	Device status
1 x red and 1 x flashing green	The boot process
Flashing red	Device error / connection establishment / no IOL connection
misc	ready for operation

LED	Clamping status	
	Clamping slide	**Presence**
No signal	Opened	Detected / not detected
red	Undefined / closed without clamping pins	Detected / not detected
green	Clamped with clamping pin	Pallet detected
	→ Correctly clamped	

6 Teaching the sensor system

After assembly, the AFS3 (-R) IOL must be taught to the specific on-site operating conditions (field calibration). For this purpose, the threshold values for the presence and clamping slide sensor must be determined and acyclic parameters must be described with these values at the appropriate point.

⚠ WARNING

Surrounding media (e.g. water) influence the sensor signal and may lead to a display of incorrect clamping statuses.

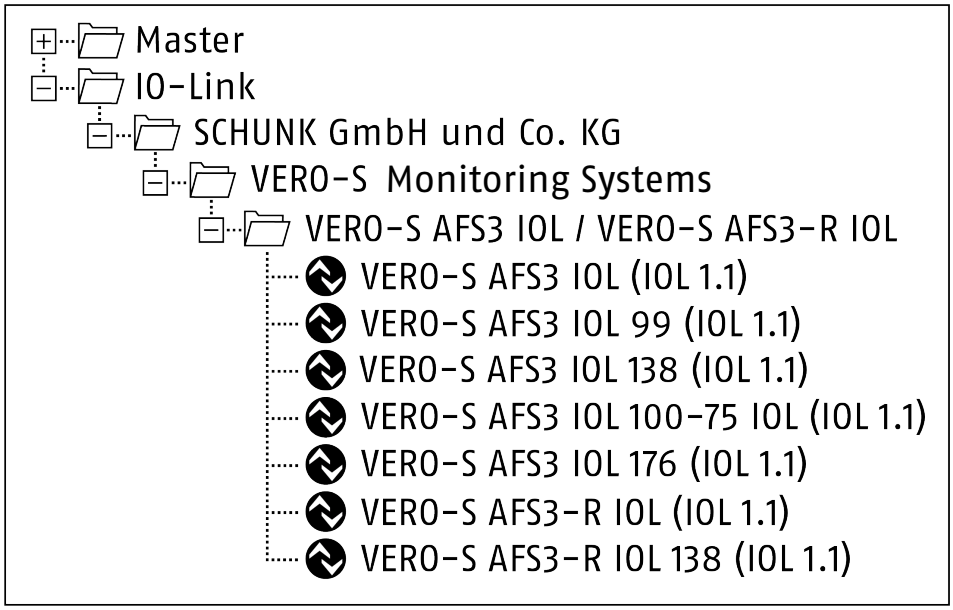
NOTE

Before delivery, the AFS3(-R) IOL sensor system was already been taught to a reference system (factory settings). The on-site operating conditions of each quick-change pallet system that are relevant for the sensor system usually differ from this.

NOTE

For error-free functioning, the sensor system must be taught again after each (new) installation or change of surrounding media!

First, the variant of the module used (e.g. NSE3 138) must be selected via the respective IODD selection menu:



Ilustration shows IODD selection menu in Siemens PCT tool

6.1 Teaching the presence sensor

Automated teaching

The AFS3(-R) IOL has an automated teaching routine that can be used to internally determine the threshold S_{an}(MHz) and write it via the acyclic data parameter "Threshold -> Present" (▸ 3 [🗋 9]).

Anwesenheitssensor				
Anwesenheitssensor We...		M..		Anwesenheitssensor Wert Beschreibung
Schwellwert -> Anwesend		M..		Anwesenheitssensor Schwellwert geteacht
Schwellwert Werkseinst...		M..		Anwesenheitssensor Schwellwert Werkseinstellung
Teach-Befehl	[1] Teachvorgang starten Position Abwesend			
Teach-Befehl	[2] Teachvorgang starten Position Anwesend			
Teach-Befehl	[255] Werkseinstellung laden			
Anwesenheitssensor Te...	[0] keine Meldung			Anwesenheitssensor Teach-Antwort Beschreibung
Gerätetemperatur Teach...		°...		Gerätetemperatur Teachen Anwesenheit

Illustration shows the GUI (Siemens PCT tool) for teaching the presence sensor

To do this successfully, the following sequence must be observed:

- Move pallet to absent state
- Set teach command (▸ 3 [🗋 9]):
  [1] "Start absent position teaching procedure"
- Move pallet to present state and clamp pallet without turbo function
- Set teach command (▸ 3 [🗋 9]):
  [2] "Start present position teaching procedure"

The status of the teaching process can be queried via the acyclic parameter "Presence sensor teach response" (▸ 3 [🗋 9]). The status is also output via bit 7 of the device status of the process data, as well as via an IO-Link event (0x1817). In the event of an error, the sequence described must be repeated in full.

Load factory settings:

The value saved as the "Factory setting threshold" parameter (▸ 3 [🗋 9]) can be loaded with the

- teach command (▸ 3 [🗋 9]): [255] "Load factory setting"

as the new "Threshold -> present" (index 101).

Note:

NOTE

The raw value signal of the presence sensor is temperature-dependent. An internal algorithm is used to offset the temperature dependency. Temperature-induced cross influences in the range of the permissible operating temperature are therefore minimized. The corresponding temperature coefficients are coordinated beforehand at the production facility.

NOTE

The raw value signal of the presence sensor depends on the material, see Illustration 1. When using different target materials (e.g. aluminum and steel pallets), it is therefore important to ensure that the material with the lowest raw value signal is taught, in the example in Illustration 1, this material is steel. This ensures that the other pallet materials will also be detected via clamping state bit 7 when approached. If aluminum were to be taught in the example in Illustration 1, "Threshold -> present" (San) would be greater than any raw value signal for steel and steel might therefore not be detected if present.
Note also that the detection distance depends on the material. Using the teaching routine described above will result in a detection distance of about 0.6 mm for steel and 0.3 mm for aluminum, see Illustration 1.

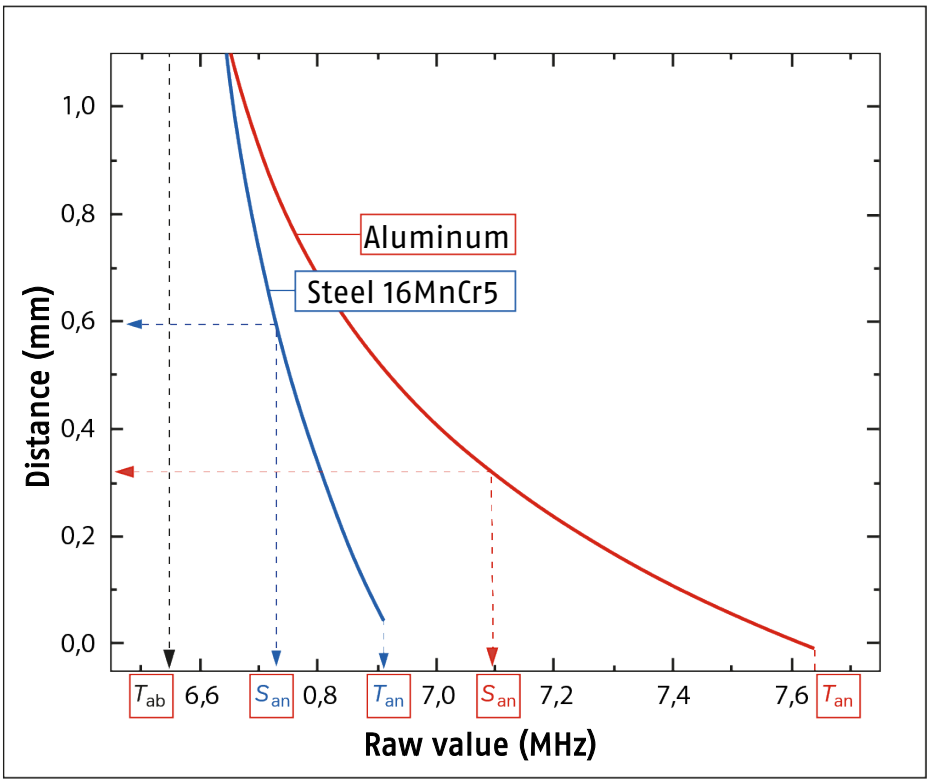


Illustration 1: Characteristic curves of the presence sensor with the absent (T_{ab}), present (T_{an}) teach points and automatically determined threshold values (S_{an}) for different target materials.

6.2 Teaching of the clamping slide sensor

Automated teaching:

The AFS3(-R) IOL has an automated teaching routine that can be used to internally determine the threshold S_i(MHz) for i = 1,...,3 and overwrite the corresponding acyclic data parameters (index 111, index 112 and index 113).

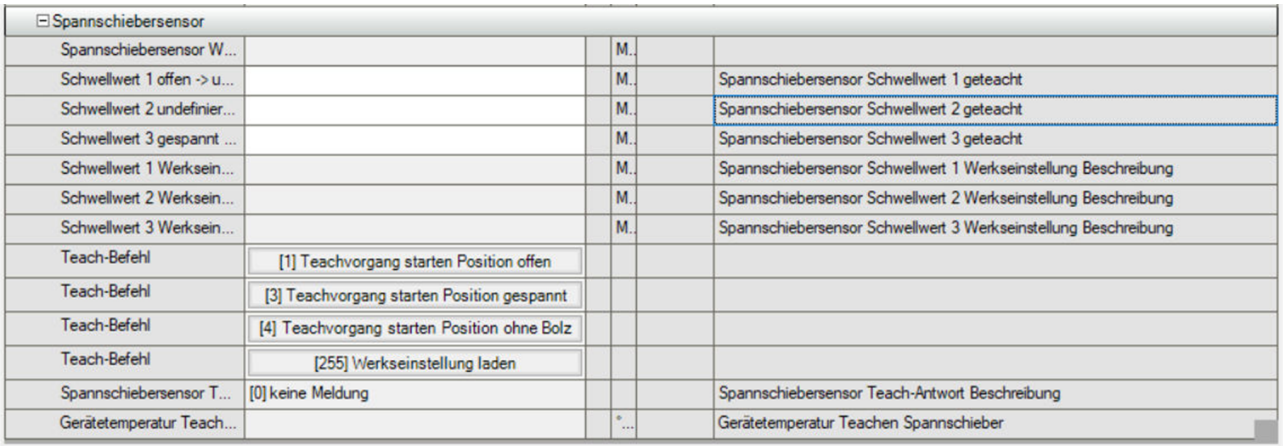


Illustration shows the GUI (Siemens PCT tool) for teaching the clamping slide sensor

To do this successfully, the following sequence must be observed:

- Set the clamping module in open status
- Set teach command (▸ 3 [🗋 9]):
  [1] "Start open position teaching procedure"
- Move the clamping module to the **spring-clamped status with clamping bolt** (without turbo!)
- Set teach command (▸ 3 [🗋 9]):
  [3] "Start clamped position teaching procedure"
- Move the clamping module to the status closed **without clamping pin**
- Set teach command (▸ 3 [🗋 9]):
  [4] "Start without pin position teaching procedure"

The status of the teaching process can be queried via the acyclic parameter "Clamping slide sensor teach response" (▸ 3 [🗋 9]). In the event of an error, the sequence described must be repeated in full.

For the automated teaching routine, the parameters "Teach weight threshold 1-3" ▸ 3 [🗋 9] (corresponding to g_1, g_2 and g_3) are set at the production facility and can only be accessed via the service parameters.

Load factory settings:

The values saved as the "Threshold value 1-3 factory setting" parameter (▸ 3 [🗋 9]) can be loaded with the

- teach command (▸ 3 [🗋 9]): [255] "Load factory setting" as new threshold values ▸ 3 [🗋 9].

Illustration 2 shows the relationship between the clamping states and their threshold values using a typical clamping slide characteristic curve.

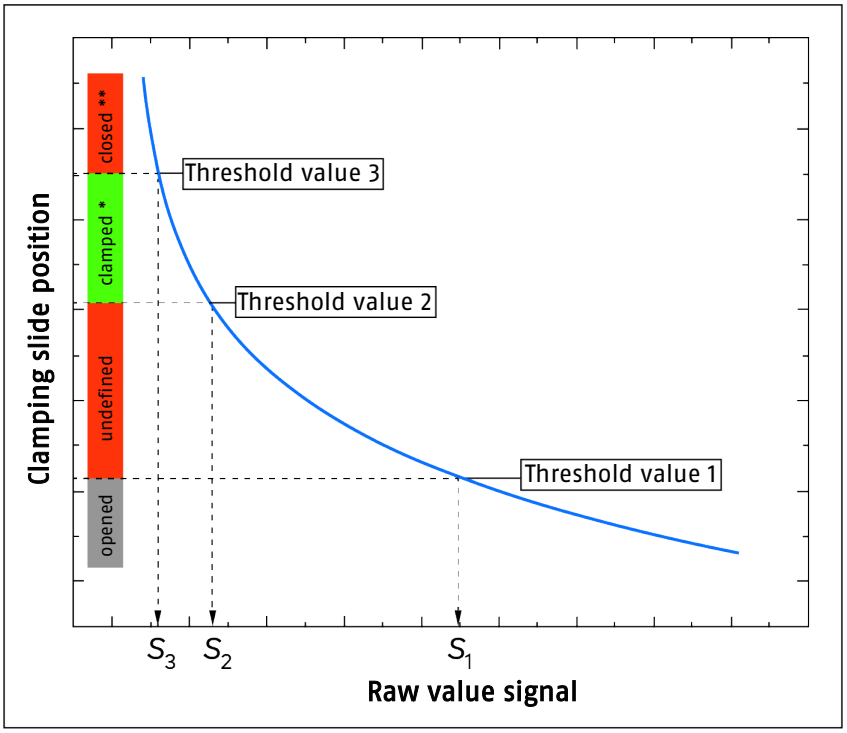


Illustration 2: Characteristic curve of the clamping slide sensor with clamping state open, clamped with pin, closed without pin, and the corresponding threshold values S_1, S_2 and S_3.

*	Clamped with pin
**	Closed without pin

NOTE

For successful teaching and reliable status detection, a minimum distance between the teach points T_2 – T_3 is required. This is set at the production facility. If the value falls below this value, the teaching process will be aborted and an error message is displayed. Reasons for falling below this value are:

- Incorrectly mounted monitoring system
- Incorrectly performed teaching process
- Wear or dirt on the clamping pin / clamping slide

NOTE

The raw value signal of the clamping slide sensor is temperature-dependent. An internal algorithm is used to offset the temperature dependency. Temperature-induced cross influences in the range of the permissible operating temperature are therefore minimized. The corresponding temperature coefficients are coordinated beforehand at the production facility.

7 Temperature offset

The corresponding temperature coefficients and reference temperatures are coordinated beforehand at the production facility.

8 Firmware update

The IO-Link firmware update profile is supported and makes updating the device software easier. A special file (*.iolfw) is provided by SCHUNK for a firmware update. With appropriate tools (e.g. Siemens PCT tool) the file can be read and the update process can be started. The compatibility of the firmware and device is first checked before the device is switched to bootload mode and the actual transmission and storage of the new software starts. After a successful update, the device restarts so that it can then be used with the new functionality. It may be necessary to teach the sensor system again ▶ 6 [🗋 16].

H.-D. SCHUNK GmbH & Co.
Spanntechnik KG

Lothringer Str. 23
D-88512 Mengen
Tel. +49-7572-7614-0
Fax +49-7572-7614-1099
info@de.schunk.com
schunk.com

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