Baumer
Passion for Sensors

Operating Manual

DAB10, DST53, DST76

Amplifier electronics for Strain sensors and Bridge amplifier

EN-US

V3 | 12/6/2021

List of contents

1 About this document

1.1 Purpose

This operating manual (subsequently referred to as *manual*) allows the safe and efficient handling of the product.

The manual does not provide instructions on operating the machine in which the product is integrated. Information on this is found in the operating manual of the machine.

The manual is a constituent part of the product. It must be kept in the immediate vicinity of the product and must be accessible to personnel at all times.

Personnel must have carefully read and understood this manual before beginning any work. The basic prerequisite for safe working is compliance with all safety instructions and handling instructions given in this manual.

In addition, the local occupational health and safety regulations and general safety regulations apply.

The illustrations in this manual are examples only. Deviations are at the discretion of Baumer at all times.

1.2 Validity of the operating manual

The operating manual is valid for the following product variants:

- Measuring amplifiers:
  - DAB10-AU
  - DAB10-AI
  - DAB10-AL
- Strain sensors:
  - DST53-AxxxU
  - DST53-AxxxI
  - DST53-AxxxL
  - DST76-B500U
  - DST76-B500I
  - DST76-B500L

1.3 Applicable documents

- Download from www.baumer.com:
  - Data sheet
  - EU conformity declaration
- As a product insert:
  - Quickstart
  - General information insert (11042373)

1.4 Warnings in this manual

Warnings draw attention to potential personal injury or material damage. The warnings in this manual indicate different hazard levels:

Symbol	Warning term	Explanation
	**DANGER**	Indicates imminent danger entailing a high risk of death or serious personal injury if not being avoided.
	WARNING	Indicates a possible danger entailing medium risk of death or (serious) personal injury if not being avoided.
	CAUTION	Indicates a danger with low risk, which could lead to light or medium injury if not avoided.
	NOTE	Indicates a warning of material damage.
	**INFO**	Indicates practical information and tips that enable optimal use of the devices.

1.5 Labels in this manual

Identifier	Use	Example
Dialog element	Indicates dialog elements.	Click the ***OK*** button.
Unique name	Indicates the names of products, files, etc.	*Internet Explorer* is not supported in any version.
`Code`	Indicates entries.	Enter the following IP address: `192.168.0.250`

1.6 Liability limitation

All information and notes in this manual have been compiled in accordance with the applicable standards and regulations, the state of the art, and our many years of knowledge and experience.

The manufacturer accepts no liability for damage due to the following reasons:

- Non-observance of the manual
- Improper use
- Use of unqualified personnel
- Unauthorized conversions

The obligations agreed in the delivery contract, the general terms and conditions and the delivery conditions of the manufacturer and its suppliers, as well as the legal regulations valid at the time of conclusion of the contract apply.

1.7 Return and repair

In case of complaints, please contact the relevant sales company.

1.8 Accessories

You can find accessories on the website at:

https://www.baumer.com

2 General information

Instructions for appropriate use

This product is a precision device designed for the detection of objects, the acquisition of physical measuring units and for the evaluation of measured values for output in the form of electrical signals for the higher-level system.

Unless not especially labelled, the product must not be used in potentially explosive atmospheres.

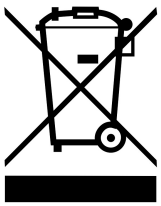
Set-up

Installation, mounting and adjustment of this product may only be executed by skilled and authorised personnel.

Mounting

Only use the fasteners and fastener accessories intended for this product for installation. Outputs not in use must not be wired. Unused wires of cable outputs must be insulated. Do not go below the permissible cable bending radii. Disconnect the system from power before the product is electrically connected. Use shielded cables to prevent electro-magnetic interference. If the customer assembles plug connections on shielded cables, then EMC-version plug connections should be used and the cable shield must be connected to the plug housing across a large surface area.

Disposal (environmental protection)



Do not dispose of electrical and electronic equipment in household waste. The product contains valuable raw materials for recycling, which is why the old product must be returned to an authorised collecting point for correct disposal/recycling. For further information see www.baumer.com.

3 Description

3.1 General functionality

The amplifier electronics process signals from sensors with strain gauges.

- Measuring amplifier: The amplifier electronics are integrated in the measuring amplifier and process signals from sensors connected to the measuring amplifier with a strain gauge full bridge (e.g. force, strain, or weight sensor).
- Strain sensor: Amplifier electronics and strain gauge full bridge are integrated in the strain sensor.

The output depends on the product variation:

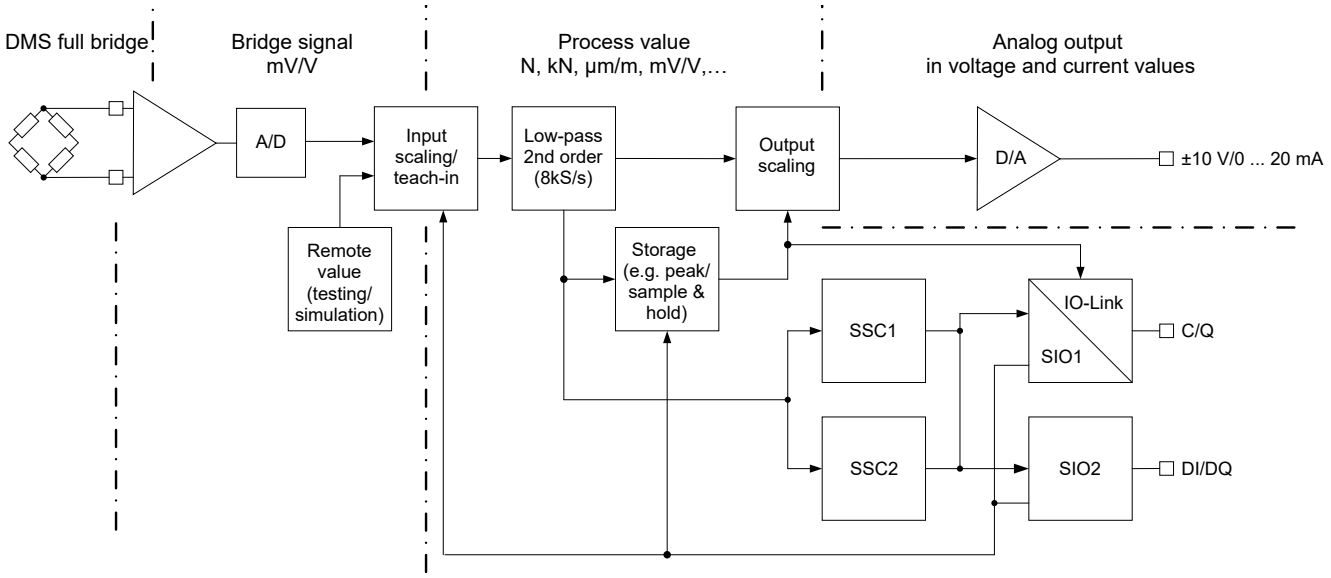
Measuring amplifiers

Product variation	Output
DAB10-AU	▪ Analog output (voltage) ▪ IO-Link
DAB10-AI	▪ Analog output (current) ▪ IO-Link
DAB10-AL	▪ IO-Link

Strain sensors

Product variation	Output
DST53-AxxxU	▪ Analog output (voltage) ▪ IO-Link
DST53-AxxxI	▪ Analog output (current) ▪ IO-Link
DST53-AxxxL	▪ IO-Link
DST76-B500U	▪ Analog output (voltage) ▪ IO-Link
DST76-B500I	▪ Analog output (current) ▪ IO-Link
DST76-B500L	▪ IO-Link

3.2 Block diagram and signal path



Ill. 1: Block diagram

The basic signal path is as follows:

1. The amplifier electronics is feeding the sensor's full bridge and amplifies the resulting passive signal (mV/V).
2. An A/D transformer digitizes the passive signal and converts it into a measuring signal (mV/V).
3. The signal is converted into the measuring unit which is delivered by the sensor (N, µm/m, kg, t).
4. Low-pass filter (optional): The amplifier smoothes the process value via a parameterizable low-pass filter.
5. Storage: The amplifier stores the max./min. process value or the peak peak process value (delta between min. and max.). In addition, with the sample and hold (S&H) function, the signal is stored at a specific point in time or the subsequent change of the signal measured.
6. Output: The amplifier electronics optionally outputs the process value, a peak value, or an S&H value via IO-Link or (only for product variants xxI and xxU) via an analog output.

Both switching signal channels (SSCs) enable free parameterization for output either via digital I/Os or IO-Link.

The digital I/Os can be used as an input or output:

- Input: Teach-in functions; resetting the peak value or S&H storage
- Output: Values from the SSC1/2, internal alarm or warning signals

All digital functions are also available via cyclic IO-Link communication.

3.3 IO-Link communication (overview)

The IO-Link communication takes place via cyclic and acyclic data:

- **Cyclic data**:
  Data that is transferred by the device automatically and at regular intervals (*Process data*).
- **Acyclic data**:
  Data that is transferred by the device only upon a command. The device can be parameterized via this data stream (*Adjustable data*). In addition, the acyclic data allows the transfer of data for diagnosis (*Diagnosis data*).

Process data (cyclic)	Adjustable data (acyclic)	Diagnosis data (acyclic)
Process value Scale exponent for the process value SSC1/2 Quality bit Alarm bit	Sensor setting: - Unit of the process value - Nominal measurement range - Nominal key value - Offset Signal processing: - Filter function SIO1/2: - Function selection for SIO1/2 - Input delay for SIO1/2 Analog output (only for xxI & xxU): - Signal selection for analog output - Scaling of the analog output - Parameterization of the signal range - Parameterization of the alarm signal	Process value Min. process value Max. process value Peak peak process value (delta min. and max.) Sample and hold process value Sample and hold process value (delta) CPU temperature Input signal (mV/V) Device status Detailed device status (up to 10 messages) Operating time (since switch-on) Operating time (service life) Number of switch-on cycles (service life) Number of tare cycles (service life)

4 Transport and storage

4.1 Transport

NOTICE

Material damage due to improper transport.

a) Practice the greatest diligence when unloading the delivery packages and when transporting them within the company.

b) Note the information and symbols on the packaging.

c) Only remove packaging immediately before installation.

4.2 Delivery inspection

Upon receipt, immediately inspect the delivery for completeness and transport damage.

Claim any defect as soon as it is detected. Damages can only be claimed within the applicable claims deadlines.

In case of externally visible transport damage, proceed as follows:

Instruction:

a) Do not accept the delivery or only with reservations.

b) Note the scope of the damage on the transport documents or the delivery slip of the carrier.

c) Initiate the claim.

4.3 Storage

Store the product according to the following conditions:

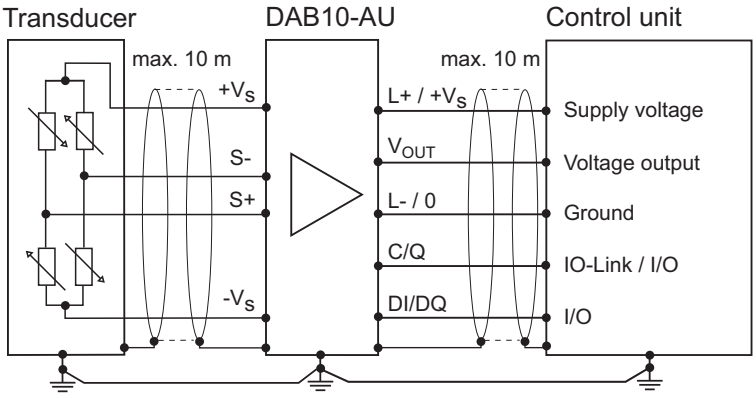
- Do not store outdoors.
- Store dry and free from dust.
- Do not expose to aggressive media.
- Keep away from the sun.
- Avoid mechanical agitation.
- Storage temperature: -40 ... +85 °C
- Ambient humidity: 20 ... 85 %
- When storing for longer than 3 months, regularly check the general status of all parts and the packaging.

5 Electrical installation

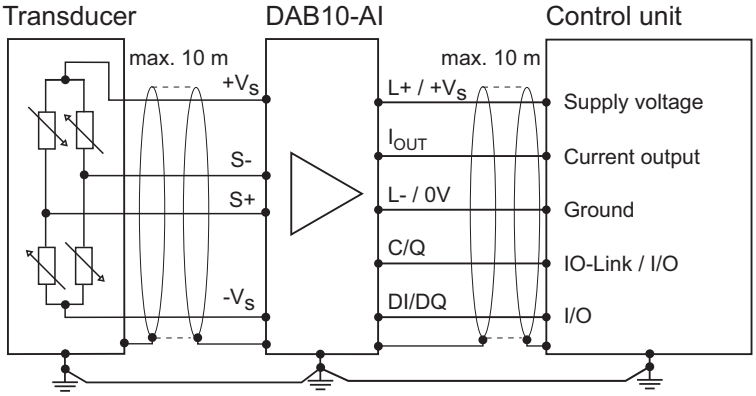
5.1 Connection diagram

5.1.1 Connection diagram of measuring amplifier DAB10

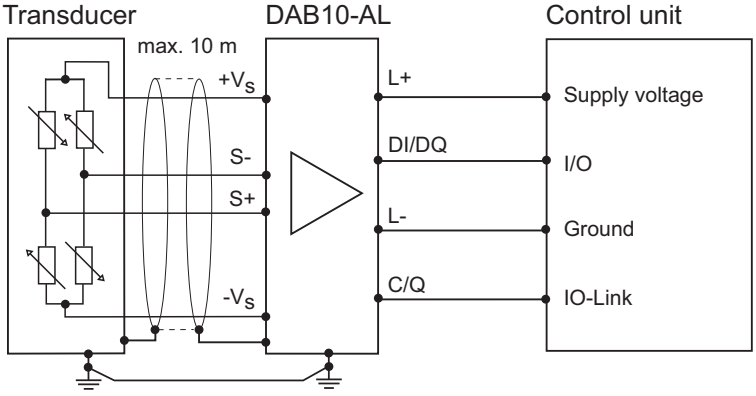
DAB10-AU



DAB10-AI

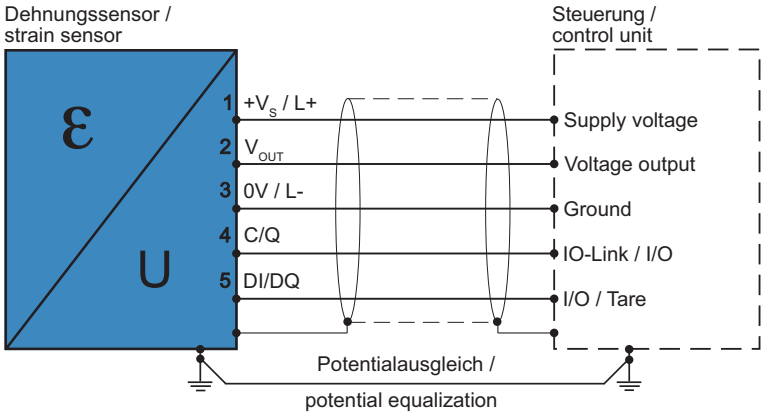


DAB10-AL

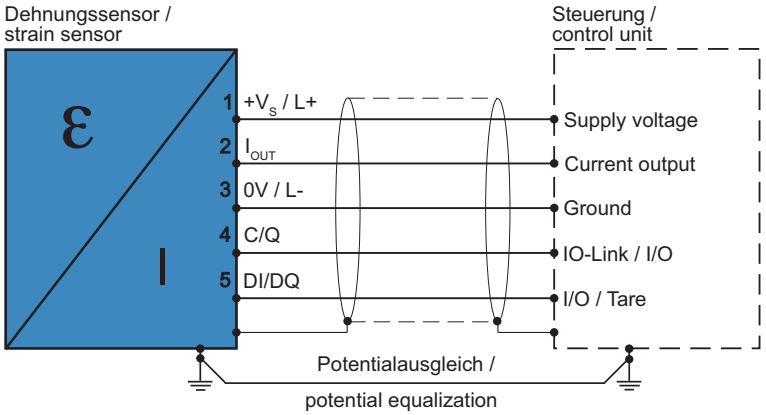


5.1.2 Connection diagram of strain sensor DST53

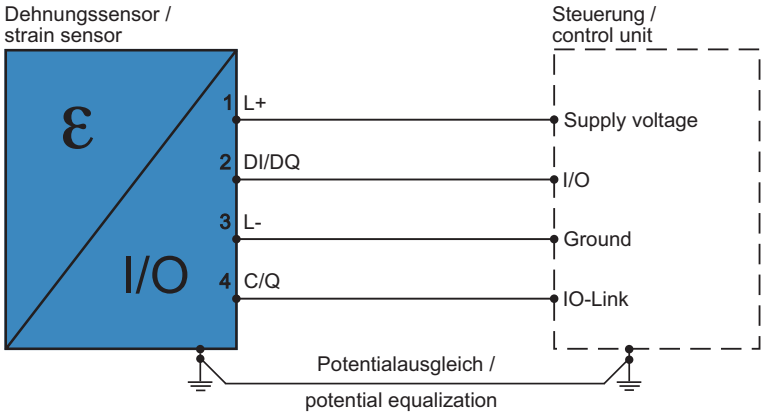
DST53-AxxxU



DST53-AxxxI

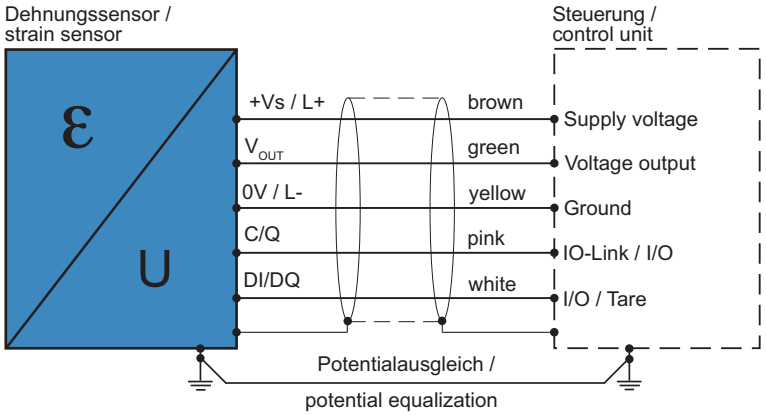


DST53-AxxxL

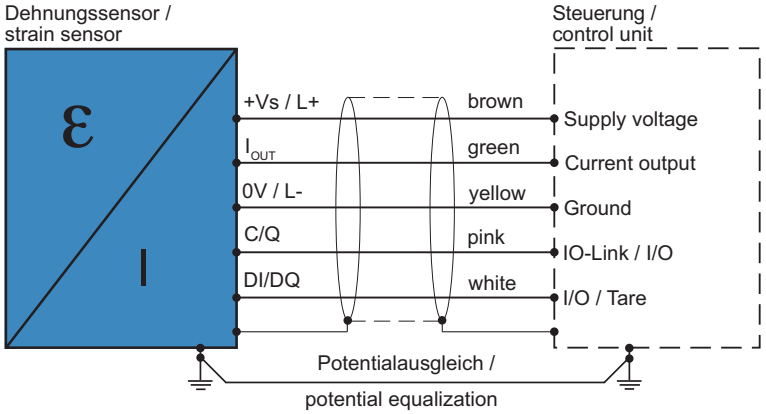


5.1.3 Connection diagram of strain sensor DST76

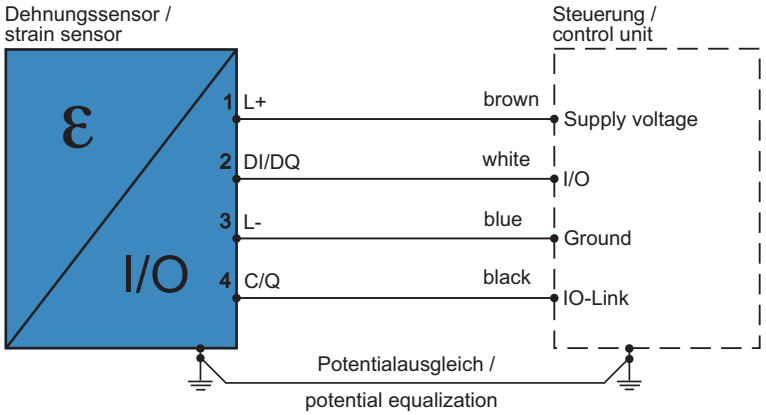
DST76-B500U



DST76-B500I



DST76-B500L

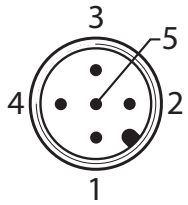


5.2 Plug/pin assignment

5.2.1 Pin assignment measuring amplifier DAB10

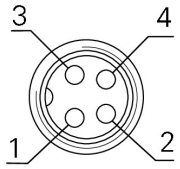
DAB10-AU

Control side



1	+Vs / L+
2	Vout
3	0 V / L-
4	C/Q (IO-Link / SIO1)
5	DI/DQ (SIO2)

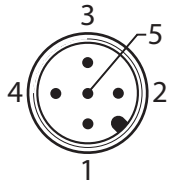
Sensor side



1	+Vs
2	Sig +
3	-Vs
4	Sig -

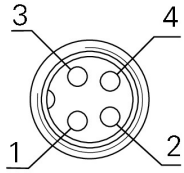
DAB10-AI

Control side



1	+Vs / L+
2	Iout
3	0 V / L-
4	C/Q (IO-Link / SIO1)
5	DI/DQ (SIO2)

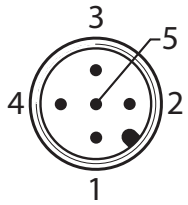
Sensor side



1	+Vs
2	Sig +
3	-Vs
4	Sig -

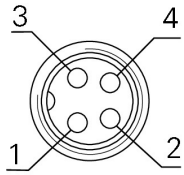
DAB10-AL

Control side



1	L+
2	DI/DQ (SIO2)
3	L-
4	C/Q (IO-Link / SIO1)
5	n. c.

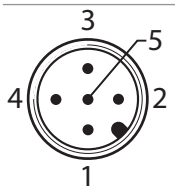
Sensor side



1	+Vs
2	Sig +
3	-Vs
4	Sig -

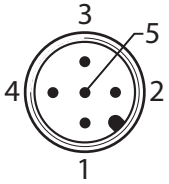
5.2.2 Pin assignment strain sensor DST53

DST53-AxxxU



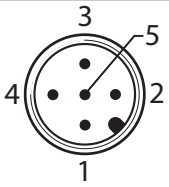
1	+Vs / L+
2	V_{OUT}
3	0V / L-
4	C/Q (IO-Link / SIO1)
5	DI/DQ (SIO2)
Housing	Shield

DST53-AxxxI



1	+Vs / L+
2	I_{OUT}
3	0V / L-
4	C/Q (IO-Link / SIO1)
5	DI/DQ (SIO2)
Housing	Shield

DST53-AxxxL



1	L+
2	DI/DQ (SIO2)
3	L-
4	C/Q (IO-Link / SIO1)
5	n. c.

5.2.3 Wire assignment strain sensor DST76

DST76-B500U

brown	+Vs / L+
green	V_{OUT}
yellow	0V / L-
pink	C/Q (IO-Link / SIO1)
white	DI/DQ (SIO2)
Housing	Shield

DST76-B500I

brown	+Vs / L+
green	I_{OUT}
yellow	0V / L-
pink	C/Q (IO-Link / SIO1)
white	DI/DQ (SIO2)
Housing	Shield

DST76-B500L

brown	L+
white	DI/DQ (SIO2)
blue	L-
black	C/Q (IO-Link / SIO1)

6 Commissioning

6.1 Measurement amplifier commissioning

The measurement amplifier input is set as standard to 1 mV/V and thus directly matched to the Baumer force sensors. You can commission the measurement amplifier via plug & play.

6.2 Strain sensor commissioning

The sensor is calibrated for strain by default (according to the selected measuring range). The signal (± 10 V, 4 ...20 mA, IO-Link) is output according to the nominal strain of the sensor. You can put the sensor into operation via plug & play. To achieve even better measurement results, you have the option of parameterizing the sensor via the integrated amplifier electronics to suit the application via the IO-Link interface. For this purpose, the sensor is connected to an IO-Link master.

6.3 Factory settings

6.3.1 Factory settings of measuring amplifier DAB10

DAB10-AU

	Value
Input (sensor side):	
Process value unit:	mV/V
Nominal key sensor value:	1 mV/V
Offset:	0
Output:	
Output signal (at V_{out}):	±10 VDC
SIO1:	Inactive
SIO2:	Teach-in offset

DAB10-AI

	Value
Input (sensor side):	
Process value unit:	mV/V
Nominal key sensor value:	1 mV/V
Offset:	0
Output:	
Output signal (at I_{out}):	4 ... 20 mA
SIO1:	Inactive
SIO2:	Teach-in offset

DAB10-AL

	Value
Input (sensor side):	
Process value unit:	mV/V
Nominal key sensor value:	1 mV/V
Offset:	0
Output:	
Output signal (at C/Q):	mV/V
SIO1:	Inactive
SIO2:	Inactive

On the IO-Link channel the input signal of 1 mV/V is output directly unprocessed.

6.3.2 Factory settings of strain sensor DST53

DST53-AxxxU

Output signal (at V_{OUT}):	±10 VDC
SIO1:	Inactive
SIO2:	Teach-in offset, tare

DST53-AxxxI

Output signal (at I_{OUT}):	12 mA ±8
SIO1:	Inactive
SIO2:	Teach-in offset, tare

In the unloaded state, the sensor is preset to 12 mA and can thus indicate tensile and compressive loads. The output signal can be parameterized to the application; e.g. 4 ...20 mA for tension or compression.

DST53-AxxxL

Output signal (at C/Q):	µm/m
SIO1:	Inactive
SIO2:	Inactive

6.3.3 Factory settings of strain sensor DST76

DST76-B500U

Output signal (at V_{OUT}):	±10 VDC
SIO1:	Inactive
SIO2:	Teach-in offset, tare

DST76-B500I

Output signal (at I_{OUT}):	12 mA ±8
SIO1:	Inactive
SIO2:	Teach-in offset, tare

In the unloaded state, the sensor is preset to 12 mA and can thus indicate tensile and compressive loads. The output signal can be parameterized to the application; e.g. 4 ...20 mA for tension or compression.

DST76-B500L

Output signal (at C/Q):	µm/m
SIO1:	Inactive
SIO2:	Inactive

6.4 Parameterization of the amplifier electronics

INFO

Parameterization requires a USB IO-Link master, the *Baumer Sensor Suite* (parameterization software), as well as the sensor's IODD. Both *Baumer Sensor Suite* and IODD are available for download at www.baumer.com.

To adjust the sensor to your application you have the following parameterization options (parameterization via IO-Link):

- Sensor setting:
  - Unit of the process value
  - Nominal measurement range
  - Nominal key value
  - Offset
- Signal processing:
  - Filter function
- Analog output (only for xxI & xxU):
  - Signal selection for analog output
  - Scaling of the analog output
  - Parameterization of the signal range
  - Parameterization of the alarm signal
- SIO1/2:
  - Function selection for SIO1/2
  - Input delay for SIO1/2
- IO-Link communication (cyclic data)
  - Signal selection
- SSC1/SSC2:
  - Mode (single point/window/two point)
  - Hysteresis
  - Reply delay
  - Pulse duration

7 Functions

Using the *Baumer Sensor Suite* you can access all functions of the amplifier electronics under the following 4 registers:

- Process data
- Observation
- Parameter
- Diagnosis

Also see about this

- Process data [▶ 23]
- Observation [▶ 25]
- Parameter [▶ 28]
- Diagnosis [▶ 49]

7.1 Process data

In the *Process Data* register the process value as well as the individual status bits are presented.

7.1.1 Process value Process Data In (PDI)

This is where the cyclical process value is presented. Via ***Parameter*** | ***MDC Selection Source*** you select what should be presented here via the IO-Link communication (cyclic). The following options are available:

- Process value
- Min. process value
- Max. process value
- Peak peak process value (delta between min. and max. process value)
- Sample and hold process value
- Sample and hold process value (delta)

INFO

The cyclic process value is always transmitted as Int32. For simplification, all process value-related acyclic parameters/values are therefore also transferred as Int32. The scaling exponent -5 is mapped in the IODD, but not applied by all masters. Thus, depending on the master, the representation is done as Int32 or as Int32 scaled with 10^{-5}.

The process value is transferred to the unit that was parameterized in the input scaling (N, µm/m, kg, t). Independent of the unit, the process value is always presented with the identical exponent:

- *MDC Descriptor.Scale Exponent* = `-5`

This way, process values of up to ±20000 can be transferred. Each process value that can be displayed in the amplifier is double the set nominal measurement range of the sensor:

- 2 × parameter *Nominal Process Value*

With very small nominal values, the resolution is increasingly reduced. However, in such cases another value can be selected that is better suited for the fixed exponent (e.g. 100 N instead of 0.1 kN).

Nominal value	Resolution			Display range
	as value	in %FS	in bits	
0.01	0.0001	0.1 %	10.0	-0.0200 ... 0.0200
0.1	0.0001	0.01 %	13.3	-0.20000 ... 0.20000
1.0	0.0001	0.001 %	16.6	-2.00000 ... 2.00000
10	0.0001	0.0001 %	19.9	-20.00000 ... 20.00000
...	...	...	...	...
10000	0.0001			-20000.00000 ... 20000.00000

7.1.2 Status Bits Process Data In (PDI)

The following bits are presented:

Status bit	Description
Bit 0: SSC1	▪ Switching status of SSC1
Bit 1: SSC2	▪ Switching status of SSC2
Bit 2: Quality	▪ An internal value is not in the optimal range and possibly near the function threshold. ▪ The presented process values remain valid. ▪ You can find out the precise reason under *IO-Link Device Status*.
Bit 3: Alarm	▪ The presented process values are invalid. ▪ Possible causes: ▪ The input signal is outside the measurable range ▪ Internal signal spillover ▪ Hardware or system error ▪ You can find out the precise reason under *IO-Link Device Status*.

7.1.3 Status Bits Process Data Out (PDO)

The following bits are presented:

Status bit	Description
Bit 2: S&H trigger	▪ Trigger signal for the sample and hold functions (flank-triggered). ▪ Flank-triggered means that the sample and hold stores the process value if the bit was set to 0 at the last transmission and to 1 at the most recent transmission.
Bit 3: Teach-in offset / tare	▪ Triggers an offset teach-in (*teach-in offset*). ▪ The function remains active as long as the bit is set.
Bit 4: Memory reset	▪ Trigger signal for resetting the storage functions: max., min. or peak peak process value (flank-triggered).
Bit 5: Teach-in sensitivity	▪ Triggers a sensitivity teach-in (*Teach-in sensitivity*). ▪ The function remains active as long as the bit is set. ▪ The function is only active if the parameter *Teach-in.Sensitivity Enable* is set to `Enable`. If not, this bit is not evaluated.

7.2 Observation

In the *Observation* register, next to the processed process value, peak values and sample and hold process values are presented.

INFO

Resetting memory values and sample and hold

Memory values and sample and hold can each be reset via the cyclic data or via one of the two I/O pins. The peak value is reset via the signal *Memory Reset*, while sample and hold is reset via the signal *Sample and Hold Trigger*.

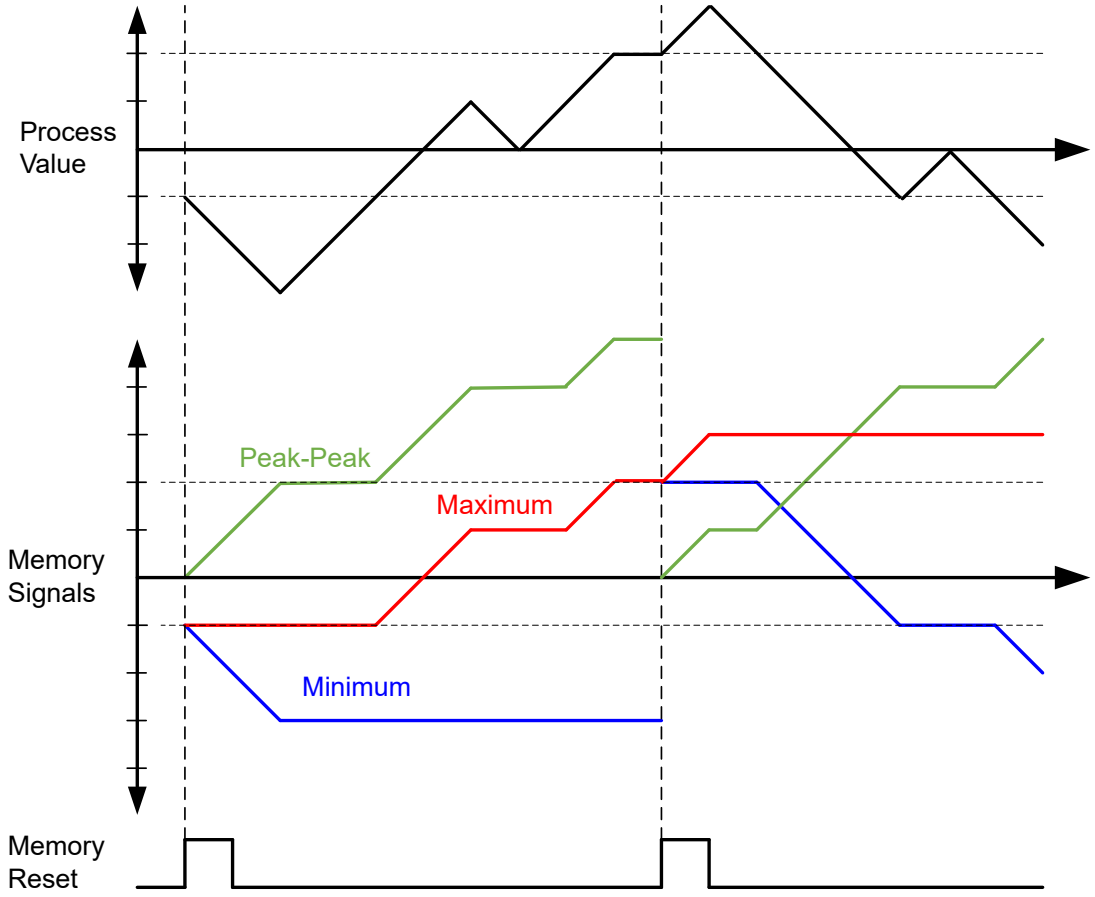
IO-Link parameter: Peak value storage and sample and hold (measured values)

Parameter designation	Description
Process Value.Processed	Presentation of the current process value (processed).
Process Value.Minimum	Presentation of the min. process value since the last memory reset.
Process Value.Maximum	Presentation of the max. process value since the last memory reset.
Process Value.Peak Peak	Presentation of the peak peak process value (delta between min. and max. process value) since the last memory reset.
Process Value.Sample and Hold	Presentation of the process value that was held during the last S&H trigger.
Process Value.Sample and Hold Delta	Presentation of the difference between the process value held during the last S&H trigger and the current process value.

7.2.1 Peak value storage (memory values)

With the Memory Values the following values are stored:

- Min. measured process value since the last memory reset
- Max. measured process value since the last memory reset
- Peak peak process value (delta between min. and max. process value)



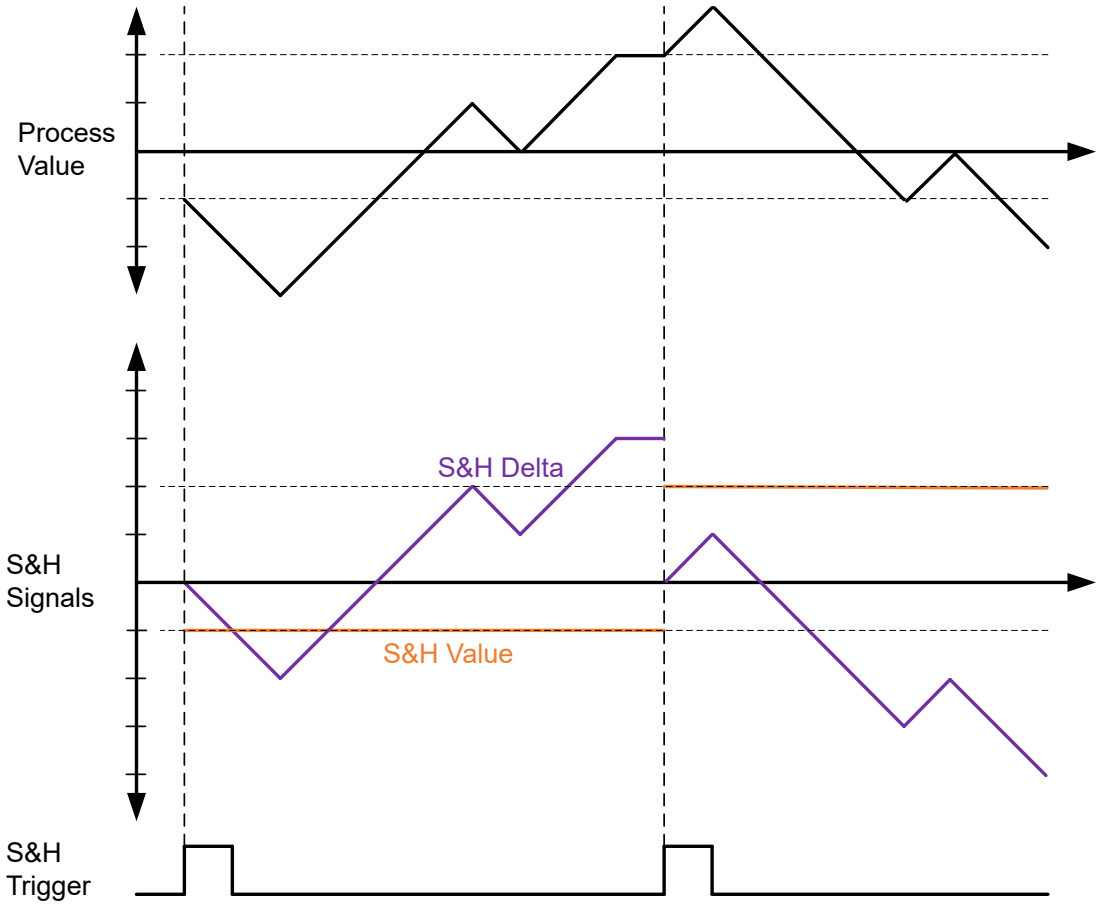
Ill. 2: Peak value storage

The peak values are output via the cyclic process data and/or the analog output (the latter only for product variations xxI and xxU). In addition, all storage values can be read out via IO-Link.

7.2.2 Sample and Hold

In sample and hold (S&H) the following values are stored:

- The process value that was held during the last sample and hold trigger.
- The difference between the process value held during the last sample and hold trigger and the current process value.



Ill. 3: Sample and hold

The values are output via the cyclic process data and/or the analog output (the latter only for product variations xxI and xxU). In addition, all storage values can be read out non-cyclical via IO-Link.

7.3 Parameter

In the *Parameter* register you can set various characteristics of the sensor.

7.3.1 Parameterization of the sensor characteristics

With the parameterization of the characteristics of the connected sensor you can define the conversion of the input signal (mV/V) into the process value (N, kN, µm/m, ...). You have the following options for setting the parameters:

- Manual parameterization of the sensor characteristics (teach-in by value): Input of the parameters directly via IO-Link
- Teaching in the parameters via the teach-in process
  - Offset teach-in (teach-in offset/taring)
  - Key value teach-in (teach-in sensitivity)

7.3.1.1 Parameterizable sensor characteristics

In general, you can parameterize the following properties for the sensor at the amplifier electronics:

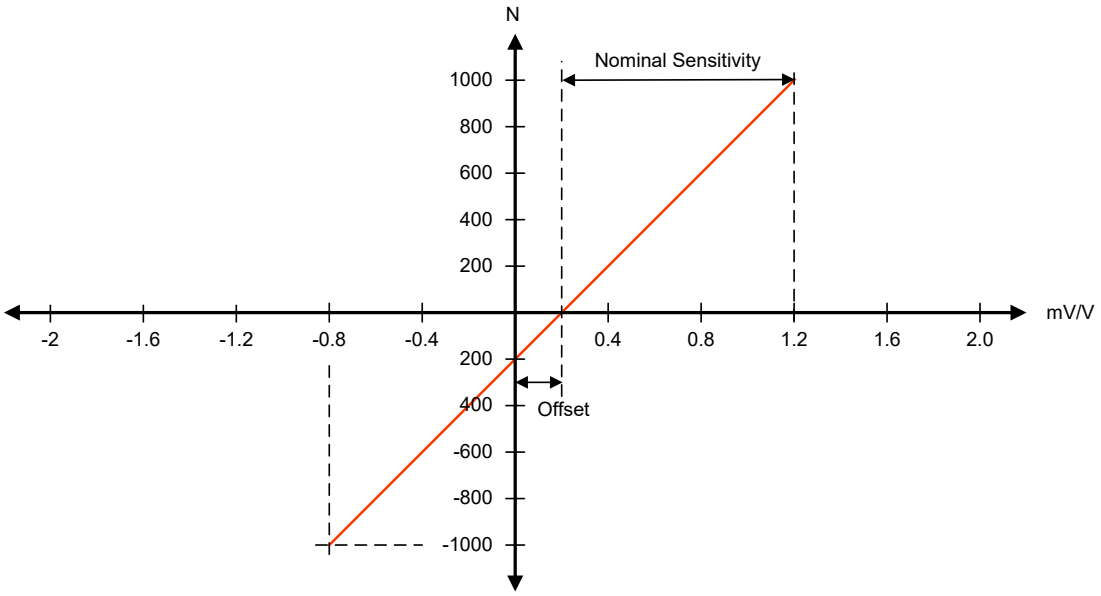
- Unit of the process value (*Process Value Unit*)
- Nominal measurement range of the process value (*Nominal Process Value*)
- Nominal key value of the sensor in mV/V (*Nominal Sensitivity*)
- Input signal in mV/V at which a process value of 0 should be presented (*Offset*)

Example: Conversion of the input signal into the process value

The sensor is parameterized with the following sensor characteristics:

- *Process Value Unit* = `N`
- *Nominal Process Value* = `1000 N`
- *Nominal Sensitivity* = `1 mV/V`
- *Offset* = `0.2 mV/V`

This means that the process value is converted based on the following diagram:



Ill. 4: Converting the input signal into the process value

NOTICE

Limited evaluable measurement range

The evaluable measurement range is limited to double the set parameter *Nominal Process Value* (in positive and negative signal direction). Example:
Nominal Process Value: 1000 N
Input signal range: -0.8 ...1.2 mV/V (nominal)
Evaluable measuring range: ±(2 × 1000 N) = ±2000 N
This corresponds to: 0.2 ± (2 × 1 mV/V) = -1.8 ...2.2 mV/V
Therefore: Process values smaller than -2000 N or larger than +2000 N are not displayed (see *Diagnosis* | *Device Status*).

7.3.1.2 Manual parameterization of the sensor characteristics (teach-in by value)

With the function *Teach-In by Value* you enter the characteristics of the connected sensor directly as values via the IO-Link.

Example

Characteristics of the sensor:

- Nominal process value: 1000 N
- Nominal key value: 1.511 mV/V
- Zero point: is not specifically stated, but lies in a certain specific bandwidth.

Parameterize the amplifier electronics as follows:

- *Process Value Unit* = `N`
- *Nominal Process Value* = `1000 N`
- *Nominal Sensitivity* = `1.511 mV/V`
- *Offset* = initially `0`, can be set via *Teach-In Offset*

IO-Link parameter: Manual parameterization (customer sensor adjustment)

Parameter name	Description
Customer Sensor Adjustment.Process Value Unit	Enter the unit of the process value that is measured with the sensor.
Customer Sensor Adjustment.Nominal Process Value	Enter the nominal process value (in the unit defined for the process value).
Customer Sensor Adjustment.Nominal Sensitivity	Enter the nominal key value of the sensor (in mV/V).
Customer Sensor Adjustment.Offset	Enter the input signal at which a process value of 0 is presented (in mV/V).

7.3.1.3 Teaching in the sensor characteristics via the teach-in process

In addition to the manual parameterization of the sensor characteristics, you can also carry out the parameterization via a teach-in process:

- Offset teach-in (*Teach-In Offset/Taring*)
- Key value teach-in (*Teach-In Sensitivity*)

During the teaching-in process, the amplifier electronics superimpose the filter *Moving Average* over the input signal. The filter increases the precision for measuring the input signal.

7.3.1.3.1 Offset teach-in (Teach-In Offset/Taring)

With the *Teach-In Offset/Taring* function you can tare the sensor. Carry out the offset teach-in after installation and ideally following several cycles at full load. The following options are available to you for the offset teach-in:

- Via IO-Link (cyclic data)
- Via one of the two I/O pins. In the factory settings SIO2 (DQ/DI connection) is assigned with this function.

Example 1: Offset teach-in without pre-load

Characteristics of the sensor:

- Nominal process value: 1000 N
- Key value: 1.511 mV/V
- Output signal in an unloaded state: 0.2 mV/V

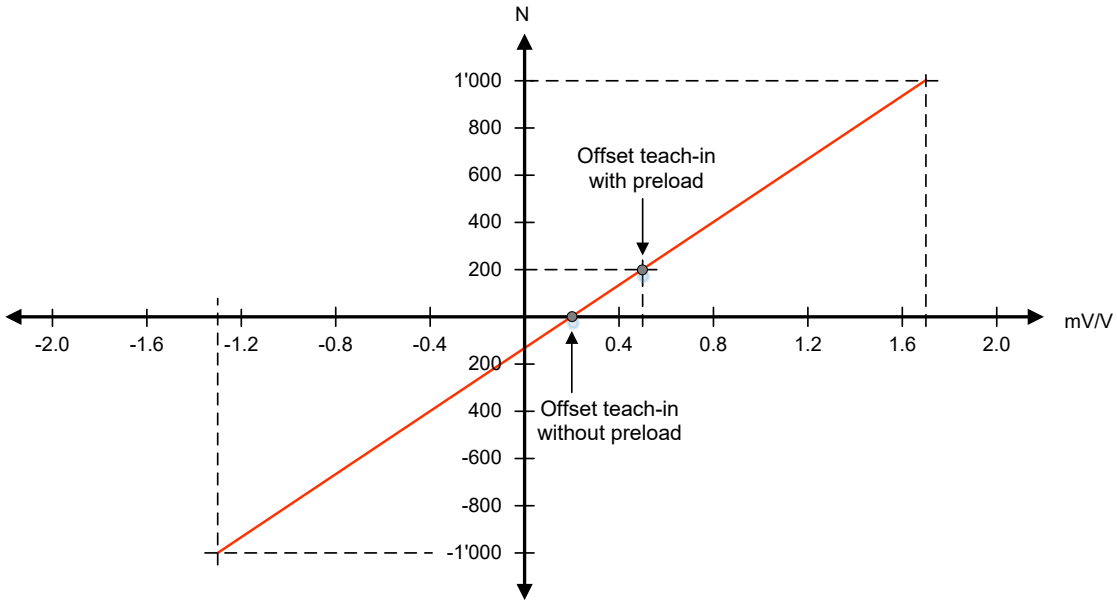
Enter the nominal process value and the key value under ***Parameter*** | ***Customer Sensor Adjustment***. The activation of *Teach-In Offset* under ***Process Data*** | ***PDO*** initiates the offset teach-in. Subsequently, the value 0.2 is displayed under ***Parameter*** | ***Offset***.

Example 2: Offset teach-in with pre-load

Characteristics of the sensor:

- Nominal process value: 1000 N
- Key value: 1.511 mV/V
- Pre-load (sensor in a loaded state): 200 N
- Output signal with pre-load: 0.502 mV/V

Enter the nominal process value and the key value under ***Parameter*** | ***Customer Sensor Adjustment***. Now enter the pre-load 200 N in the parameter *Teach-in.Offset Process Value*. With the above key value, 200 N result in a signal of 0.302 mV/V. Deducting this value from 0.502 mV/V results in the actual offset of 0.2 mV/V no-load. The activation of *Teach-In Offset* under ***Process Data*** | ***PDO*** initiates the offset teach-in. Subsequently, the value 0.2 is displayed under ***Parameter*** | ***Offset***.



Ill. 5: Offset teach-in (with and without preload)

IO-Link parameter: Offset teach-in (Teach-in Offset/Taring)

Parameter designation	Description
Teach-in.Offset Process Value	Process value for which the current input signal is equal to this process value. The teach-in offset only affects the register offset and does not alter the sensitivity register.

7.3.1.3.2 Sensitivity teach-in (teach-in sensitivity)

With the sensitivity teach-in the sensitivity is set in such a way that the current input signal (mV/V) complies with this process value without changing the previously taught-in offset. The sensitivity and the offset register are affected.

Condition:

⇨ You carried out an offset teach-in before the sensitivity teach-in. The taught in offset is not affected by the sensitivity teach-in and serves as the first reference point.

Instruction:

a) Activate the function sensitivity teach-in via the parameter *Teach-in.Sensitivity Enable*.

b) Carry out the sensitivity teach-in.

✓ The parameter *Customer Sensor Adjustment.Nominal Sensitivity* is set in such a way that the current input signal (mV/V) presents the process value that is specified in the parameter *Teach-in.Sensitivity Process Value*. The offset is not altered.

c) Deactivate the function via the parameter *Teach-in.Sensitivity Enable* (thus preventing the overwriting of the sensitivity).

Example

A strain sensor is mounted on the supporting stand of a press. The strain sensor has the following characteristics ex factory:

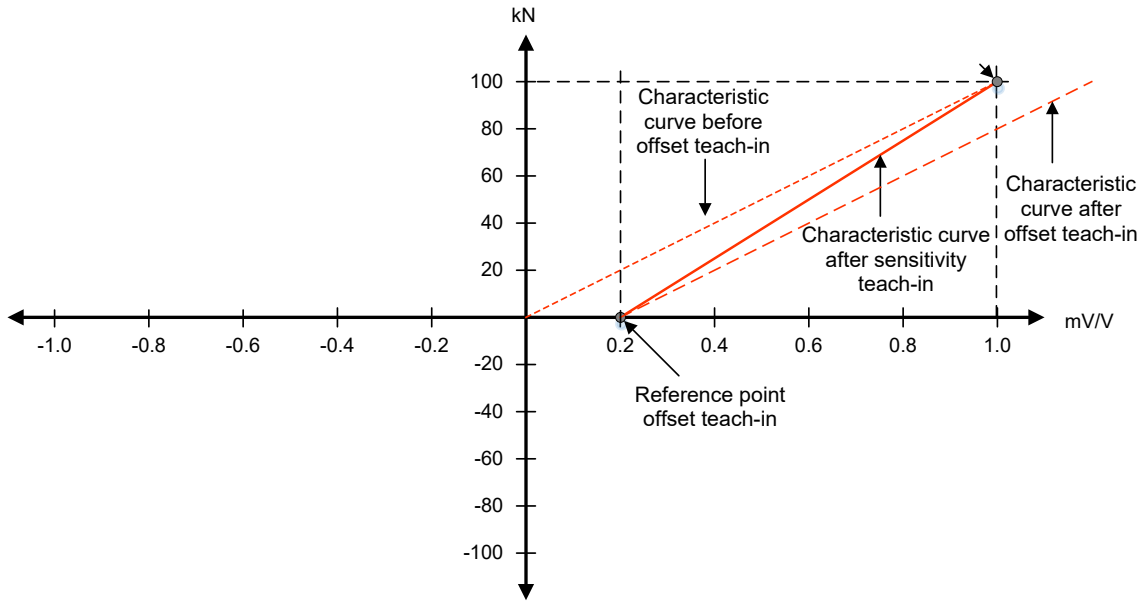
- 500 µm/m
- Sensitivity: 1 mV/V
- Presented process value when there is no press force: 100 µm/m (= 0.2 mV/V)
- Presented process value with a press force of 50 kN: 300 µm/m (= 1 mV/V)

Prior to the offset and sensitivity teach-in, enter the following parameters via IO-Link:

- *Customer Sensor Adjustment.Process Value Unit* = `kN` (the press force should be measured)
- *Customer Sensor Adjustment.Nominal Process Value* = `100` (maximum force to be measured)
- *Teach-in.Offset Process Value* = `0`
- *Teach-in.Sensitivity Process Value* = `50 kN`

Parameters:

	before Offset teach-in	**after Offset teach-in**	**after Sensitivity teach-in**
Process Value Unit	kN	kN	kN
Nominal Process Value	100	100	100
Nominal Sensitivity	1 (factory setting)	1 (factory setting)	1.6
Offset	0 (factory setting)	0.2	0.2



Ill. 6: Sensitivity teach-in

IO-Link parameter: sensitivity teach-in (teach-in sensitivity)

Parameter designation	Description
Teach-in.Sensitivity Process Value	Sensitivity teach-in
Teach-in.Sensitivity Enable	Enabling/disabling of sensitivity teach-in: ▪ `0`: Disabled ▪ `1`: Enabled

7.3.1.3.3 Filter Moving Average for offset and sensitivity teach-in

The filter *Moving Average* is active on the input signal during the offset und sensitivity teach-in to increase the measurement accuracy. The filter smoothes the signal course by calculating the average of a specified number of measured values per filter interval. You can select the number of measured values per filter interval via IO-Link.

IO-Link Parameter: Filter Moving Average (Moving Average Filter)

Parameter designation	Description
Teach-in.Moving Average Filter	Select the number of measured values per filter interval of the filter *Moving Average*: ▪ `0`: Disabled ▪ `1`: 2 measured values/filter interval (0.25 ms) ▪ `2`: 4 (0.5 ms) ▪ `3`: 8 (1 ms) ▪ `4`: 16 (2 ms) ▪ `5`: 32 (4 ms) ▪ `6`: 64 (8 ms) ▪ `7`: 128 (16 ms)

7.3.2 Low-pass filter (IIR filter)

Optionally, you can run the input signal through a low pass filter (**i**nfinite **i**mpulse **r**esponse filter, IIR filter). The low-pass filter is recommended in the following cases:

- Increasing the effective resolution by reducing the noise.
- Bandwidth limitation when the output signal is used for other signal processing that scans more slowly.

IO-Link Parameter: Low-pass filter (Input Low Pass Filter)

Parameter designation	Description
Input Low Pass Filter.Enable	Enabling/disabling of the low-pass filter: ▪ `0`: Disabled ▪ `1`: Enabled
Input Low Pass Filter.Frequency	Select the limit frequency of the low-pass filter: ▪ `0`: 1 kHz ▪ `1`: 500 Hz ▪ `2`: 200 Hz ▪ `3`: 100 Hz ▪ `4`: 50 Hz ▪ `5`: 10 Hz ▪ `6`: 10 Hz ▪ `7`: 5 Hz ▪ `8`: 2 Hz ▪ `9`: 1 Hz

7.3.3 Parameterization of the analog output (only for product variants xxI and xxU)

Analog output parameterization allows you the following settings:

- Selecting the output signal (*Signal Selection*)
- Analog output scaling *(Signal Adjustment*)
- Parameterization of the signal range of the analog output (*Signal Limits*): 2-point adjustment of process value and analog signal
- Alarm signal parameterization (*Signal Alarm*)

7.3.3.1 Selection of the output signal (Signal Selection)

With the *Signal Selection* function you can define the signal that is presented at the analog output. The following options are available:

- Alarm signal
- Input signal (unprocessed process value) with a sample rate of 8 kS/s
- Additional functions with 2 kS/s:
  - Process value (processed)
  - Min. process value
  - Max. process value
  - Peak peak process value (delta between min. and max. process value)
  - Sample & Hold

IO-Link Parameter: Analog output signal selection (Signal Selection)

Parameter denotation	Description
Analog Output.Source	Selecting the source of the process value that is displayed as an analog output signal: ■ `0`: Disabled (Analog Output Alarm) ■ `1`: Current Process Value (8 kS/s) ■ `3`: Minimum Process Value (2 kS/s) ■ `4`: Maximum Process Value (2 kS/s) ■ `5`: Peak Peak Process Value (2 kS/s) ■ `6`: Sample and Hold Process Value (2 kS/s) ■ `7`: Sample and Hold Delta Process Value (2kS/s)

7.3.3.2 Scaling the analog output (Signal Adjustment)

By scaling the analog output you have the option of only mapping a partial segment of the sensor signal on the analog output.

Scaling takes place via 2 reference points in the block *Signal Adjustment*. For each of the 2 reference points the signal is defined that should be presented on the analog output for the respective process value (irrespective of the nominal process value of the sensor).

IO-Link parameter: Scaling the analog output (Signal Adjustment)

Parameter designation	Description
Analog Output.Process Value 1	Process value of set point 1
Analog Output.Analog Signal 1	Analog output signal at set point 1
Analog Output.Process Value 2	Process value of set point 2
Analog Output.Analog Signal 2	Analog output signal at set point 2

7.3.3.3 Parameterization of the signal range of the analog output (Signal Limits)

Via the parameterization of the signal range you can limit the signal range of the analog output (the signal range does not apply to the alarm signal). Potential purposes of the function:

- Only issue positive voltage values
- Limit the voltage range to 5 V
- Exclude 0 V as a possible signal

Please make sure that the output range is greater than the measurement range to prevent the signal from falling outside the output range (e.g. due to a temperature drift).

IO-Link Parameter: parameterization of the analog output signal range (Signal Limits)

Parameter designation	Description
Analog Output.Minimum	Minimum analog output signal
Analog Output.Maximum	Maximum analog output signal

7.3.3.4 Parameterization of the alarm signal (Signal Alarm)

Via the parameterization of the alarm signal, enter the value at which the amplifier electronics is to issue the alarm signal (not a valid signal) at the analog output. This allows the following cases to be recognized:

- The analog value to be output is outside the parameterized signal range
- Internal signal spillover
- Hardware or system error

INFO

The cause of the state of alarm is shown in the register *Diagnosis* | *Device Status*.

IO-Link Parameter: parameterization of the alarm signal (Signal Alarm)

Parameter designation	Description
Analog Output.Alarm	Level of the analog signal when no valid measured value can be presented.

7.3.3.5 Example: Parameterization of the analog output

Characteristics of the sensor:

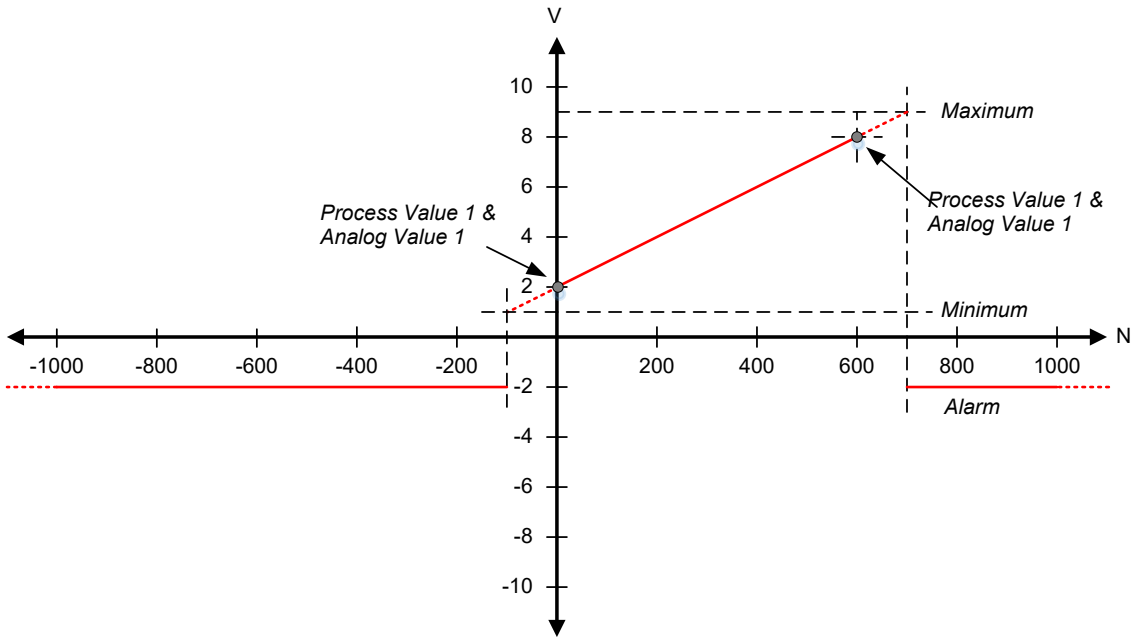
- Nominal process value of the sensor: 1000 N

Task definition:

- The force sensor should only measure within the force range of 0 ... 600 N.
- At 0 N it should output 2 V.
- At 600 N it should output 8 V.
- To allow detection of a cable break, 0 V should not be output. This is why the output range is limited to 1 ... 9 V.
- In case of error, -2 V should be output.

Parameterize the amplifier electronics as follows:

- *Analog Output.Process Value 1* = `0 N`
- *Analog Output.Analog Signal 1* = `2 V`
- *Analog Output.Process Value 2* = `600 N`
- *Analog Output.Analog Signal 2* = `8 V`
- *Analog Output.Minimum* = `1 V`
- *Analog Output.Maximum* = `9 V`
- *Analog Output.Analog Value* = `-2 V`



Ill. 7: Parameterization of the analog output (example)

7.3.4 Parameterization SIO1/2

INFO

In the IO-Link environment, the signal denotations are described from the perspective of the IO-Link master. This means: The input on the sensor is called *DO*, as DO is an output on the IO-Link master. Conversely, *DI* is an input on the IO-Link master and an output on the sensor.

For SIOx mode you can select the following functions in the parameter *Settings.SIOx Function Select*:

- DI (Digital Input):
  - State of SSC1
  - State of SSC2
  - Quality Bit
  - Alarm Bit
- DO (Digital Output):
  - High status: Teach-in offset/tare activated
  - Positive flank: Reset of the storage function
  - Positive flank: Trigger of sample and hold
  - High state: Teach-in sensitivity activated

Depending on the selected function, the SIO is connected as an input or an output.

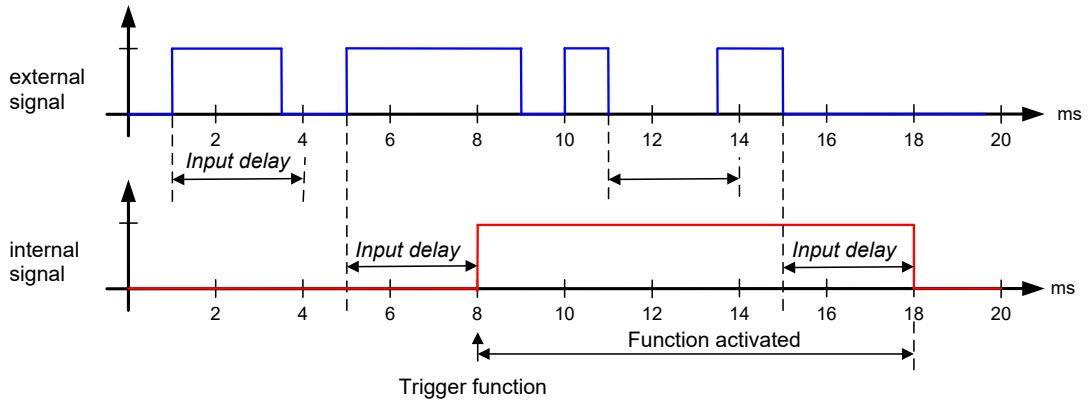
The selected functions are also available via the cyclic PDI and PDO data. The DO or PDO functions are internally connected *OR*. This means that the internally processed signal of the individual functions is *high*, when either PDO, SIO1, or SIO2 is set to *high*.

Input delay

You can set an input delay for an input signal (DO) for each SIO (*Settings.SIOx Input Delay*). Input delay means that an external signal is recognized and adopted by the amplifier electronics if the input signal is permanently in a new state throughout the time set as the input delay.

Example:

- *Settings.SIO1 Input Delay* = `3 ms`



Ill. 8: Timing SIO1/2

IO-Link parameter: parameterization of the SIO (SIOx settings):

Parameter designation	Description
Settings.SIOx Function Selection	Select the function for SIOx: ▪ `0`: SSC1 (DI) ▪ `1`: SSC2 (DI) ▪ `5`: Quality Bit (DI) ▪ `6`: Alarm Bit (DI) ▪ `10`: Inactive (DO) ▪ `11`: Teach-in Offset/Tare (DO) ▪ `12`: Memory Reset (DO) ▪ `13`: Sample & Hold (DO) ▪ `14`: Teach-In Sensitivity (DO)
Settings.SIOx Input Delay	Set the input delay time (in ms). To ensure error-free set up of the IO-Link communication, we recommend at least 3 ms.

7.3.5 Parameterization of the SSCx switching functions

With the SSC, several switching functions can be set depending on the current process value. For the parameterization of the SSC the following must be defined:

- Mode (single point/window/two point)
- Setpoints (1 or 2 setpoints, depending on the mode)
- Logic (inversion of the signal)
- Hysteresis
- Timing

IO-Link parameter: parameterization of the switching functions (SSCx Settings/SSCx Hysteresis)

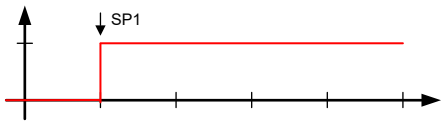
Parameter designation	Description
Settings.SSCx Mode	Select the switching behavior of SSCx: ■ *Single Point* ■ *Window* ■ *Two Point*
Settings.SSCx Setpoint 1	Definition of the process value at which SSCx is set to enabled.
Settings.SSCx Setpoint 2	Definition of the process value at which SSCx is set to disabled (for the modes *Window* and *Two Point*).
Settings.SSCx Logic	Logic of SSCx: ■ *Normal* ■ *Inverted*
Hysteresis.SSCx Alignment Mode	Selection of the hysteresis alignment (for the modes *Single Point* and *Window*).
Hysteresis.SSCx Width	Definition of the hysteresis width.
Hysteresis.SSCx.Width Mode	Define the scale of the hysteresis width of SSCx. The width can be stated as an absolute value in the unit of the process factor (e.g. 10 N).

7.3.5.1 SSC modes

You can choose among the following modes for the SSC:

- *Single Point*
- *Window*
- *Two Point*

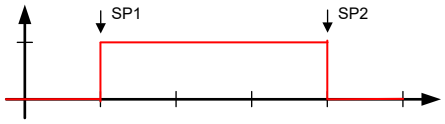
Mode *Single Point*, normal



Ill. 9: SSC mode – Single Point

- 1 switching threshold across the entire measurement range.

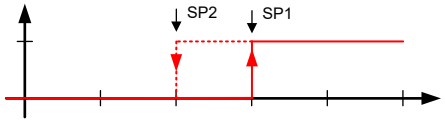
Mode *Window*, normal



Ill. 10: SSC mode – Window

- 2 switching thresholds at which the signal is reversed.

Mode *Two Point*, normal

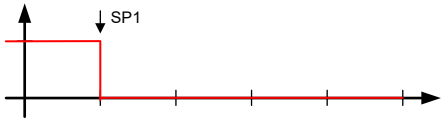


Ill. 11: SSC mode – Two Point

- 2 switching thresholds that indicate when then signal should switch to *high* and when it should switch to *low*. In this mode, the hysteresis is defined based on the setpoints. The hysteresis parameters have no effect in this mode.

7.3.5.2 SSC Logic

SSC Logic *Single Point, inverted*

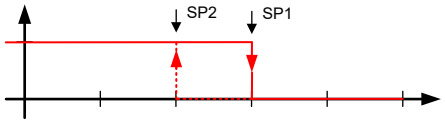


Ill. 12: SSC Logic – Single Point, inverted

SSC Logic *Window, inverted*

Ill. 13: SSC Logic – Window, inverted

SSC Logic *Two Point, inverted*



Ill. 14: SSC Logic – Two Point, inverted

7.3.5.3 SSC Hysteresis

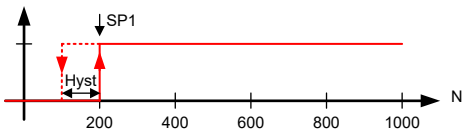
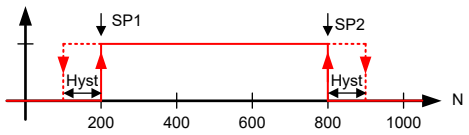
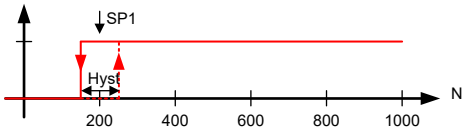
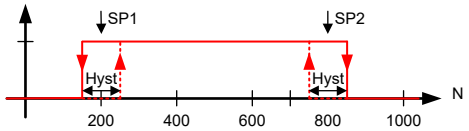
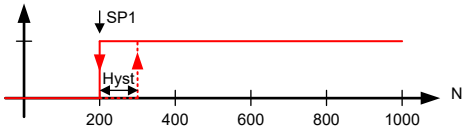
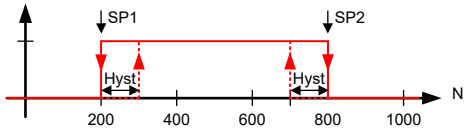
With the function *SSC Hysteresis* you can define how the hysteresis should be set in relation to the setpoint. The function is relevant for the *Single Point* and *Window* modes:

- *Single Point*: The hysteresis is set either to the left, right, or center of the setpoint.
- *Windows*: The hysteresis is set either outside, inside, or at the center of the respective setpoint.

Example 1: Hysteresis, <u>not</u> inverted

The amplifier electronics are parameterized as follows:

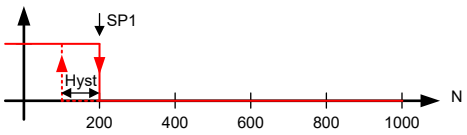
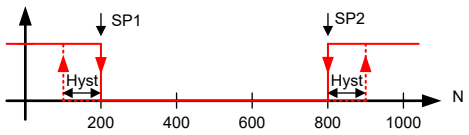
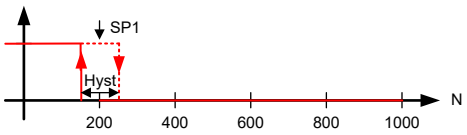
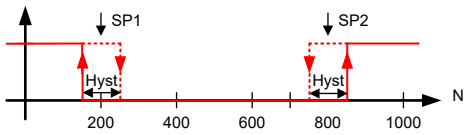
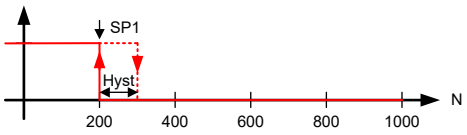
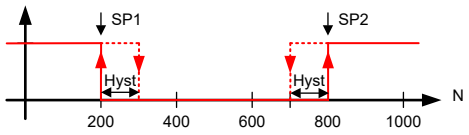
- *Settings.SSC1 Logic*: `Normal`
- *Settings.SSCx Mode*: `Single Point`, `Window`
- *Settings.SSCx Setpoint 1*: `200 N`
- *Settings.SSCx Setpoint 2*: `800 N`
- *Hysteresis.SSCx Alignment Mode*: `Left/Outer`, `Center`, `Right/Inner`
- *Hysteresis.SSCx Width*: `100 N`

	Single Point	Window
Left/ Outer		
Center		
Right/ Inner		

Example 2: hysteresis, inverted

The amplifier electronics are parameterized as follows:

- *Settings.SSC1 Logic*: `Inverted`
- *Settings.SSCx Mode*: `Single Point`, `Window`
- *Settings.SSCx Setpoint 1*: `200 N`
- *Settings.SSCx Setpoint 2*: `800 N`
- *Hysteresis.SSCx Alignment Mode*: `Left/Outer`, `Center`, `Right/Inner`
- *Hysteresis.SSCx Width*: `100 N`

	Single Point	Window
Left/ Outer		
Center		
Right/ Inner		

7.3.5.4 Timing SSCx

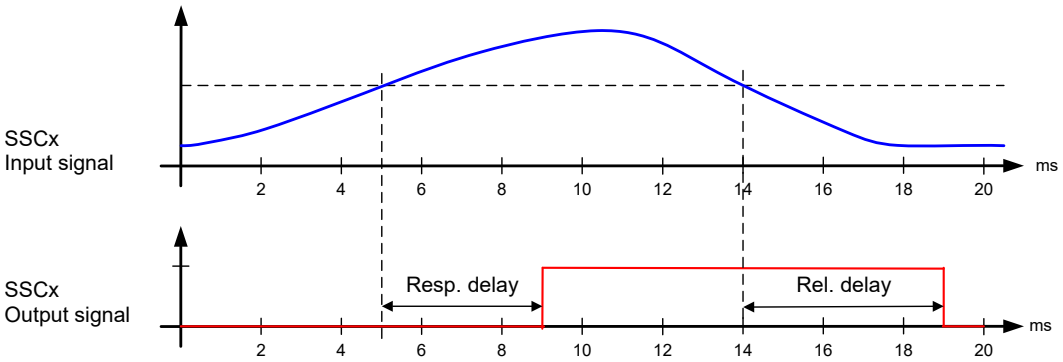
With the function *Timing SSCx* you can set the following time-related behavior:

- Switching on delay (*Response Delays*)
- Switching off delay (*Release Delays*)
- Min. pulse duration/pulse duration extension (*Minimal Pulse Duration*)

The individual functions must be activated. Response and release delays can be activated separately.

Example of response and release delay

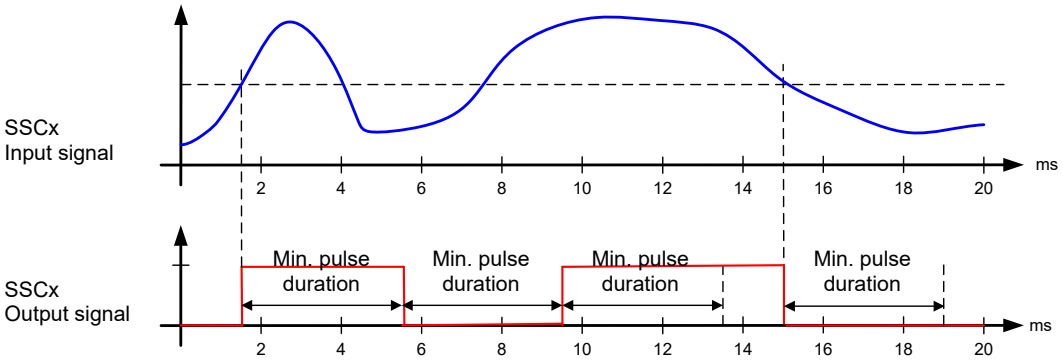
- *Response Delay.SSCx Time*: `4 ms`
- *Release Delay.SSCx Time*: `5 ms`



Ill. 15: Response and release delay

Example of minimal pulse duration

- *Minimal Pulse Duration.SSCx Time*: `4 ms`
- *Minimal Pulse Duration.SSCx Mode*: `1` (positive and negative)



Ill. 16: Minimal pulse duration

IO-Link Parameter: parameterization of the SSCX timing (SSCx delays)

Parameter designation	Description
Response Delay.SSCx Enable	Enabling/disabling of the SSCx response delay. ▪ 0: Disabled ▪ 1: Enabled
Response Delay.SSCx Time	Setting the time span for the response delay (in ms).
Release Delay.SSCx Enable	Enabling/disabling of the SSCx release delay. ▪ 0: Disabled ▪ 1: Enabled
Release Delay.SSCx Time	Setting the time span for the release delay (in ms).
Minimal Pulse Duration.SSCx Enable	Enabling/disabling of the SSCx minimal pulse duration. ▪ 0: Disabled ▪ 1: Enabled
Minimal Pulse Duration.SSCx Time	Setting the minimal pulse duration (in ms).
Minimal Pulse Duration.SSCx Mode	Setting the pulse direction of the minimal pulse duration. ▪ 1: Positive and negative ▪ 2: Positive ▪ 3: Negative

7.4 Diagnosis

In the *Diagnosis* register you can activate the remote operation and see various device status and warning messages.

7.4.1 Remote operation

The remote operation is used for test purposes and for easy commissioning of the measurement amplifier. In remote operation, a parameterizable input signal is simulated instead of the input signal of a loaded sensor (mV/V).

IO-Link parameter: parameterization of the remote operation (Remote Signal)

Parameter denotation	Description
Remote Operation Signal.Enable	Activation/deactivation of remote operation (during activation the current applicable measured value is adopted as the remote signal): ▪ `0`: Deactivation ▪ `1`: Activation
Remote Operation Signal.Selection	Selecting a signal that can be set in the parameter *Remote Operation Signal.Value*: ▪ `1`: *Physical Input Signal (mV/V)*
Remote Operation Signal.Value	Setting the parameter for the signal defined in *Remote Operation Signal.Selection*.

7.4.2 Device Status / Error Handling

With this function you can access various device statuses and warning messages. Depending on the operation state, a quality bit or an alarm bit is set.

Parameter denotation	
Device Status	Operating status of the amplifier electronics: ▪ `0`: Device is operating properly ▪ `1`: Maintenance required ▪ `2`: Out of specification ▪ `3`: Functional check (Remote mode) ▪ `4`: Failure (highest priority)
Detailed Device Status	For details see the attached table.

8 Preventive maintenance

The sensor is maintenance-free. No special preventive maintenance is required. Regular cleaning and regular checking of the plug connections are recommended.

8.1 Cleaning the device

Exterior cleaning

When cleaning the exterior of the device, make sure to use cleaning agents that do not affect the housing surface and seals.

NOTICE

Material damage due to improper cleaning.

Unsuitable cleaning agents and methods can cause leaks and damage the device, the seals, or the connections.

a) Always check the suitability of the cleaning agent for the surface to be cleaned.

b) Do not use scouring agents, solvents, or other aggressive cleaning agents.

c) Do not use jets of liquid for cleaning, for example, a high-pressure cleaner.

d) Do not scrape off contamination with sharp-edged items.

Interior cleaning

No interior cleaning of the device is required.

9 Annex

Also see about this

Error Handling [▶ 52]

Error Handling

Description	Condition	Device Status				Cyclic Data			Analog Output
		Value	Detailed Hex	Detailed Dez	Typ	Quality Bit	Alarm Bit	Process Value	
Process value outside of nominal range	> 1 · Nominal process value	1	0xE4, 0x18, 0x00	6144	Warning	1	Not affected (n. a.)	Not affected (n. a.)	Not affected (n. a.)
	< -1 · Nominal process value		0xE4, 0x18, 0x01	6145					
Process value out of measurable range	> 2 · Nominal process value	4	0xF4, 0x18, 0x02	6146	Error	n. a.	1	Out of Range (+) (+21'001)	Alarm
	< -2 · Nominal process value		0xF4, 0x18, 0x03	6147				Out of Range (-) (-21'001)	
Analog output out of range	> Analog output maximum	2	0xE4, 0x18, 0x04	6148	Warning	1	n. a.	n. a.	Alarm
	< Analog output minimum		0xE4, 0x18, 0x05	6149					
Input signal out of range	Outside of ±3.8 mV/V	4	0xF4, 0x18, 0x06	6150	Error	n. a.	1	Out of Range (+) / Out of Range (-) (±21'001)	Alarm
	Short / open wire		0xF4, 0x18, 0x07	6151					
Parameters are set, so that nominal process value range is outside of measurable input range.	120% Nominal value → >3.8mV/V	2	0xE4, 0x18,0x08	6152	Warning	1	n. a.	n. a.	n. a.
	-120% Nominal value → <-3.8mV/V		0xE4, 0x18, 0x09	6153					
Primary supply voltage over-/underrun	>30V	2	0xE4, 0x51, 0x10	20752	Warning	1	n. a.	Potentially out of specification	
	<18V		0xE4, 0x51, 0x11	20753					
Simulation active	Input signal is set remotely	3	0xE4, 0x8C,0x01	35841	Warning	1	Simulated		
Component malfunction		4	0xF4, 0x50, 0x10	20496	Error	n. a.	1	No Data (21'100)	Alarm

List of illustrations

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